

Burning water – the state, irrigation technology and the production of scarcity in Spain

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Abstract

Through studying the adoption of groundwater abstraction technology in the twentieth century in La Mancha, this research investigates the historical role of the state in the development of modern groundwater-fed irrigation in Spain between the 1940s and 1985. By focusing on the Mancha Occidental aquifer and the Las Tablas de Daimiel wetland, this study also scrutinizes how the adoption of groundwater abstraction technology led by the state fed back into the environment through ecosystem degradation and groundwater scarcity at the local and regional level.

This research examines the relationship between the state, groundwater irrigation, local communities and the environment in Spain. By studying irrigation and colonisation politics in Spain – exemplified by the town of Llanos del Caudillo in La Mancha – and the adoption of groundwater abstraction technology in Manzanares, this investigation aims to ‘bring the state back’ into irrigation and groundwater studies in Spain. This topic connects theories of nature, statecraft and technology within the established literature on groundwater irrigation in areas of high water variability and stressed ecosystems. The aim of this work is to provide a historically grounded analysis of how the state has influenced the adoption of groundwater abstraction technologies and, furthermore, its impact on groundwater socio-ecologies in La Mancha between 1940 and 1985.

Making use of Latour’s (1992) ‘hybridity of mundane objects’ and Foucault’s (1988a) concepts of political technology and state governmentality, this thesis allows for the simultaneous study of different modalities of state rule and the use of technology. The aim of this work is to reconcile these two theories and portray irrigation in La Mancha as a complex entity, enabling the state to directly and

indirectly construct political, economic and socio-natural relations between groundwater users and the environment.

By examining the historical links between technology adoption, statecraft and ecological change, this study explores the different ways through which the state has taken a prominent role in producing groundwater-fed irrigation socio-ecologies. Additionally, it traces the socio-political mechanisms involved in the progressive desiccation of the Las Tablas de Daimiel wetland and its transformation into a burning dryland. The natural and social conditions of La Mancha with its semi-arid climate and history make this region a prominent example for the study of the relationship between water, the state and the environment.

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List of acronyms and abbreviations

AEMET	<i>Agencia Española de Meteorología</i> , Spanish Meteorological Agency
ANT	Actor-Network Theory
BOE	<i>Boletín Oficial del Estado</i> , Official State Bulletin
CHG	<i>Confederación Hidrográfica del Guadiana</i> , Guadiana River Basin Authority
FAO	Food and Agriculture Organisation
GDP	Gross Domestic Product
Ha	Hectare
IBRD	International Bank of Reconstruction and Development
IGME	<i>Instituto Geológico y Minero de España</i> , National Institute of Geology and Mines
INC	<i>Instituto Nacional de Colonización</i> , National Institute of Colonisation
IRA	<i>Instituto de Reforma Agraria</i> , Institute of Agrarian Reform
IRYDA	<i>Instituto de Reforma y Desarrollo Agrario</i> , Institute of Agrarian Reform and Development
PEAG	<i>Plan Especial Alto Guadiana</i> , Special Plan of the Upper Guadiana
Pta	Peseta (Spanish currency)
Mm ³	Million cubic metres
SNCA	<i>Servicio Nacional de Crédito Agrícola</i> , National Service of Agrarian Credit
SNREST	<i>Servicio Nacional de Reforma Económica y Social de la Tierra</i> , The National Service of Economic and Social Reform of the Land
USD	United States Dollar

LANGUAGE NOTE

This work includes the translation of words, expressions, and quotations from Spanish into English. Original quotes from interviewees have also been translated. Despite the fact that the author of this thesis is a native Spanish language speaker and that efforts have been made to maintain the original meaning of the words, the translation of colloquial oral expressions might have slightly altered their original meaning. In some instances language notes referring to the original terms in Spanish have been added for disambiguation, clarity and accuracy purposes.

“‘What makes the desert beautiful’, said the little prince, ‘is that somewhere it hides a well...’”

Antoine de Saint-Exupery, 1943, *The little prince*.

*“De todas las historias de la Historia
sin duda la más triste es la de España,
porque termina mal. Como si el hombre,
harto ya de luchar con sus demonios,
decidiese encargarles el gobierno
y la administración de su pobreza.”*

Jaime Gil de Biedma, 1966, *Apología y Petición*.

*“Si hay en Europa regiones a las que se pueda – únicamente – aplicar el dictado de
desiertas, son éstas: la Tierra de Campos, la Mancha...”*

Azorín, 1967, *La Amada España*.

*“hay un puente sobre el cual pacen todo el año más de diez mil carneros: este puente
es el terreno bajo el cual corre oculto el Guadiana durante siete leguas”*

Andrea Navajero, 1525, *Viaje por España*.

Chapter 1 . Introduction

On the 26th of August 2009 smoke from peat burning underground appeared through small crevasses around the Las Tablas de Daimiel wetland in La Mancha, Spain. This iconic image spread rapidly across national and international media dramatically capturing the growing concerns of the ‘water crisis’ in Spain and globally (EL PAIS 2009; The Guardian 2009). The ‘burning water’ of La Mancha was set in the historic landscape of parched and dry lands where Don Quixote once fought imaginary demons. But how imaginary or modern was this ‘burning water’? What processes had conspired to lead to one of Europe’s most significant wetland areas self-combusting? Beyond the media hype the explanation goes beyond some of the narrower academic explanations of a groundwater ‘silent revolution’ (Fornés et al. 2005; Llamas and Martínez-Santos 2005a) but involves the complex and historical interactions of the state, technology, markets and agrarian reform. This thesis sets out to examine and analyse the politico-historical emergence of ‘burning water’ in La Mancha within the broader canvas of escalating groundwater governance and management challenges across the developed and developing world.

With these events vivid in people’s collective memory, it is hard to contemplate the immensity of La Mancha’s plains and not feel immersed in “a dateless synopsis of its own past” (Geertz 1980: 3). As a visitor, such anachronistic perception somehow still resonates in the towns of La Mancha and in the daily activities of its inhabitants. The vastness of these plains, populated by vines under the sun is somewhat overwhelming and yet human imprint on these landscapes has persisted and endured through time. Since medieval times, La Mancha has been a land

of contrast: a cruel natural southern frontier in Islamic times, with asphyxiating summers and ruthless winters. Nature and the environment have also given character and identity to the inhabitants of Castile, the '*Tierra de Campos*' (land of fields), and the 'desert of La Mancha' as Azorín¹ portrayed it. In spite of these challenges and as a manifest of a socio-natural relation binding its people with nature, the environment has allowed for the development of agriculture. Intensive irrigation with modern technology appeared more than 50 years ago, at first making use of traditional methods of dry farming with small irrigation plots and norias.² Later, the advent of modern boreholes and intensive agriculture sustained the livelihoods of farmers, their families and the development of the region. Arising from this landscape, the aim of this research is to provide new knowledge of state rule in relation to irrigation in Spain: to place the state in its historical context and to subsequently identify the state practices involved in the development of irrigation and groundwater abstraction and their interrelated socio-environmental processes.

1.1 Research context and aims

Groundwater is an important resource for irrigation. Worldwide, 70 percent of all groundwater abstraction is used for irrigation and in Spain abstractions of

¹ Azorín, writer and poet of the end of the nineteenth century was part of the cultural and social movement of the Generation of 1898. As a movement, the Generation of '98 shared above all the main consequences of the 1898 tragedy (i.e. the loss of the colonies) (Franco 1964 in Abellán 1973) expressed by a generation of writers and thinkers such as Unamuno, Azorín or Machado. The culmination of the decadence represented by this national tragedy in 1898 provoked a re-examination of the national conscience of the country, which became the main common attribute of the Generation of 98 (Abellán 1973). As described by Carr (1966: 528), they had no direct political influence though but their interest lies, as Carr wrote "in the tone they gave to the minds of a generation that come to the fore in the 1930's, and in their literary restatement of the problems of regeneration."

² *Language note:* Traditional groundwater abstraction technologies used in Spain, similar to the Persian water wheel. See Chapter 2 for a more detailed explanation.

groundwater for agriculture represent around 25 percent of the total groundwater use (Fornés et al. 2005; Llamas and Garrido 2007). Groundwater management is a well-documented area of academic research and includes cases from the United States (Kepfield 1993), India (Birkenholtz 2009; Dubash 2002), South Asia (Shah 2009), and Spain (Llamas and Martínez-Santos 2005a; Lopez-Gunn 2003). At an analytical level, these examples share a focus on the role of private initiative of thousands of farmers individually drilling wells and developing groundwater-fed irrigation. This process, called by some authors a 'silent revolution' (Fornés et al. 2005; Llamas and Martínez-Santos 2005a) postulates that the farmers' private initiative remains at the core of the process of groundwater development, over-abstraction and ecological degradation.

Similarly, notable studies on state-led water politics comprise Germany (Blackbourn 2007), India (Mehta 2001), Mexico (Wester et al. 2009), the United States (Reisner 1993; Worster 1992) and Thailand (Molle 2007). Recent investigations on water politics in Spain have also focused on the development of hydraulic politics with surface water infrastructures as the basis for their analysis (e.g. Lopez-Gunn 2009; Sauri and del Moral 2001; Swyngedouw 1999, 2007, 2013). Through their conceptualisation, it is possible to find in these studies the imprint of Wittfogel's (1957) theses on hydraulic societies. Wittfogel used centralised irrigation and water projects in Asia to develop his theses on hydraulic societies which he conceived as ruled and controlled by the state through structured bureaucratic systems. Within these studies however the underlying mechanisms of what Allan (2005) has called the hydraulic mission are still poorly understood. Much of the literature on hydraulic bureaucracies tends to minimize the role and impact of

hydraulic infrastructures on local communities and present a reductionist approach of the evolution of water management regimes (Molle et al. 2009).

More recently, attempts have been made to expand such views. Irrigation policy reforms became the subject of an edited book by Mollinga and Bolding (2004), and river basins as socio-environmental objects were the focus of Molle and Wester's (2009) compiled volume. Institutional reform has also been scrutinised by water policy analysts. Focusing on Australia, Crase and Gandhi (2009) have provided us with a general view of broad institutional reforms for water resource management whilst Feitelson and Fischhendler (2009) describe with a scalar perspective the institutional arrangements affecting the water governance system in Israel. With these examples, exploring political and managerial structures embedded within socio-natural systems, the state has become contextualised within a more complex web of institutions, actors and policies. However there are still limits to what current approaches on the hydraulic mission can analyse. These would appear to be partially limited by the emphasis of these studies on macro-level state politics and state rule and the lack of analysis of the local impacts of hydraulic politics.

Thus, a first lacuna arising from this body of work is the extent to which the state and state politics affect the development and management of water at the local level. In addition, the development of groundwater abstraction for agriculture in Spain during the 1960s and 1970s has been left outside the reach of the state and analytically relegated to the drive and opportunistic behaviour of farmers – i.e. the ‘silent revolution’ (Fornés et al. 2005; Llamas and Martinez Santos 2005a). Accordingly, a second lacuna appearing is whether the state had any role in the historical development of groundwater abstraction in Spain.

This research seeks to reconcile these two lacunae by examining the relationship between the state, groundwater irrigation, local communities and the environment in Spain. By studying irrigation and colonisation politics in La Mancha – exemplified by the town of Llanos del Caudillo – and the adoption of groundwater abstraction technology in Manzanares, this investigation aims to ‘bring the state back’ into socio-political studies of groundwater in Spain. In order to avoid falling into the state-centred hydraulic reductionist trap, this thesis will theoretically and empirically frame the development of state irrigation politics within the context of locally produced groundwater socio-ecologies. The study of groundwater socio-ecologies and irrigation technology in India and South East Asia by authors such as Birkenholtz (2006), Mollinga (2003) Mosse (2003), and Shah (2009) provides the lens through which to study the development of groundwater irrigation. Given the fact that such focus has rarely been used in the European context, this research represents an opportunity to test the replicability of such approach in a different geographical context.

Following from this, a theoretical framework has been established allowing for the simultaneous study of different modalities of state rule and the use of technology. Latour’s (1992) ‘hybridity of mundane objects’ and Foucault’s (1988a) concepts of political technology and state governmentality have been combined to characterise groundwater abstraction technologies (i.e. groundwater wells) as material and political structures. By focusing on this essential duality, the aim of this work is to reconcile these two theories and portray irrigation in La Mancha as a complex entity, enabling the state to directly and indirectly construct political, economic and socio-natural relations between groundwater users and the environment.

The conceptual nature of this research employs a methodology based on qualitative and quantitative data in order to examine the different facets of the adoption of groundwater abstraction technology in La Mancha. During the course of these investigations, a series of historical records (national archives from the Ministry of Agriculture and local archives from the community of irrigators in Manzanares) were identified, collated and analysed. Along with interviews and field visits, used to triangulate the archive records and generate more nuanced qualitative data, these previously unseen materials provide the empirical basis used to develop the theoretical arguments of this thesis and have contributed to new insights in the involvement of the state in irrigation in La Mancha.

The natural and social conditions of La Mancha with its semi-arid climate and history make this region a prominent example for the study of the relationship between groundwater, the state and the environment. By examining the historical links between technology adoption, statecraft and ecological change, this study explores the different ways through which the state has taken a prominent role in producing groundwater-fed irrigation socio-ecologies. Additionally, it traces the socio-political mechanisms involved in the progressive desiccation of the Las Tablas de Daimiel wetland into a burning peatland. The findings of this research provide insights into a more complete story about the adoption of irrigation in Spain and the impacts on the environment. This topic connects theories of nature, statecraft and technology within the established literature on groundwater irrigation in areas of high water variability and stressed ecosystems. The aim of this work is to provide a historically grounded analysis of how the state has influenced the adoption of groundwater abstraction technologies and, furthermore, its impact on groundwater socio-ecologies in La Mancha between 1939 and 1985.

This research has four specific objectives. First, to explore the social, political and environmental elements driving the development of groundwater irrigation in Spain. Second, to examine the characteristics of the adoption of groundwater abstraction technology and the historical role of the state in the development of modern irrigation and groundwater abstraction in La Mancha. Third, to understand the hydraulic mission in Spain by focusing on the role of the state in the development of local groundwater-fed irrigation infrastructure. Fourth, to understand the capacity of technology and the role of the state in shaping groundwater socio-ecologies in La Mancha and producing water scarcity in the Mancha Occidental aquifer and in the Las Tablas de Daimiel wetland.

1.2 Burning landscapes, the state and hydraulic societies

1.2.1 Understanding the burning landscapes of La Mancha

La Mancha epitomises certain socio-cultural characteristics and references related to the aridity of the land, the coarseness of its climate and the myth of Don Quixote dating as far back as the seventeenth century. These traits are embedded in its landscapes and inhabitants and still resonate today within the common Spanish mentality. Across these landscapes we find irrigation artefacts such as norias and boreholes acting as material expressions of traditional rural cultures that make use of groundwater.³ By focusing on these groundwater abstraction technologies it is

³ This type of socio-cultural trait has an impact on the cultural construction of the landscape. From the cultural aspects attributed to landscapes (Cosgrove 1993) to linguistic and literary studies by Baudrillard (1994) or Bender (2006) and symbolic studies reflecting on the mythology of landscape (Pringle 1988; Smith 1950), these studies share the representation of a reshaped cultural identity and geography linked to the landscape and the use of natural resources. See Chapter 4 for further analysis

possible to contextualise, as Baker (1992: 3) wrote, the study of the production of irrigated landscapes “within its own natural and cultural history – its own ancestry and upbringing”. As Baker (1992: 3) also put it, the historical study of the landscape must be “grounded in an analysis of material structures [...] properly concerned with tangible, visible expressions of different modes of production, with hedgerows and field systems, with canals and factory systems.”

This analytical mindset can also be linked to Swyngedouw’s (1999: 444) concept of ‘waterscape’ in Spain where the social, economic, and ecological landscape cannot be understood “without [...] explicit reference to the changing position of water in the unfolding of Spanish society”. On a wider theoretical level, it also connects with the concept of political ecology directed, according to Paul Robbins (2004: 12), “at finding causes rather than symptoms of problems” and critically explaining “what is wrong with dominant accounts of environmental change”. Following the influence of political ecology, this study intends to unveil the relations behind certain socio-environmental conditions and to cut and prune away “the stories, methods, and policies that create pernicious social and environmental outcomes” (*ibid.*).

Building on these theoretical premises, this research seeks to explore society's interaction with the environment through the study of the use of technology for irrigation in Spain. As Mosse (2003: 302) wrote, “standard narratives of degradation have to be replaced by detailed political histories of resource control”. In La Mancha, stories about groundwater wells help contextualise water management and irrigation within the political and social evolution of twentieth century Spain and reflect the social and political story behind these instances of burning peat. This study provides

on how some of these aspects associated with the ‘rurality’ of landscape were ideologically used by Franco during his dictatorship.

an explanation of the socio-politically induced change experienced by La Mancha's natural ecosystems and identifies the political mechanisms of state rule in the production of irrigated landscapes in La Mancha. By looking at the key role of technology in structuring the relationship between the state, society and the environment, this investigation will also examine politically fabricated aspects of water scarcity, induced by the interaction between humans and the environment.

1.2.2 The state and hydraulic societies

Despite the fact that Wittfogel's (1957) work on hydraulic bureaucracies arose from the study of total state rule in Eastern cultures, it is difficult to avoid its wider relevance when it comes to dealing with one aspect: assessing the social and historical conditions of the role of the state in the appropriation of nature (e.g. water for irrigation) (Peet 1988). Following Molle et al. (2009), the development of hydraulic bureaucracies and large-scale water infrastructure has been a defining feature of state building during the 20th century. During this historical period, states became endorsed within "the role of (large-scale) developer of water resource" as part of a process of public legitimisation, investment and development (Molle et al. 2009: 332). This thesis is located within the same tradition of research in that it explores the hydro-political context of state politics and "the socio-natural production of nature" (Swyngedouw 2007: 24) in the context of Spain between 1939 and 1985.⁴

⁴ Studies outside the historical scope of this research have shown that the hydraulic mission in Spain has not been static and that a change in paradigm occurred after the end of Franco's dictatorship in 1975 (Lopez-Gunn 2009; Sauri and del Moral 2001; Swyngedouw 2013). The water management regime in Spain was also transformed between the end of the nineteenth century and the final years of Franco's dictatorship. While the former was characterised by ideas of water as private property, the latter involved increasing attempts by the state to centralise its regulation and management of water

As referred by Molle et al. (2009), in spite of the understanding of hydraulic societies as essential for building and managing water management structures, one of the limitations of this approach is the need to unpack the notion of the ‘hydraulic mission’. This would involve further expansion of the reasons for the strength and persistence of particular hydro-political constructions, as called by Swyngedouw (2007), as well as to understand in what ways irrigation has played “different roles in state formation” (Molle et al. 2009: 344).

The hydraulic mission arising from Wittfogel’s study also brought excessive emphasis on state bureaucracies taking a central stage whilst avoiding ‘the matter of scale’ (Perry 1988: 79). The study of central political processes and the role of formal institutions in water management at the state level have the potential to detract attention from micro-processes operating at the local level. Similarly, research on both informal institutions and local aspects of irrigation politics could overlook the overarching aspects found in state water politics. This research builds on the above-mentioned notions, tackling the complex task of reconciling centralising water management bureaucracies and state-rule on local communities and individuals. For these reasons, a theoretical framework has been chosen which combines the analysis of groundwater irrigation at the local level in Manzanares and Llanos del Caudillo with the study of central state irrigation politics.⁵ As will be presented later, the use of governmentality (Foucault 1988a) bridges the gap between the locality of groundwater abstraction and the centrality of state politics in order to simultaneously

(Costejà et al. 2004). This new historical context re-allocated administrative and political power to the regions in Spain and gave birth to a new regime of water governance characterised by a high degree of political, institutional and legal complexity (*ibid.*). Local and regional environmental organisations were set up in order to challenge the monolithic views of the state on nature and the preservation of the environment (Corral Broto 2008; Costejà et al. 2004).

⁵ See Chapter 3 for a detailed map of the study area.

address the role of the state in the development of irrigation and its impacts on local communities.

1.2.3 Studying ‘the state’

In this research, considering ‘the state’ as a monolithic and independent entity can present some conceptual and analytical limitations especially due to the changing historical context of the period examined. This section introduces some key characteristics arising from existing literature in order to clarify the understanding of what is meant by ‘the state’ and its role in the development of irrigation policies within the political and historical analytical framework of this study.

The state is the main subject of analysis and the main agent of development and rule in irrigation. A key insight, encapsulated in the book *Bringing the state back in* by Evans et al. (1985) relates to studying the state as an agent shaping social and political processes. This notion was originally developed through state-centered research approaches arising in the 1980s and focused on “the state’s distinctive administrative powers – especially those rooted in its capacities to produce and enforce collectively binding decisions within a centrally organised, territorially bounded society” (Jessop 2006: 118). However, this type of approach has not remained unchallenged. As Jessop points out, Evans’ work is often criticised for focusing “one-sidedly on state and party politics at the expense of political forces outside and beyond the state” and above all positing “clear and unambiguous boundaries between the state apparatus and society, state managers and social forces, and state power and societal power” (Jessop 2006: 119).

Amidst a large variety of theoretical contributions to the definition and characterisation of the state – e.g. Marxist, feminist, discursive and relational (Jessop 2006) – that used as a guiding premise in this thesis is Foucault’s consideration of the state through the lens of governmentality. As discussed by Jessop (2006: 120), Foucauldian approaches find the state as a:

“crucial site of statecraft and ‘governmentality’ (or governmental rationality). What interested him was the art of government, a skilled practice in which state capacities were used reflexively to monitor the population and, with all due prudence, to make it conform to specific state projects.”

In his approach Foucault does not reject the central role of state institutions in the regulation and ruling of society but rather allows for a more prevalent and pervasive notion of power within society. As works by Dean (1999) and Agrawal (2005) make clear, there is a large body of literature drawing on Foucault’s concepts of power and government. As Agrawal (2005: 219) suggests, Foucault’s concept of governmentality has increasingly been used in the context of liberal regimes “to trace the history of changing forms of governmental authority and practice in the West”. Moreover, the use of governmentality allows moving “around familiar questions about the nature of the state and the extent to which states shape social processes” (Agrawal 2005: 223). However Dean (1999) has focused on the role of governmentality in authoritarian governments, used by Foucault himself to study National Socialism in Germany (Foucault 1979 in Dean 1999: 141). In the study of either liberal or authoritarian governments, the key issue is that modern states “can be understood as different articulations of forms of pastoral power with forms of

sovereignty” (Dean 1999: 138). Thus different types of state rule other than liberalism “are no less distinctive assemblages of elements of a bio-politics concerned with the detailed administration of life and of sovereign power that reserves the right of death to itself” (*ibid.*).⁶

During Franco’s dictatorship in Spain (1939-1975), the state was the sole receptacle of authority, social, economic and political control over citizens. As defined by Carr and Fusi Aizpurua (1979), after winning the Civil War Franco sought legitimacy within Spain through the development of a complex social and political system. He united under his rule different ‘institutionalised families’ such as the Nationalist army, the Falange⁷ and the church, within a single political regime ideologically based on fascist principles. As Rutledge Southworth points out, (1976: 2) fascism in Spain was:

“brought to birth by the class struggles of its epoch. From the basic doctrinal texts of Spanish fascist leaders, an outline of the proposed seizure of the Spanish state by the Spanish fascists has been constructed. The first phase of this programme was the *formation of the movement*. It had to have a national organization, form leaders and militants. [...] After this first phase of the plan had been completed, after the movement had been organized, the second phase, the conquest of the state, would be undertaken. This state was to be a totalitarian state, each Spaniard had to be situated in the place where he could

⁶ In Foucault’s wider theoretical framework, bio-politics is a term used “for a form of politics, conducted largely since the eighteenth century, concerned with the administration of the conditions of life of the population” (Dean 1999: 209).

⁷ The Falange was a right-wing fascist political party founded in 1933 during the Second Republic by José Antonio Primo de Rivera. During the Civil War it supported Franco’s uprising, previously formalised in February 1934 under a political alliance of right wing parties. After the Civil War, Franco unified the Falange and other right wing parties and groupuscules into one only legal political party, the *Falange Española Tradicionalista y de las Juntas de Ofensiva Nacional Sindicalista*, giving Franco’s political movement its fascist veneer (Payne 1961; Preston 1995).

best serve this state. The totalitarian state was to be solidly anchored on the rock of Spanish unity [Emphasis in original].”

Franco aimed therefore to unify the Spanish state territorially, politically and socio-economically, which meant “the strengthening of the central power in Madrid, and the ruthless suppression of the movements for regional autonomy in Catalonia, the Basque country and Galicia” (Rutledge Southworth 1976: 2). Additionally, existing trade unions would be abolished and “national-syndicalist ‘vertical’ unions would be formed to take their place” (Rutledge Southworth 1976: 3). In spite of these ideals however, as Carr and Fusi Aizpurua (1979: 26) wrote, Spain “never became the totalitarian imperial state of Falangist dreams”. The Falange defined as the expression of fascism in Spain “neither triumphed as a mass party nor became the axis of a one-party state” (*ibid.*). For these authors, neither Franco nor the other conservative political families wanted this type of party. “They preferred the rule of one man to the rule of a party. [...] Franco still attributed to it an important political role. But as a party it increasingly faded away into the wider, vaguer Movement” (*ibid.*).

In spite of the fact that the regime suffered various internal readjustments based on the allocation of elites, political allegiances and power, this research is interested in the mechanics, practices and manifestation of state rule in the context of irrigation politics rather than the nature and evolution of the state per se. Thus, the quote ‘*bringing the state back in*’ does not entail the study of the state following state-centered theories (Jessop 2006), but is a way to complement the study of hydro-politics in Spain (Swyngedouw 1999, 2007) by re-engaging the study of the use of technology for irrigation and groundwater abstraction with state politics. In this context, the study of the state is a way to historically contextualise public rule within

the period analysed (i.e. Franco's dictatorship between 1939 and 1975), a time during which the state represented the most important expression of public rule in irrigation politics.⁸

1.3 Structure of the dissertation

The theoretical and empirical body of this dissertation is structured in six main chapters. Chapter 2 introduces the theoretical and conceptual framework used to analyse groundwater lifting technology, the role of the state in the development of groundwater socio-ecologies and the production of water scarcity in La Mancha. Chapter 3 describes the study site and presents the mixed methods approach used to gather quantitative and qualitative data for this thesis. It also analyses some of the research limitations encountered during the fieldwork arising from the use of oral history and historical archive records.

Chapter 4 presents a historical overview of the evolution of irrigation and colonisation politics in Spain. This chapter introduces the antecedents of colonisation politics in Franco's Spain and presents the state as a major actor in the development of agriculture and agrarian reforms through changing political regimes during the twentieth century.

⁸ There are limitations to considering the state as a single entity and approaching the study of it with a single analytical framework. As a result, this thesis is not directly concerned with the multiplicity of internal political, social, and economic processes, private and public actors and interests affecting the distribution of power and organisation of state institutions during the period studied. To counteract this potentially monolithic view of the state, descriptions of specific ministerial regulation, administrative control and powers with emphasis on groundwater regulation have been included (See Chapter 3 and Chapter 7). Specifically referring to water politics in Spain, Swyngedouw (2007) has established the influential role of networks of interest such as powerful landowners and the Corps of Civil Engineers in the development of Franco's regime hydro-political agenda and centralized water management plans. The authors Pérez-Díaz et al. (1996) have called these networks a 'community of hydraulic politics'. For these authors, the coincidence of interests and homogeneity of technical criteria for hydraulic projects along with the fluidity of communication and contacts inside the administration guaranteed the stability to the traditional hydraulic paradigm.

Chapter 5 expands on the previous chapter and focuses on the role of the state in the development of colonisation and irrigation plans at the local level, illustrated by the case study of Llanos del Caudillo. An analysis of the planning and construction of this colonisation town and the creation of new ‘irrigation subjects’ (i.e. settlers) will exemplify the use of political technologies to exercise state control and regulation over social and economic aspects in the agrarian community of Llanos del Caudillo. Based on original historical records, this chapter also presents the state-led plans to develop groundwater abstraction technology for intensive irrigation in La Mancha.

Chapter 6 describes the evolution of groundwater abstraction technologies from traditional to modern in Manzanares. This chapter presents and analyses unpublished data on the characteristics of groundwater abstraction technology and the process of adoption of modern groundwater technology in La Mancha. This chapter also complements the previous chapter and gives additional insights into the process of adoption of modern groundwater abstraction technology in La Mancha. It also includes a quantitative assessment of the data gathered about the adoption of groundwater abstraction technology in Manzanares.

The aims of Chapter 7 are twofold. First, it re-introduces the state in the development of groundwater-fed irrigation by examining the role of state subsidies for agriculture and the modernisation of irrigation and public water legislation to regulate groundwater abstractions in La Mancha. Second, it looks at the role of groundwater abstraction technology in mediating and sustaining socio-ecological change and groundwater depletion in the natural environment of Las Tablas de Daimiel wetland, illustrating the intricate relationships that occur within groundwater socio-ecologies.

Chapter 8 summarises the main findings and presents new research avenues that could be further explored such as the importance of land ownership and the role of social capital in the study of groundwater socio-ecologies in Spain.

Chapter 2 . Theoretical and conceptual framework

2.1 Introduction

This chapter presents the conceptual and theoretical grounds providing insights on the processes and outcomes of different modalities of state and technology impacts on socio-ecological systems and the social and political production of water scarcity in La Mancha. The structure of this chapter is as follows. The second section reflects upon the need to integrate new approaches to the study of technology based on the concept of hybridity of ‘mundane objects’ (Latour 1992). By conceptualising the groundwater well (and by extension irrigation technology) as hybrid structures, both material and symbolic, it is possible to understand irrigation as a ‘political technology’ and its social, political and environmental consequences. However, due to the fact that Latour’s hybridity theory does not account for modalities of state-rule (Wainwright 2005), the third section draws from theories of state governmentality (Agrawal 2005; Foucault 1988a) to understand the scope and use of irrigation as a political technology by the state and its impacts on society, agriculture and the creation of new environmental subjects (i.e. irrigation settlers) at the local level. The fourth section then turns to the context of Spain and describes how this type of political and socio-ecological practices have participated in the creation of water scarcity as the underlying mechanism of the adoption of modern groundwater abstraction technology in La Mancha. Finally, the last section illustrates with a unifying conceptual framework the different theoretical strands that have been applied to the case study material.

2.2 The hybridity of groundwater abstraction technologies and irrigation

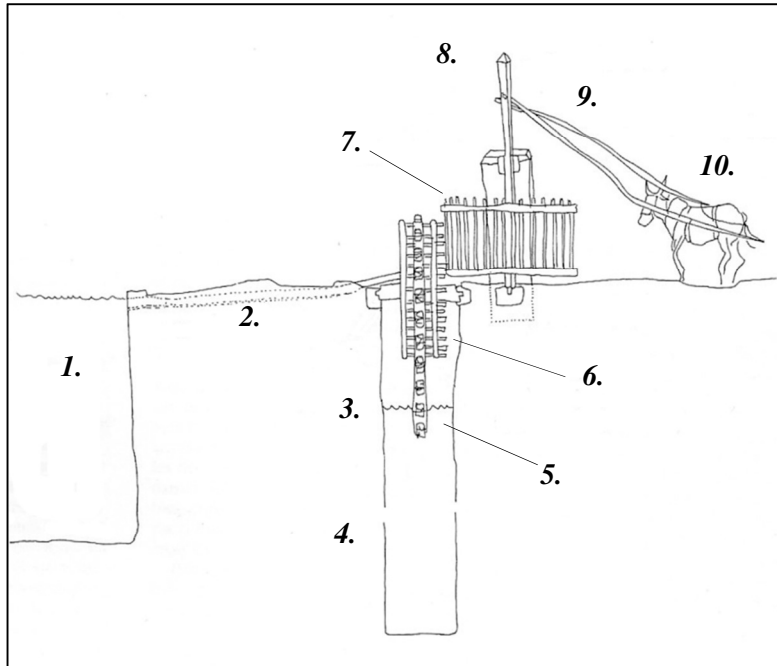
2.2.1 Material technologies for groundwater abstraction

In this thesis two different types of technologies to abstract groundwater are investigated: the traditional *noria* (Persian water wheel) and the modern borehole with vertical centrifugal pump. The Persian waterwheel or *saqiya* (Hill 1996; Glick 1970) has been identified as part of the wide array of traditional water lifting instruments used in countries like India or Spain to lift groundwater for irrigation (e.g. Agarwal and Narain 1997; Birkenholtz 2009b; Giner and Carrion 1999; Glick 1977; Hardiman 1998). The short shaft waterwheel with parallel cogs, (i.e. the *noria*), is the type found in La Mancha since early medieval times (Glick 1992) (Figure 2.1 and Photograph 2.1). In his depiction of this device, Schioler identifies the gear as the crux of these machines, with the function of “altering the motion from horizontal to vertical” (Schioler 1973: 18). The power is then transferred to the machine by the drawbar. The draught animal would usually be,

“a mule or a donkey wearing on its shoulders and neck a collar harness that transmits the power through two traces to a double-tree fastened to the drawbar. The drawbar passes through a hole in the upright shaft. The leading rein, which is attached to a second bar protruding from the shaft, forces the animal to follow the circular track, although it cannot see this because his eyes are blinkered. [...] The pot garland wheel has two functions: it is primarily a

cogwheel, but it also forms the drum that carries the pot garland” (Schioler 1973: 19-20).

Figure 2.1 Diagram of an animal-drawn noria



Note: 1. Water reservoir; 2. Water pipe; 3. GroundWater level; 4. Well; 5. Pot garland; 6. Vertical noria; 7. Horizontal wheel; 8. Upright shaft; 9. Drawbar; 10. Animal.

Source: Based on Malpica Cuello 1995.

Photograph 2.1 Traditional noria in La Mancha, 1950s



Source: Archive, Ministry of Agriculture.

Although the original design of the noria suffered modifications and improvements to adapt it to new technological designs and agrarian necessities, norias had technical and also natural limitations linked to their source of energy (i.e. animal). This limitation made norias impossible to sustain the proliferation of extensive irrigation due to their small water abstraction capacity (Giner 1990; Giner and Carrión 1999).

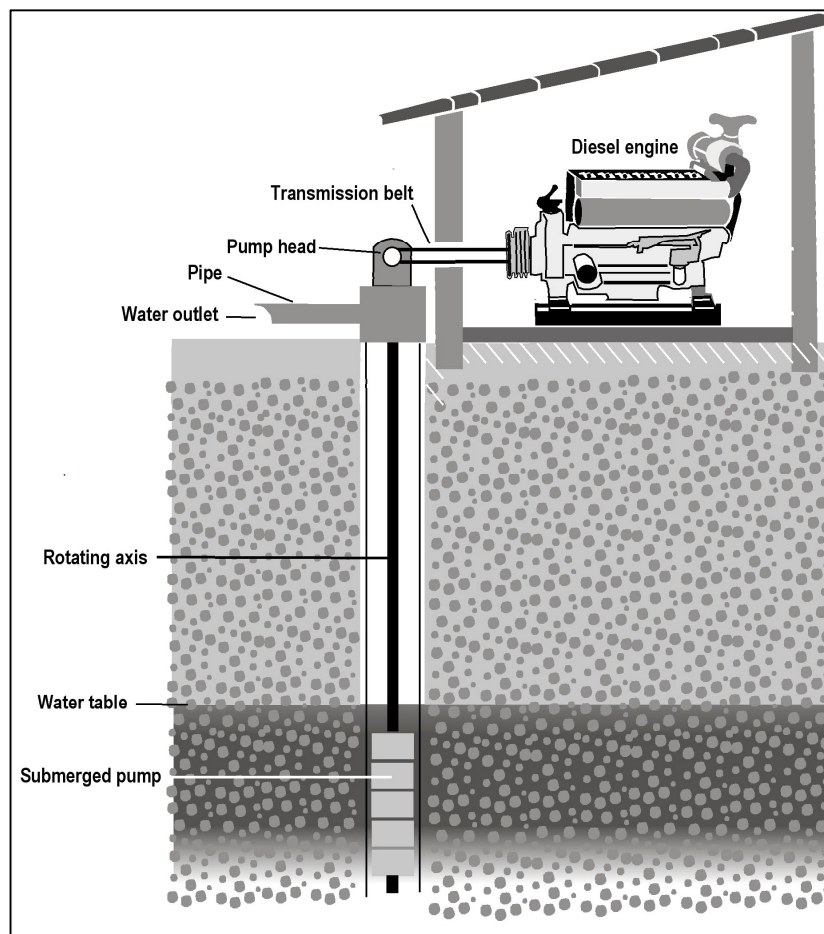
Water lifting technologies powered by gasoline engines began to be used in the United States as early as 1895 and centrifugal pumps in the early 1900s started replacing windmills for the abstraction of groundwater in shallow areas along riverbeds (Kepfield 1993). In the 1920s, vertical centrifugal pumps allowed the deepening of groundwater wells and “freed farmers from interstate rivalries on streams [...] and allowed more diversification of crops” (Kepfield 1993: 240). Later technological developments in the 1930s in the United States allowed the farmers in Nebraska to install high-speed multi-cylindere d engines with geared-heads connecting the engine differential with the pump replaced the old transmission belts (Kepfield 1993).

The end of the Dust Bowl in the Great Plains in the 1930s also provided enough arguments to turn to groundwater irrigation as a more reliable source of water (Kepfield 1993; Worster 2004). Electrification of the countryside in the 1930s and 1940s also helped promote innovation in pump design suited for electricity with more efficient designs and easier maintenance than gasoline pumps (Kepfield 1993). In the Mekong Delta in Vietnam, the innovation of the use of motor pump for irrigation responded to the labour intensive, unproductive, and non-efficient traditional foot-pedal-operated water wheels (Sansom 1969).

According to Israelsen and Hansen (1965), the centrifugal pumps used in boreholes have the advantage of having high performance results, not many failures, low cost and also ease to install and maintain. The pump is connected to an engine on the surface (electric or diesel) through individual sections going down the column of the borehole (Figure 2.2). The turbines or impellers “are suspended on a vertical line shaft that is housed within the pump column which conducts the water to the surface.” (Driscoll 1989: 595). As Driscoll (1989: 596) points out, the column of the borehole is connected,

“at the surface to a discharge head which serves several purposes. It provides a base for a driver [...]; creates a packing box around the shaft, that prevents water from entering the motor; acts as an elbow to divert the discharge into the above ground piping system; and also supports the column pipe in the well.”

Figure 2.2 Diagram of a borehole with diesel engine



Source: Author.

2.2.2 The hybridity of wells: materiality and symbolism of groundwater abstraction technologies

2.2.2.1 Technology studies and hybridity

Technology in its material form has been analysed by a variety of different disciplines: from engineering accounts and technology encyclopaedias (e.g. William's six volumes of *A History of Technology*, 1978) to anthropological studies on material cultures (Hogdes 1964). The social context from where technology is generated has also interested historians examining the evolution of technology or 'the structure of

scientific change' (Fox 1996). Sociologists like Latour (1992, 2005) have also found ways to challenge previous academic studies on technology with new postulates such as Actor-Network Theory (ANT), the social construction of technology by Pinch and Bijker (1996) or the study of cyborg natures (Haraway 1991). As Bakker and Bridge (2006: 18) contend, material studies have enabled researchers to acknowledge that “the 'things (commodities, bodies, biophysical processes) that make a difference in the way social relations unfold are not pregiven substrates that variably enable and constrain social action, but are themselves historical products of material, representational and symbolic practices”.

Within the Marxist literature, technology can be determined as part of the relationship between society and nature by the “dialectical interaction between natural conditions and characteristics, on the one hand, and prevailing social relations of production on the other” (Liodakis 1997: 70). As Liodakis (*ibid.*) adds, technology is a “mediating instrument in this transformative process between human beings and nature.” Moreover, nature appears not as static but as a changing non-human nature “continuously extended through human productive activity or intervention” (*ibid.*). Similarly, Picon (1996: 40) suggests that the study of the history of technology “must take account of the simultaneous representations of nature and society.” Technology in its more abstract form, as Ritzer (2009: 227) points out, also includes “not only the obvious, such as robots and computers, but also the less obvious, such as the assembly line, bureaucratic rules, and manuals prescribing accepted procedures and techniques.”

In this thesis the concept of hybridity is informed by the fact that technology can be defined “as being social in its very constitution” (Alemany Gomez 2009: 389). Hybridity in the study of objects such as technological devices allows the researcher

to attribute to technologies alongside their material form a new dimension: a symbolic and ideological facet which allows the possibility to contemplate social and political interlinkages whilst describing material and physical structures at the same time. Thus, defining technology as a hybrid object allows us to reveal both its material and social characteristics.

Hybridity following Hinchliffe (2007: 50) has been used to establish a relation between geography and social science “wherein the mixtures and configurations of machines, animals, states, organizations, ecologies, politics are continually made up of all manner of elements, which themselves are nothing if not hybrid forms.” One of the most prominent applications of these precepts is ANT. Using this idea, ANT analyses how social relations are bound by the material and natural world, “drawing the nonhuman back into the sociological fold” (Lee and Brown 1994: 774).

Hybridity is the central aspect of the study of the co-production of technological natures (Hinchliffe 2007), and technonatures (Swyngedouw 1999; Kaika 2006), and has been applied to different fields such as urbanization and water management politics (Gandy 2004; Kallis 2010), mundane artefacts (e.g. the seat belt by Latour 1992) or human geography as a discipline (Hinchliffe 2007; Whatmore 2002). This approach also developed by Bakker and Bridge (2006: 5) focusing on reengaging with notions of 'materiality' indicates that it is possible to understand human geography recognising “the way the 'material and the 'social' intertwine and interact in all manner of promiscuous combinations”. These authors suggest that hybridity allows for the definition of quasi-objects through “associations rather than separations” (Castree 2002 in Bakker and Bridge 2006: 16). Such approach allows studying relationally and distributively what appear to be permanent and stable

relations within society “and to show how the competencies and capacities of 'things' are not intrinsic but derive from association” (Bakker and Bridge 2006: 16).

Using this focus, irrigation technology can encompass both the social and the material while constantly interacting with the natural environment. It incorporates more material aspects (materials, parts, design, construction, operation, management) and at the same time more symbolic aspects (its social dimension and the political and economic structures around it). Thus, the dialectical understanding of technology allows the researcher to postulate its role as something more than the mere application of techniques to social and economic structures in the country. It represents the material and symbolic connection between society and nature, human and non-human realities in La Mancha.

2.2.2.2 Studying the adoption process of hybrid technologies

Researchers such as Birkenholtz (2006, 2009b), Swyngedouw (1996, 1999, 2004) or Bakker and Bridge (2006) have explored the adoption process of hybrid technologies as a dualistic combination of material and symbolic elements embedded within a constant process of interaction between society and nature. In this sense, the concept of hybridity itself allows “to break down the binaries of nature/society” and “show how these reductionist categories have never existed but that things or ‘quasi-objects’ are both social and natural: socionature” (Birkenholtz 2006: 112). For these authors, once having established that technology is to be appraised as a dualistic material-symbolic element, the necessity to focus on the hybridization process (i.e. the process of producing quasi-objects) as a natural step is brought to their attention.

This premise is for Birkenholtz (2006) necessary if we want to avoid falling into the deterministic trap of assuming specific drivers of the social process that apply to the process of production of hybridity (i.e. in between society and nature). As Birkenholtz (2006: 114) writes, “rather than thinking of non-human processes as always the outcome of prior human intention, we need to think of the possibility of them driving (both enabling and constraining) change in human and non-human nature as well.”

In an attempt to go further, Swyngedouw's (1996, 1999, 2007) emphasis on the production of quasi-objects through the conceptualization of the cyclical-spiral process of hybridization allows us to consider such process as a perpetual cycle of formation and transformation, interaction, adaptation and change, trial and error. Connections and differentiations within this process become relevant and “arise simultaneously through process of production” (Bakker and Bridge 2006: 17).

The duality between nature and society based on technology and society strongly marks hybridity studies. Technology innovation has been studied by Callon (1992 in Allaire et al. 2003) as the system of interaction between the environment in which they are diffused and the production of innovation itself. This evokes different networks of agents and institutions directly involved in the creation, diffusion and use of such technology: Actor-Network Theory (ANT) following Latour (2005) as part of a social system including industrial, financial, economic and political relations all participating in the process of producing and diffusion of technology innovations (Allaire et al. 2003).

Science and technology studies also treat nature as an intrinsic part of society, “a component of the practice-arrangement nexuses through which social life progresses” (Schatzki 2003: 82). Technology for Schatzki (2003) is not a mere example of society's grasp over nature or the mediator between society/history and

nature, it is what gives form to socio-natural history. For this author, technology determines human life and vice versa, it is part of a “mutually embedded, enabling, and determining” story where “social life inherently transpires as part of nexuses of human practices and material arrangements” (Schatzki 2003: 84-91).

As Johnson and Wetmore (2009: xii) wrote, if we ought to “direct technology in the most beneficial ways, we need to know [...] more than science and engineering traditionally offer – we need an understanding of how devices, techniques, people, institutions, goals, and values are intertwined.” For them,

“[t]echnology neither exists nor has meaning without the human activities of which it is a part and similarly, many social practices would be impossible or incomprehensible without material objects. Thus, to understand the ways in which technology permeates and constitutes our everyday lives, we have to examine material objects together with the social practices and social relationships that make the material objects possible and useful” (Johnson and Wetmore 2009: xiii).

Michel Callon (1987: 83) has also discussed the role of social research in technology studies and argued for the role of social scientists in studying technology itself as a ‘sociological tool of analysis’. For Escobar (1999: 12), these types of studies provide new analytical tools for examining the “alternative networks linking humans and nonhumans” and facilitate “the study of the co-production of technoscience and society”.

Other studies have also examined the capacity of technology in conducting socio-environmental change (Birkenholtz 2009b) but the way in which such practices

originate and participate in the establishment of new natures or social relations is tantamount to the production of local identities and political strategies (Escobar 1999). Although some studies have been criticized for giving too much agency to non-human actors, in particular ANT (Hinchliffe 2007; Lee and Brown 1994), one of the postulates of this research is based on the fact that groundwater abstraction technology is revealed as the prism through which the study of irrigation history becomes possible. It is a way of connecting different stages within the process of statecraft and irrigation as well as different scales (material and symbolic, natural and social).

Building on this, the study of technology based on the duality material/symbolic allows the conceptualisation of technology's dual physical (the different material components, techniques and used to develop groundwater abstraction) and political aspects (as used by the state to fulfil specific political and ideological strategies). Examining with such lenses these processes, the dialectic between the social and environmental fabric of irrigation will unfold.

2.2.2.3 Groundwater wells: where materiality meets symbolism

With these different studies as a theoretical ground, this section explores the binary essence of technology. Being defined as material and symbolic, technology finds its sources in the interlinkages between nature and society (Mosse 1997). According to the *Oxford English Dictionary*, irrigation can be defined from a technical point of view as the “supply of water to (land or crops) to help growth, typically by means of channels.” To carry out this purpose, irrigation requires the use

of technology to abstract, transport and provide water for the crops and in the fields used in different agrarian modes of cultivation. However, by developing the concept of hybridity applied to technology, the study of irrigation systems can be expanded. As defined by Mosse (2003), irrigation systems⁹ conceal two levels of conceptualisation. On the one level they are irrigation structures but on the other they are public institutions having contributed to the organization of society in South India whilst shaping social, political and cultural relationships by incorporating political strategies of rule and statecraft. Irrigation presents the duality of a sociotechnical system: neither natural nor social but both.

Irrigation as a social product has been studied by authors such as Ton and De Jong (1991) or Bolding et al. (1995). Moreover, authors such as Mollinga (2003) or Mosse (1997, 2003) have written about the social constructs and institutions involved in irrigation technologies. In general terms, agriculture, as a socio-natural system, connects food production with the natural and biological system, natural resources, economy and society. All these elements interact within the agricultural system where “[t]he connections between science, technology, society, and government seem especially clear in agriculture” (Schlebecker 1977: 641).

Within the context of technology studies, this research investigates the implications and connections between humans and non-humans and socio-ecological change (Birkenholtz 2006, 2009a, 2009b). Through technology adoption processes, the lives of humans “become increasingly dependent on, bound up with, and even centered on such objects” (Schatzki 2003: 91). Specific elements of the social order

⁹ In this research irrigation systems comprise but are not limited to material irrigation technologies and structures (e.g. canals and wells). Following Mosse (2003), irrigation systems are beyond physical surface water management structures (i.e. tanks) and include systems of patronage, power and symbolism. Mosse's emphasis on Bourdieu's concept of symbolic capital allows him to conceptualize common property resources and its management structures as 'repositories' of symbolic as well as material interests and social resources (Bourdieu 1977 in Mosse 1997: 472-473).

are connected with these material structures; informal institutions and political relations; the formal administration of water management projects; land ownership and social relations. Economic dependence and productivity are also linked with these material structures.

Technological devices can be conceptualized as hybrid, reflecting the intrinsic duality of these objects: material and symbolic, natural and social. Research carried out by Birkenholtz (2006) in India on groundwater tubewell irrigation – a similar groundwater abstraction technology –, has shown that this type of device operates within social processes such as caste and class. These systems can be adapted to changing social and ecological conditions and the adoption of this type of technology “intersects with both the material (production and reproduction) and the discursive (representation and signification)” (Birkenholtz 2006: 115). Additionally, the presence of tubewells “intersects with both the material (production and reproduction) and the discursive (representation and signification)” (Birkenholtz 2006: 123).

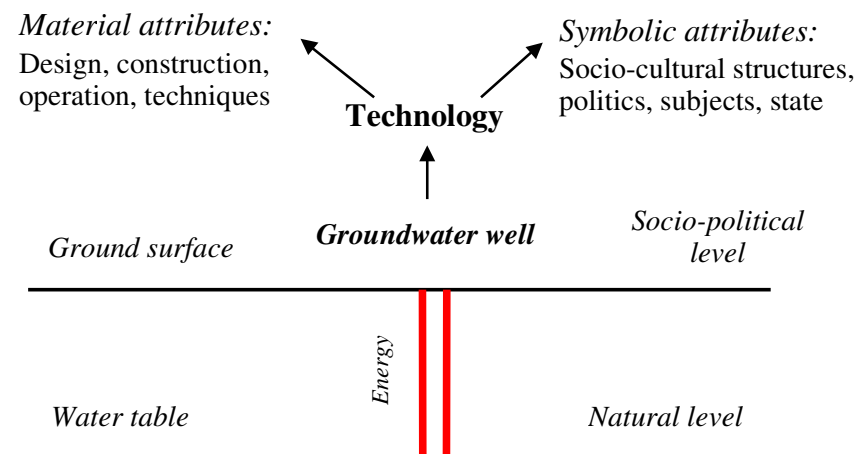
Through a similar lens, Mollinga (2003: 262) has called the surface outlets of surface water irrigation systems the ‘point of contact’ between public administrations and water users: the ‘material connection’ between the farmers’ irrigation plots at the outlet and the Irrigation Department bureaucratic and administrative structure. Such quotidian elements, called also by Latour (1992) ‘mundane objects’, are created by technology and can internalize specific social situations and determine the way humans behave and interact with their environment. These technological devices show the existence of hybrids as “mixtures of nature and culture” (Latour 1993: 30). As shown by Mollinga, irrigation technologies require socio-political structures for their use, embedded within specific forms of social cooperation. As examined previously, groundwater wells are part of a material irrigation structure but at the

symbolic level they also express politics and power in society, economic and social structures, the same way temples in India express cultural memory, relations of dominance, dependence and caste ranks (Mosse 2003).

By combining Latour's concepts of the socio-natural construction of common objects and the socio-political and cultural dimensions attributed to irrigation structures by Mosse, the groundwater well manifests itself as a symbolic element connecting nature below (i.e. the aquifer) with the socio-political on the surface with the use of energy¹⁰ (Figure 2.3). It facilitates the individual abstraction and allocation of resources but also catalyses agrarian and social relationships. It acts as a 'transmission chain' linking the natural and physical groundwater system with the social system. It also helps define a public domain, a socio-natural structure around which agrarian economies and socio-political relations occur. At the material level, groundwater wells are part of an irrigation structure but at the symbolic level, they operate within socio-historical and political processes (Birkenholtz 2009b), express power in society, politics and economic structures and connect water and land institutions (e.g. water abstraction rights, land ownership, agrarian markets).

¹⁰ Energy in the form of diesel or electricity used to fuel the engines connected to the pumps plays an important part in the development of groundwater abstraction technologies as explained in Chapter 6 and 7.

Figure 2.3 Materiality and symbolism of a hybrid groundwater well



Source: Author

2.3 Irrigation, governmentality, water politics and statecraft

Having established in the previous section that groundwater abstraction technologies can be characterised by its dual material/symbolic dimensions, this section explores in further detail the symbolic characteristic of irrigation technologies applied in this thesis. Using Latour, hybrid structures show that the existence of a political structure connecting the body politic with the poles of nature and society is intrinsically engaged in the constant creation of hybrid objects. The state-Leviathan becomes thus a skein of intangible and tangible networks between society and nature (Latour 1993).

However, Latour's (2004) philosophical metanarrative about politics, society and nature does not give many clues about specific modalities of state engagement at the political level nor about state structures and policies affecting the development of specific technological arrangements. Moreover, as Wainwright (2005: 119) points

out, Latour “does not inquire into the political and historical conditions under which realities actually emerge” and the “thorny problems of power, discourse and history are wholly elided.” Additionally, Latour's views make difficult to address questions such as “Who decides what the content or affordances of a particular technology are? Why does one version come to dominate over others? How are users 'configured' to accept (or otherwise) the preferred reading?” (Whittle and Spicer 2008: 614-615).

Against this backdrop, the use of hybridity in technology is complemented with the concept of governmentality in order to fully grasp the reach of the state in the development of irrigation. By building on the concept of ‘hybridity’, irrigation structures include the materiality of groundwater wells but also the socio-political processes set in place to control and manage those same structures.

2.3.1 Irrigation as political technology

In his book Mosse (2003) borrows Foucault’s term of ‘political technology’ to characterise irrigation policy in South India. This research aims at developing this concept and applying it to the study of state irrigation and colonisation politics in Spain and La Mancha.

As described by Foucault (1988a: 18), four major types of technologies coexist and each of them is associated with a type of symbolic domination:

“(1) technologies of production, which permit us to produce, transform, or manipulate things; (2) technologies of sign systems, which permit us to use signs, meanings, symbols, or signification; (3) technologies of power, which

determine the conduct of individuals and submit them to certain ends or domination, an objectivizing of the subject; (4) technologies of the self, which permit individuals to effect by their own means or with the help of others a certain number of operations on their bodies and souls, thoughts, conduct and way of being, so as to transform themselves in order to attain a certain state of happiness, purity, wisdom, perfection, or immortality.”

According to Foucault, the state can adopt and make use of these technologies and the expression of such domination can take a symbolical form (e.g. discursive) or a more physical form or expression of power (e.g. physical domination). Examples used by Foucault include madness and the birth of the asylum or the development of prisons with the design of the *panopticon system* devised as a technology of surveillance and control embodied in architectural designs (Foucault 1991). Moreover, the disciplinary space is divided by Foucault according to the hierarchisation of space and structures following the principle of elementary location, breaking the disciplinary space into as many parts as bodies in order to decompose the collectivity and organise the plurality and where “each individual has his own place; and each place its individual” (Foucault 1991: 143).¹¹

Foucault also points out that different types of political techniques and technologies of government in the hands of the state make the individual a significant element subject to state-power. Foucault builds on this to define different political rationalities as embodied in institutions and dependent upon economical, social, cultural and technical processes. He also considers that these techniques and practices

¹¹ See Chapter 5 for the application of this principle in state-sponsored colonisation and irrigation projects in the town of Llanos del Caudillo, La Mancha.

give form to ‘a new political rationality’, i.e. the state, and to new kinds of relationships “between the social entity and the individual” (Foucault 1988b: 153).

This type of analysis has already been attempted in Spain. Focusing specifically on theories of power, the author José Manuel Naredo (1978) has used a similar theoretical construct based on Foucault’s disciplinary theses to study what he calls ‘the coercive mechanisms of colonisation’ used in the colonisation plan of Badajoz in Extremadura. Following this author, the disciplinary space created around the settlers and colonisation towns reproduces hierarchic and paternalistic relations between the bureaucratic structure of colonisation and the farmers. By developing this theoretical approach and conceptualising the groundwater well as a hybrid artefact it is possible to consider irrigation technology as a political device as well as a material technology used as a mechanism to affect and change rural societies (Table 2.1).

Table 2.1 Material and political dimensions of irrigation

<i>Dimension</i>	<i>Components</i>	<i>Type of technology</i>	<i>Example</i>
<i>Material</i>	Construction materials Technology parts	Water lifting technology	Norias, boreholes
<i>Political</i>	Governmentality The state	Political technology	Colonisation politics Irrigation politics Llanos del Caudillo

Source: Author.

Based on these hybrid properties, the analysis of technology devices for irrigation enables the simultaneous study of the connections between central state-rule and the ‘hydraulic mission’ and local subjects. In his book on Foucault, Gutting (2005: 87) highlights how Foucault’s prison-model (1991) “has metastasized throughout modern society”. As Gutting (2005: 87) also pointed out, society “appears

as a multitude of dominated others: not only criminals but also students, patients, factory workers, soldiers, shoppers ... Each of us is – and in a variety of ways – the subject of modern power.” Building from this, in newly irrigated landscapes new forms of citizenship and agrarian relationships appear, regulated by the state. As a consequence, irrigation plans and policies fabricate new docile bodies (i.e. settlers and farmers) through different political technologies (symbolical, discursive, political) expressing control and discipline in settlements created by colonisation politics.

2.3.2 Governmentality and the creation of irrigation subjects and space

Governmentality is used here to focus on the different political apparatuses used by the state to rule and govern irrigation projects. Governmentality is the term used by Foucault to explain the rational regulation of subjects under an ensemble of ‘governmental apparatuses’ or as Foucault calls it ‘technologies of domination’ (Biebricher 2008; Burchell et al. 1991). As Foucault (1988a: 19) puts it, “[t]he contact between the technologies of domination of others and those of the self I call governmentality.”

Based on Foucault's work, Agrawal (2005) has reflected upon the impacts of the environment and government on the creation of specific subjects and named this process 'environmentality'. According to Agrawal (*ibid.*), governments have created through specific strategies of power/knowledge technologies of government responsible for the re-structuring of socio-political relations with the environment. These new government technologies have redefined political and administrative links between the state and localities as well as having realigned institutional and social

relationships within local communities. As Agrawal (2005: 89) put it, they have also laid out “the emergence of a more widespread concern with the environment and the making of environmental subjects.” Building on Foucault’s notion of governmentality, Agrawal develops to the concept of environmentality to examine the effects of decentralised environmental governance on local structures and individuals. Through environmentality, Agrawal looks at how the emergence of the environment as a domain has been regulated by the state and generated linkages with local knowledge, politics, institutions and individual subjectivities (Agrawal 2005 in Birkenholtz 2009a: 211). As Biebricher (2008) points out, the techniques of the self at the individual level are related under Foucault’s governmentality with collective identities and collective techniques of governmentality. For Foucault (1980: 74), “[t]he individual, with his identity and characteristics, is the product of a relation of power exercised over bodies, multiplicities, movements, desires, forces.”

Following Agrawal (2005), the emergence of new environmental subjects is linked to governmentalised state practices and their local impact on regulatory communities and rural residents. As will be analysed in subsequent chapters,¹² through the development of irrigation and technology, colonisation politics in modern twentieth century Spain materialised as a way of 'doing government'. As Glick described it this new type of technological structure was able to create a ‘new polity’ (Glick 1979) or a new public domain of institutional relations (Mosse 1997). From there, new irrigated spaces, new irrigation subjects and new rules emerged as national and local statecraft practices in rural La Mancha. A new way of making government and the creation of a new society through government practices in which the state

¹² See Chapter 4 for a detailed analysis of the different state and government policies aimed at controlling and developing a newly irrigated countryside through colonisation and irrigation plans. Chapter 5 expands this analysis and provides a detailed description of the case study of the colonisation town of Llanos del Caudillo.

seeks its legitimacy through different political technology structures as “techniques and tactics of domination” (Foucault 1980: 102).

2.3.3 Water politics and the hydraulic mission

The study of water politics is a well-documented area of academic research and includes case studies from the United States (Reisner 1993; Worster 1992), India (Mehta 2001, 2005), Mexico (Wester et al. 2009), and Thailand (Molle 2007). At its analytical level, these examples share the imprint of Wittfogel's (1957) theses on hydraulic societies. Wittfogel used centralised irrigation and water projects in Asia to develop his theses on hydraulic societies as ruled and controlled by the state through structured bureaucratic systems. However, within these later studies the mechanisms of transmission and perpetuation of what Allan (2005) has called the hydraulic mission are still poorly understood. The hydraulic mission, or as Mosse (2008) put it the ‘engineering paradigm’, has dominated policy approaches and water governance regimes in Spain (Sauri and del Moral 2001; Swyngedouw 2007) and the United States (Reisner 1993; Worster 1992) for decades. Surface irrigation studies are abundant and the specific area of South East Asia offers an almost unlimited palette for studying society's interaction with nature through surface irrigation schemes and technology (e.g. Bolding et al. 1995; Mollinga 2003; Mosse 2003). Much of the contemporary literature on ‘hydraulic bureaucracies’ (e.g. Molle et al. 2009; Swyngedouw 2007; Wester et al. 2009) tends to minimize the role of hydraulic infrastructures and technology within communities and present a linear and generic

approach to the evolution of national water management policies and water governance regimes.

Several attempts have been made to expand such monolithic views. Irrigation policy reforms became the subject of an edited book by Mollinga and Bolding (2004), and river basins as socio-environmental objects were the focus of Molle and Wester's (2009) compiled volume. Institutional reform has also been under the scrutiny of policy analysts. Focusing on Australia, Crase and Gandhi (2009) have provided us with a general view of broad institutional reforms for water resource management while Feitelson and Fischhendler (2009) describe with a scalar perspective the institutional arrangements affecting the water governance system in Israel.

Moreover, studies focusing on the state's central hydraulic mission tend to overlook groundwater abstraction for irrigation is generally due to the idea that the groundwater 'revolution' was mainly sustained and carried out by the sum of small abstraction infrastructures (i.e. wells) resulting from farmers' individual decisions – the 'silent revolution' (Fornés et al. 2005; Llamas and Martínez-Santos 2005a).

However there are limits to what such previous insights on the hydraulic mission have shown. As described by Glick (1970: 187), “the 'hydraulic' approach to irrigation is from the top; it concentrates on the centralized administrative direction of hydraulic works. Yet, if examined from another point of view, irrigation systems [...] reveal institutional patterns of a local nature which exist wherever irrigation agriculture is practised and which are ecologically, more than culturally, derived.” Echoing Mosse's (2003) work, the role of water in the public domain of tank irrigation in villages in India acts as a simplified model of a complex society consisting of a multiplicity of overlapping socio-cultural and symbolic processes. Within this region, water management is part of the historical and ecological making

of place and locality, understood as an active and continuous social process. Against this backdrop, the underlying aspects of the hydraulic mission, the role of the state in groundwater management and its impacts on society and the environment remain to be theorised in the context of Spain.

2.3.4 The study of irrigation, land and colonisation

As will be emphasised in the context of Spain, the interaction between irrigation, society and politics acquires more relevance when examined alongside the processes of internal colonisation and land reclamation.¹³ Several authors have documented the connection between state politics, land and water management policies and colonisation.¹⁴ Worster (1992) and Reisner (1993) have revealed the connection between the United States settlement, colonisation and development policies and water management infrastructure in the West. Gibbs (2009) has detailed how the colonial imperative of developing the nation meant the instauration of water management regimes in Australia. Bernal's (1997) research on the development of the Gezira irrigation scheme in Sudan by British colonial rule in the 1920s, focuses on the study of symbolic and hegemonic structures of power in irrigation projects, making clear the power these projects had over both land and society. Thus, these systems of

¹³ Through the research carried out by Falkenmark et al. (1999) and by Falkenmark and Rokstrom (2006) on the interaction between green and blue water in hydrological systems, it is possible to relate land-use decisions to water-use decisions and "close the gap between hydrology and ecology" (Falkenmark et al. 1999: 8). Land management partly controls the water balance and affects the physical determinants of water flow such as the infiltration and storage of water in "a composite system where ecohydrological phenomena from important components" (Falkenmark et al. 1999: 58).

¹⁴ The term colonisation is understood here as the political and technical process by which the state reclaimed and expropriated land within its national boundaries to develop agriculture and establish irrigation plans and water management infrastructures.

British colonial rule in Sudan regulated, disciplined and constructed a highly rationalised and controlled agrarian society (Bernal 1997).

Other historical cases of agrarian landscape transformation include Mussolini's colonisation of the Pontine river marshes in 1930s Italy (Caprotti 2007, 2008) and the 'organic design of space' in Eastern Europe under Nazi Germany (Blackbourn 2006). Colonisation and land reclamation plans by Mussolini and Hitler make clear that these projects responded to the will of the government to dominate and transform both society and nature through the creation of modern rural landscapes.

In fascist Italy, Mussolini developed an intensive national program of land reclamation and agrarian urbanisation called '*bonifica integrale*'. This program was based on: the integration of central government and local institutions; the facilitation of agriculture; the creation of 'fascist' citizens; and a strict policy of demographic development of rural areas through land reclamation (Caprotti 2007). Settlers were selected and new towns were built participating in the creation of a modern urban landscape which sustained the ideological, social and political postulates of the fascist regime (*ibid.*).¹⁵

In Germany during the 1940s the transformation and reclamation of the Pripyet Marshes in Byelorussia gave the Nazi government the opportunity to enlist human labour on a large scale in order to productively contribute to reclamation projects (Blackbourn 2006). Such a program of drainage and reclamation would add economic and agrarian value to the land and sustain the development of agriculture (*ibid.*). In similar projects in other parts of occupied Europe, farmers settling in the Eastern

¹⁵ Authors such as Alares López (2010) and Alvaro Tordesillas (2010) have documented a direct political, ideological and technical influence between Mussolini's '*bonifica integrale*' and the colonisation activities and policies of the INC in Spain.

borders would be portrayed by the Regime's Nazi propaganda as revitalizing the ideals of nature in accord with modern economic and technological needs (*ibid.*).

At a more fundamental level and in line with Fontein's (2008) work, the development of more comprehensive studies of land and water management policies indicates that struggles over land, water and the environment cannot be reduced to simplistic distinctions between water allocation, infrastructures or water rights. Rather, these are immersed in a complex variety of social and political structures through which both water and land management politics are equally at play. As Fontein (2008: 223) points out, "it is impossible to understand the history of water in Africa without due consideration to the history and politics of land." Equally, as Mosse (2008: 944) makes clear, "water shares the complexity of land (from which it is rarely separable) as a medium or meaning and material relations, while adding movement and the dimension of time and process to the relationality that is inherent in space."

As proved by Dubash (2002:14), the study of groundwater has to be contextualised within the development of land ownership patterns since, "the distribution of landownership and the extent of land subdivision and fragmentation affect the development and use of groundwater. More precisely, the relative fit between the scale of available irrigation and the scale of cultivation influences the economic viability of groundwater irrigation in any given region." The interaction between land and water is therefore relevant to this research (albeit secondary to the practice of groundwater abstraction) as a driver for the adoption of modern technology by farmers or the state. As Mosse (2003: 5) writes, land and water are connected through water management technologies defining a common public domain

“and a set of resources (material and symbolic) through which authority and social order have been articulated”.

2.4 Groundwater socio-ecologies, the state and the production of scarcity

2.4.1 The study of groundwater socio-ecologies

One of the initial premises of this study is to extend knowledge on groundwater socio-ecologies established by Birkenholtz (2007, 2008), Mosse (2003) in India and Shah et al. (2003) in Asia and translate it to Spain’s historical and socio-natural context through examining the different modalities of state participation and statecraft processes. The creation of groundwater socio-ecologies (Birkenholtz 2009b) represents a way of looking at nature-society-technology relations based on the study of groundwater irrigation as complex socio-ecologic systems permeated by social, cultural and political institutions.

In his book *Taming the Anarchy*, Tushaar Shah (2009) explores the central role of irrigation in South Asian society and the growing anarchy impregnating these irrigation economies. In South Asia, intensive groundwater irrigation has been mainly driven by population pressure over land and intensive diversification of crops through the use of groundwater abstraction technologies (*ibid.*). According to Shah’s typology of groundwater socio-ecologies, however, the driver of the expansion of intensive groundwater use in industrial agricultural systems (e.g. Spain and the United States) is a response to water scarcity.

The use of Shah's dynamics of groundwater socio-ecologies informs this research on groundwater abstraction in La Mancha. Shah characterises the dynamics of rising and falling groundwater socio-ecologies in South Asia as a four-stage progression. As Shah (2009: 125) wrote, "[t]he typical progression begins when farmers tap a previously unutilized groundwater resource and create an agrarian boom but then deplete the aquifer and go bust". This process ultimately leads to the decline of groundwater based irrigation services and markets and the depletion of groundwater levels if not properly managed and regulated. During this process, the increasing use of groundwater abstraction leads to the rise of a green revolution and tube well technology along with state subsidies (Stage 1), followed by a 'groundwater-based agrarian boom' (Stage 2), causing the appearance of symptoms of groundwater over-abstraction along with crop diversification and falling water tables (Stage 3) and finally causing the decline of groundwater socio-ecologies and bringing impoverishment to agrarian communities (Stage 4).

2.4.2 Groundwater socio-ecologies, irrigation and agriculture in context

This thesis stems from a tradition of water studies such as Agarwal and Narain (1997), Birkenholtz (2006, 2009a, 2009b) and Mosse (1997, 2003) where technology is used to understand the links between the environment, social institutions and history. Previous research has observed that the use of technology has allowed for the production of specific socio-ecological structures in a variety of contexts. These include: the regulation of natural resources in Tamil Nadu, India (Mosse 2003); cultural practices and social institutions in India (Agarwal and Narain 1997; Mosse

1997); the production of groundwater scarcities in Rajasthan, India (Birkenholtz 2009b); and political crises in Sicily, Italy (Giglioli and Swyngedouw 2008).

Tubewell technologies have been the focus of several studies in India and South Asia (e.g. Appu 1974; Birkenholtz 2009b; Biggs and Clay 1981; Dommen 1975; Dubash 2002; Shah 2009). These studies demonstrate how this type of technology enables groundwater management institutions – constituted through social, cultural, economic, political and historical structures – and affects social and agrarian structures. Birkenholtz (2009b) approaches his study by focusing on the production of irrigated landscapes in Rajasthan, while Biggs and Clay (1981) have documented the different modes of adaptation of tubewell technology to farmers' specific economic needs and Dubash (2002) has focused more on the establishment of market-led initiatives affecting agrarian trajectories of change. Herath (1985) on a more economic study has reported the impact of tubewell irrigation on the development of a youth settlement farm in Sri Lanka.

Wang et al. (2006) reviewed research carried out on groundwater well technologies and studied the factors of ownership change from communal to private in Northern China. Their work stated that water scarcity and beneficial government grants and bank loans induced farmers to switch to privately owned wells replacing surface water use for groundwater. Meinzen-Dick (1996) studied tubewell ownership in Pakistan and concluded that groundwater as well as technology availability and affordability are determinant factors for the ownership of tubewells. The access to such technology allows tubewell owners to increase their agricultural yields and also to set up groundwater markets and hence institutional structures to allocate and sell water to other users.

Barker and Molle (2002) established that irrigation agriculture is due to a dialectical interaction between resources, technology, institutions, and culture. Building on this dialectic interaction between technology and nature, modern irrigation technology development through tubewells in Pakistan studied by Mustafa and Qazi (2007) has shown how technology can disrupt traditional social capital.

Dubash (2002) provides us with a pioneering analysis of the effects of groundwater management on agrarian production relations and the arising institutions governing its use. He also notices that more attention needs to be drawn to “how the resource and social conditions are mutually constitutive” and how “the struggle for access to, and control over groundwater, shapes the course of agrarian change and development” (Dubash 2002: 2-3). In Gujarat, the use of groundwater from deep alluvial aquifers determined the technological requirements of irrigation and the pattern of agrarian change (Dubash 2002). The existing social relations of agrarian production were both shaped and shaping the interaction with natural factors. In Dubash's example, the “access to credit and social networks determined access to groundwater, which in turn influenced the ownership of key irrigation assets and the pattern of social differentiation” (*ibid.*) Additionally, access to groundwater was dependent on community operated wells and the development of a market for groundwater (*ibid.*).

Hayami and Ruttan's (1971 in Shah 2009: 46) studies on irrigation helped Tushaar Shah observe that irrigation technology since the early years of the twentieth century was supported by subsidies and loans from state governments in South Asia. After 1975, growth in pump irrigation was however mainly influenced by the demand by farm-households “to make better use of land and labour” (Shah 2009: 46). Public irrigation programs on the contrary, “focused on developing surface water where

technically feasible” and canal irrigation, “did not reach even a substantial proportion of the region's smallholders outside command areas.” As a result, farmers were left on their own and turned to the pump and tube well (Shah 2009: 47).

Building on these academic examples, this study concentrates on the socio-political implications at the statecraft and community level of groundwater irrigation and agrarian changes driven by the adoption of new groundwater abstraction technology. Dubash's (2002: 10) approach is again illustrative of the aims of this thesis as he pays attention “to the social relations around water and the way in which the natural resource base, moulds agrarian societies and influences their trajectories of change.”

Irrigation and technology are the central aspects of this research. However, as Sundaram (2003: 3) wrote, “the effective use of irrigation technology as a tool for agricultural modernization needs a relevant understanding of the social and cultural framework within which the farmers in peasant society experience a distinctive kind of production relations.” It is from these premises that this research on irrigation in Spain and La Mancha begins, concentrating on the interaction between technology and irrigation with social and political relations and “the impact of irrigation on the conditions of production” (*ibid.*) as well as on socio-political and economic structures.

2.4.3 The theoretical context of the social and political production of water scarcity

On a theoretical level, Lefebvre's (1991) ideas on the production of space in capitalist societies have laid some of the essential elements influencing posterior work on the social production of nature. According to Lefebvre (*ibid.*), social space contains and assigns the social relations of reproduction (i.e. bio-physical relations between people) and the relations of production (i.e. the division of labour and its structure around hierarchical social functions). Political and economic relations occur in this social space. Space is used on a daily basis to connect people, ideas, manufactures; it is the basis of our social and also physical life.

Exploring a similar path, Neil Smith's (1996: 50) work on the production of nature reflects socially organised systems of capitalist production and reproduction internal within societies. In this context the study of landscape "must specify the processes by which material landscapes and their representations *function* in society". In Neil Smith's (2008: 50) words, "when this immediate appearance of nature is placed in historical context, the development of the material landscape presents itself as a process of the production of nature." For Castree (2000: 26), "various socially produced 'natural' landscapes – agrarian, forest, mineral etc. – become subject to twin forces, internal to capital, of geographical equalisation and differentiation". Within the context of a capitalist society, the development of material landscapes is presented itself as a process arising from the production of nature (Smith 2008).

Social and economic relations of production have also influenced and shaped the landscape. Mitchell (1996: 28) in his study about the origin of landscape by means of the working and labour relations in California describes how landscapes can be

considered as a dualistic unity composed of materiality and representation, produced by labour and “constructed out of the contest between various social groups possessing varying amounts of social, economic and political power” (Mitchell 1996: 28). The dialectic relationship between uses and constructions of the landscape shows, as Mitchell claims (1996: 29), how the morphological landscape is a manufactured by social struggles and developed “as both a product of and a means for guiding the social and spatial practices of production and reproduction in an area.”

More discursive approaches have also dealt with the similar concept of the 'construction' of nature focused on the concept of scarcity. Downing and Bakker's (2000) interdisciplinary research on drought portrays its human-made facets. For these authors it is possible to understand “the various relationships, institutions, and socio-ecological configurations from which drought emerges and that drought reinforces and destabilises” through the study of drought discourses. Natural and scientific storylines are partially challenged adding an invaluable dimension of ‘non-meteorological factors’ to the study of drought manifestations (Downing and Bakker 2000: 227). As they conclude, “an understanding of the discursive production of drought, in addition to the norms and vagaries of weather and climate, is critical to societies’ preparedness and management of water scarcity” (Downing and Bakker 2000: 228).

At the same time, socio-political approaches to water scarcity have identified how it can be socially produced (Bakker 2000; Otero et al. 2011). As a social product, water scarcity sits at the confluence between water consumption and demand, as well as physical conditions and social institutions. Castro et al. (2003) and Bakker (2004) have suggested that water shortages are the result of merging natural hydrological processes with patterns of water demand; suggesting that perhaps this construction is

largely related with perceptions of water availability arising from the local political and techno-natural history (Giglioli and Swyngedouw 2008).

Samer Alatout's (2008, 2009) historical studies in Israel reflect the construction of water scarcity perceptions as a technopolitical achievement and its effects on national identity. Through a complex web of powerful policy-making institutions and technologies, a scarcity thesis was developed when the state was in need of a strong and rallying symbol. The scarcity thesis also helped build a "strong, centralized nation-state and in constructing the Jewish subject as citizen" (Alatout, 2008: 962). This process of legitimisation implied a new spatial framework (i.e. a homogeneous water scarce national space) and a new form of subjectivity (i.e. the modern citizen of Israel).

West and Smith (1996, 1997) have studied how drought discourses respond to symbolic and cultural needs and are relatively autonomous from both natural rainfall precipitation and economic factors. Other studies have considered drought from a socio-political angle, integrating both the idea of natural phenomena but also its interaction with humans (Bakker 2002, Castro et al. 2003; Giglioli and Swyngedouw 2008). For Heathcote (1969: 176), "drought means different things to different people, and there are probably as many definitions as there are users of water." Solway's (1994) approach uses drought as indicator of a revelatory crisis of latent or contained structural socio-economic contradictions in Botswana.

However, discourses about water scarcity have also real and material consequences. Mehta (2001) has studied how the production of scarcity discourses is rooted in India's social and power relations and for Worster (2004: 4), the Dust bowl in the 1930s in the United States perfectly illustrates the human-made facet of scarcity as the "inevitable outcome of a culture that deliberately, self-consciously, set itself

that task of dominating and exploiting the land for all it was worth”. The social production of water scarce landscapes also shows both the embeddedness of social and political structures and their effects on the ecology of these landscapes (Mosse 1997).

2.5 Bringing the state back into groundwater studies in Spain

2.5.1 Spain and the hydraulic mission

In Spain, the role of the state in the development of the hydraulic mission has been translated into the development of large surface water irrigation plans and dams for irrigation and energy generation (Houston 1950; Lopez-Gunn 2009; Swyngedouw 1999, 2007). This role altered during the twentieth century from merely supervising private agricultural activity, to allowing and protecting irrigation works and colonisation, to directing and controlling colonisation politics as the epitome of the public role in hydraulic politics (Mangas Navas 1990; Naylor 1967; Ortega Cantero 1979, 1993).

Processes of colonisation, infrastructure development and re-definition of private and public water rights occurred in parallel with processes of state and society formation. Earlier research on the interaction between society and ecological systems through irrigation has revealed the instrumental role of water in the evolution of social institutions (e.g. Mosse 2003; Ostrom 1990). Glick (1970) and Ostrom’s (1990) research on Valencia’s *huerta*¹⁶ institutions in Spain have proved how despite the

¹⁶ *Language note:* Traditional irrigation systems for fruits and vegetables existing in South and East Spain since medieval times.

limited quantity of rainfall, social institutions in irrigation systems have governed the use of water allocation whilst ensuring social and political stability. At the same time however, the development of irrigation also allowed the state to use water politically, transforming dry landscapes into wet landscapes (Costa Martínez 1911).

At the turn of the nineteenth century, irrigation was seen by a group of intellectuals and politicians (i.e. the Regenerationists) as the major instrument to transform Spain's inland landscape and to develop the nation after the 1898 Disaster¹⁷ (Driever 1998; Swyngedouw 1999). After the Civil War in 1939, the development of hydraulic politics and dam construction revisited such Regenerationist postulates and acquired a new socio-political meaning sustaining the ideological and economic foundations of the newly installed dictatorial regime by Francisco Franco (Swyngedouw 2007).

2.5.2 Irrigation, colonisation and the state in Spain

Recent studies on the evolution of water politics in Spain have mentioned irrigation and colonisation activities as part of the mechanisms used by the state to fulfil its hydraulic mission (Lopez-Gunn 2009; Swyngedouw 2007). Other studies have specifically examined the role of the Ministry of Agriculture and the National Institute of Colonisation (INC)¹⁸ in managing irrigation and land concentration projects in Spain (Houston 1950; Nylon 1967). Peperkamp (1972) has also studied the activities of the INC, particularly in La Mancha and the towns of Llanos del Caudillo and Cinco Casas. During Franco's regime, colonisation politics became the

¹⁷ The 1898 Disaster refers to the loss of the last Spanish colonies in Central America (i.e. Cuba) (See Chapter 4).

¹⁸ *Language note: 'Instituto Nacional de Colonización' in the original Spanish language.*

union of both hydraulic politics and agrarian politics: the state was the sole planner, financier, regulator and builder. The transformation of the countryside through colonisation plans with irrigation became the cornerstone of agrarian politics (Ortega Cantero 1993). The development of large irrigation areas with new villages and settlers was based on a new conceptualisation of agrarian politics aiming to improve the technical and economic viability of irrigation plans. This was accompanied by an ideological and political apparatus following the postulates of an incipient agrarian fascism (Alares López 2010). An administrative and bureaucratic structure made of civil servants, engineers and technicians ensured its rationalisation and development. Within this structure, the role of the INC became essential in order to coordinate the different agrarian activities in the irrigated areas (Gómez Benito 1995).

In Franco's Spain, the majority of colonisation plans focused on managing surface water and involved major infrastructures such as dams and irrigation canals.¹⁹ Given the necessity of large amounts of water for irrigation, it is plausible to establish that the presence of a majority of colonisation projects using surface water responded to a larger availability of surface water over groundwater. However, it is also conceivable that this dominance of surface water infrastructure in irrigation was also linked to the fact that hydrogeology was in its early stages during the first half of the twentieth century (Fornés and Senderos 2002). With the development of better drilling techniques and the first hydrogeological studies in Spain in the 1950s the Ministry of Agriculture and the INC drilled 1,588 wells between 1954 and 1965, amounting to a total of 212,984 metres of drilled wells (*ibid.*).²⁰ Thus, the development of groundwater abstraction projects by the INC responded to the growth

¹⁹ Two of the most iconic plans include the Plan Jaen in Andalucía in 1952 (Araque Jiménez et al. 2006; Sánchez Domínguez 2001) and the Plan Badajoz in Extremadura in 1953 (López Santamaría 1954).

²⁰ Compared to a total accumulated length of 2,611 metres of wells drilled by the INC between its creation in 1939 and 1954 (Fornés and Sendero 2002).

of hydrogeology and the need to find water for irrigation in areas with poor surface water availability and large groundwater reserves.²¹ Following this trend, other areas by the INC using groundwater for irrigation included Alicante (Ponce Herrero 1992; Sevilla Jiménez et al. 2010), Almeria and Murcia (Sevilla Jiménez et al. 2010).²²

These studies however have not attempted to reconcile the understanding of state-led hydraulic politics, their connection with colonisation and irrigation technology and politics, and their social and environmental implications at the local level. Against this backdrop, this thesis aims to approach the history of colonisation and irrigation in Spain in the context of state rule as a political technology combining both its material and symbolic aspects. The analysis of technology change in La Mancha will be the medium used to explore the historical inside of the hydraulic mission focusing on the development of a particular region in Spain. This approach informs the study of the creation of a new socio-ecological polity: the colonisation town. The use of irrigation technology by the state served to create an ideological and political 'spatial mechanism of power' with administrative and bureaucratic structures fixing families in newly built villages to transform some of the dry and barren lands of Spain into fertile irrigated plains. Moreover, the selection of areas to be colonised and irrigated went in parallel with the creation of new irrigation subjects: settlers selected according to psychological, political, social characteristics as well as professional skills. Through state-led colonisation and irrigation plans it is possible to

²¹ This is the case of the colonisation of Hellin in Albacete. The INC had secured from the Ministry of Public Works a constant flow of 1,000 litres per second of surface water from the Canal of Hellin coming from the Camarillas and Cenajo Dams in the Segura river basin. The INC then complemented this allocation with 350 litres per second from groundwater abstractions developed in the area. This represented the increase in irrigated surface in Hellin from 1,183 hectares to 2,938 (Canales Martínez and Jerez Cordero 1993).

²² The case of publicly funded wells in Spain can also be compared to India (Molle et al. 2003; Shah 2009), where "the government program to establish public tube wells in Uttar Pradesh way back in the 1930s provided the first exposure of farmers to the advantages of the modern tube well technology" (Molle et al. 2003: 13).

point out the ideological fabrication of irrigation subjects supported by new political structures and agrarian policies within a newly created countryside of colonisation towns and irrigated fields. A complex legal and political machine sustained this system through decrees, regulation and control exerted over the settlers and their families, controlling agriculture production, crops and revenues.

2.5.3 What lies beneath – the state, irrigation and groundwater abstraction

Fornés et al. (2005) and Llamas and Martínez-Santos (2005a: 337) have coined the term ‘silent revolution’ to describe the phenomenon of groundwater overabstraction carried out mostly “by the personal initiative of millions of modest farmers in pursuit of the significant short-term benefits groundwater usually triggers.” The term ‘silent revolution’ shows the destructive power of farmers' individualistic behaviour during the adoption of intensive groundwater abstraction technologies and reflects well-known tragedy of the commons (Hardin 1968) in Spain.²³ This process has been widely studied both at the national and regional level by an array of academics (e.g. Bromley et al. 2001; Fornés et al. 2005; Garrido et al. 2006; Martínez Cortina 2001; Martínez-Santos et al. 2008).

In general, groundwater management studies in Spain have focused mainly on institutional arrangements, policies, agricultural output or general ecosystem impacts of irrigation plans (e.g. Cruces de Abia and Martínez Cortina 2000; Lopez-Gunn 2003; López Sanz 1998; Martinez Santos et al. 2008). Fewer have focused on the

²³ The ‘tragedy of the commons’ is a concept developed by Garrett Hardin in 1968 depicting the depletion of a commonly owned resource by individuals acting independently and rationally according to their own individual interests. A dilemma arises between the individual’s own rationality associated with the private marginal gain of consuming the resource and the group’s long-term sustainable future linked to the common depletion of the resource.

intricate historical connections between socio-political and agrarian change, statecraft processes, groundwater management and technology adoption (Giner and Carrión 1999, 2005; Glick 1970, 1977, 1992). As part of this study, the involvement of the state in the groundwater ‘silent revolution’ will be re-assessed by analysing the political, ideological and material role played by groundwater abstraction technology in state colonisation, land management and state irrigation plans, contextualised within a wider lens of agrarian politics.²⁴ As Garrabou (1990: 63-64) put it, the study of the process of mechanisation of agriculture in Spain “is incomprehensible if it is isolated from the general economic context and especially from the specific evolution of the agrarian sector”.

A study by Pérez Picazo and Lemeunier (1990) points in that direction. These two authors have observed how in Murcia a contagious hydraulic 'fever' emerged with the increase in *huertas* and spread into dry lands surrounding the irrigated fields. Investment for these projects was due to the increasing role of social capital in newly created agrarian societies with the objective of purchasing and cultivating land. In their analysis, they also reflect on the difference between the role of the state and the role of the community in developing irrigation projects. As they contend, at the end of the nineteenth century and beginning of the twentieth, large hydraulic infrastructure

²⁴ Traditionally, the study of colonisation focused on the empirical knowledge of the ‘agrarian reality’ needed for the development of the Spanish countryside. These studies were established from the 1950s by different authors, mainly economists and agrarian engineers, associated or close to different institutions of the Spanish fascist regime (Gómez Benito 1995). It is possible to find in these publications a platform for the internal ideological development of ideas influencing the legislation of agrarian reform and colonisation politics. They also present meticulous accounts of the different policies and legislations and also the introduction of foreign accounts of international colonisation and agrarian experiences (e.g. Mussolini’s *bonifica integrale* or the american Tennessee Valley Authority experience) (*ibid.*). One of the preponderant discursive arenas for the development of colonisation doctrine, ideology and studies was the Institute of Agrarian and Social Studies (*Instituto de Estudios Agro-Sociales*) and its main publication the *Revista de Estudios Agro-Sociales* (Journal of Agro-social Studies), closely linked to the political and administrative structure of the Ministry of Agriculture (Gómez Benito 1995). More contemporary studies of colonisation plans and colonisation politics (e.g. Ortega 1979) have contextualised the development of colonisation politics within the wider framework of post-Civil War politics, the necessity to articulate new structures of state and the need for Franco’s government to develop the countryside, agriculture and Spain’s economy.

was developed by state-led public initiative whilst private initiative was concentrated on technologies that would provide short-term benefits. Hence, “the substitution of old water elevation devices for engines, a process which facilitated the extension of the limits of the traditional huertas” (Pérez Picazo and Lemeunier 1990: 173-174).²⁵

Against this backdrop, one of the aims of this thesis is to comprehend the role of the state in sustaining the development of groundwater irrigation, by understanding the underlying local aspects of technology transmission and adoption, and the local and regional responses of agrarian societies. Irrigation as a political technology in Spain has to be seen within a broader context of socio-political changes and environmental issues. It helped create in some cases political as well as social and economic subjects in the new towns and in the newly irrigated areas. As for Mosse (2003: 7) where, “water control systems come to inscribe new forms of power and new articulations of state and society”, during Franco's dictatorship irrigation and colonisation were seen as ideological tools to help create a new society and erase any traces of the preceding state. If irrigation systems can be understood as social systems (Mosse 1997), technology enabled the state to fix people to the land and create new social structures and communities, thus allowing for new forms of social and economic capital to emerge within new agrarian societies.

2.5.4 Burning water – the production of water scarcity in Spain

Another concern of this research is the production of water scarcity as a consequence of the adoption of groundwater abstraction technology in La Mancha.

²⁵ Author's translation from original quote in Spanish.

Although water scarcity and drought are naturally-occurring and spatially-moderated phenomena in the Iberian peninsula (Dominguez-Castro et al. 2008; Olcina Cantos 2001; Rico Amorós 2004), national governments since the nineteenth century have had a continuous interest in fabricating a semi-permanent state of drought in order to justify large national or emergency waterworks (Costa Martínez 1911; Morales Gil et al. 1999; Olcina Cantos 2001), thus neglecting the role of society in the fabrication of this (un)natural state. According to del Moral and Giansante (2000: 94-95), “the perception of a water deficit is embedded in Spanish water policy as a more or less permanent situation”. As they state, “[t]he experience of a water crisis, when it occurs, contributes to the justification and consolidation of the water management model [...] based on the systematic regulation of the hydrological system”.

Particular studies on water scarcity in Spain (Aguilera-Klink et al. 2000) show how the socially constructed notion of water scarcity in the Canary Islands operates within an arena of conflict over the allocation of water, arising from the political and institutional structures involved in the extraction and distribution of water. This does not take place in isolation from the physical world but in connection with it: the physical and natural processes are thus induced by the political as well as the social and institutional systems. Similarly to Aguilera-Klink et al. (*ibid.*), the irrigated landscapes of La Mancha are produced through a socio-political history of land and water management; technology and politics; nature and society (Llamas and Martínez-Santos 2005a). Thus, groundwater socio-ecologies create an intertwined arena where institutions, politics, society and nature are in constant interaction. The depletion of water resources can be seen as a by-product of the direct dialectical

relationship between the state, technology and society amidst a lax institutional regime of groundwater regulation.²⁶

2.5.5 A framework to analyse the role of the state in the production of groundwater socio-ecologies in La Mancha

Despite several major contributions to the revision of water politics in Spain (e.g. Lopez-Gunn 2009; Sauri and del Moral 2001; Swyngedouw 1999, 2007), an analysis of the material and political role of irrigation technology on socio-political structures at the national and local community level, and their impact on the environment, has yet to be undertaken. This approach reveals how irrigation politics has evolved historically, shedding light on how the political structures linked with irrigation water management affect both agrarian politics and agrarian socio-economic systems in Spain. Moreover, this research aims to elucidate the role of the state in the emergence of irrigation technology in Spain and the socio-political and environmental impacts of irrigation technology at the local level.

Against this backdrop, this research presents a framework for studying the different social, political, economic and environmental connections created by the use of irrigation technology. As Mollinga (2003: 16) states, “a comprehensive understanding of irrigation requires a framework that integrates technical and social science perspectives”. In his research Mollinga (2003) contends that irrigation is an inherently socio-technical phenomenon, the study of which requires understanding

²⁶ This research draws on previous studies of the transformation of the Las Tablas de Daimiel wetland, highlighting key factors affecting the hydrology of the river and the aquifer below (e.g. Bromley et al. 2001; Martinez Cortina 2001; Martínez Santos et al. 2008). The biophysical conditions and changes of the Mancha Occidental aquifer and the hydrological system of La Mancha as a result of irrigation are explained in more detail in Chapter 3 and Chapter 7.

both irrigation and technology as a social construction. As Mollinga (2003: 47) also put it, irrigation artefacts are “the most easily recognised embodiment of technology, and their design and construction forms the core of the professional competence of irrigation engineers”.

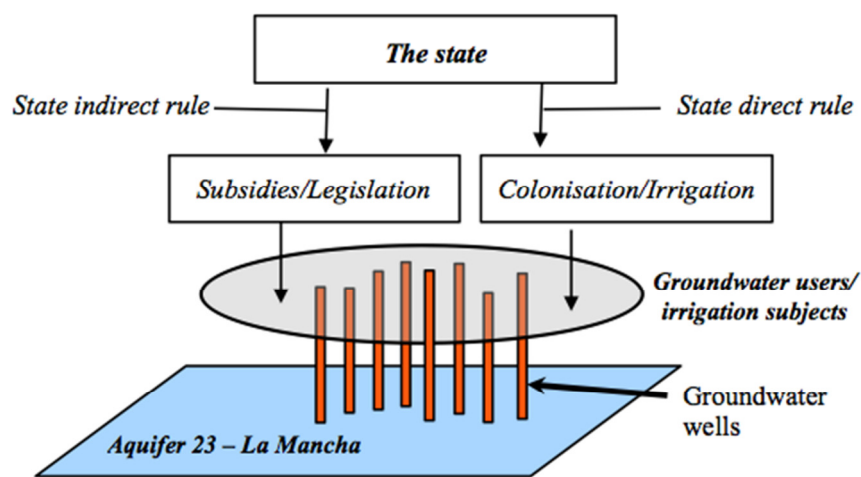
While technology represents the material structures, devices and objects of irrigation, it reflects political aspects of the process also. Thus, the study of technology has to differentiate between these two aspects in order to fully grasp the wider implications and repercussions of new technology. Irrigation technology simultaneously operates within a material system, political and social system. This technology therefore reflects its ideological and political uses through structures of power and control by the state. It is a system that connects nature and society, human and non-human categories; a hybrid system where technology sits at the centre, catalysing the interactions, exchanges and trade-offs between the agrarian, social, political, economic and the natural.

The material and symbolic dimensions of groundwater wells connect the physical system (i.e. the aquifer) with the socio-political level (groundwater users and state level) and create interdependencies at the watershed level.²⁷ Figure 2.4 is a visual model of these processes, depicting the state ruling indirectly over groundwater users through subsidies and water and agrarian legislation, and ruling directly through irrigation and colonisation politics. Irrigation as a 'political technology' had the effect of producing new irrigation subjects (the settlers as subjects of colonisation) and helped define a specific public polity and a new socio-natural structure. This aligned

²⁷ Studying groundwater socio-ecologies at the watershed level in La Mancha connects, as Schlager and Blomquist (2008) pinpoint, a physical landscape (i.e. natural resources, habitants and physical structures) with an institutional and political landscape. This institutional landscape is “a complex but largely invisible terrain of rules and organizations that govern and affect human choices about the making of decisions, the use of resources, and the relationships of people to nature and one another” (Schlager and Blomquist 2008: 1).

society, economy and nature with new political and bureaucratic structures and permitted the creation of new forms of socio-political and economic organisation in the countryside (e.g. water rights, land ownership, agrarian cooperatives). Thus, farmers in La Mancha appear as subjects of irrigation politics, not independent of state rule but in a structured and hierarchical relationship with it.

Figure 2.4 A visual model of state-ruled groundwater socio-ecology in La Mancha



Source: Author.

The following chapters will examine the role of the state in the production of groundwater socio-ecologies, the different types of state rule regulating the use of groundwater abstraction technology and the impact on irrigation farmers in La Mancha. Publicly funded irrigation and colonisation projects and the sponsorship of private irrigation by the state with a particular legal system of water abstraction rights affected the use and adoption of modern groundwater abstraction technology, which ultimately impacted on the regional environment of the Mancha Occidental aquifer and the Las Tablas de Daimiel wetland.

Chapter 3 . Study location and methodology

3.1 Introduction

This chapter outlines the methodology employed to study the role of the state in the development of modern groundwater socio-ecologies in Spain. The methods chosen to address these issues include: the study of state irrigation and colonisation politics in La Mancha; the construction of the town of Llanos del Caudillo; and the process of adoption of groundwater abstraction technology in Manzanares. Although there is ample academic research on the environmental impacts of groundwater abstraction in La Mancha (e.g. Alvarez-Cobelas et al. 2008; Bromley et al. 2001; Martinez-Santos and Martinez-Alfaro 2010; Martínez-Santos et al. 2008), the study of the history of groundwater abstraction technology in La Mancha is not so well documented.²⁸ A multi-method research approach was undertaken in order to examine the history of this phenomenon and to grasp the extent of the use of groundwater abstraction technology in La Mancha.

The structure of this chapter is as follows. The following section presents the study area and introduces the research site. The third section describes the design of the qualitative and quantitative research methods used to collect data for this research and the different validity issues and triangulation processes used. This section also raises some methodological limitations concerning the construction of historical narratives and the use oral history and archives. The final section includes an account

²⁸ Some of the few studies include those by Giner and Carrión (1999, 2005) and Glick (1970, 1977, 1992).

of the research methods used in this study, the origin of different sources of data and limitations affecting the data gathering process.

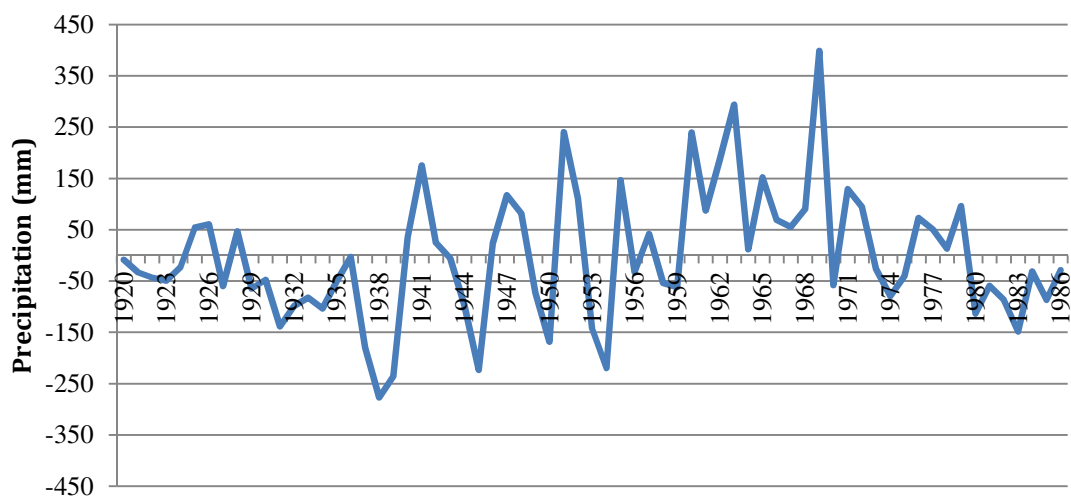
3.2 Study location

3.2.1 The Guadiana River Basin, the Mancha Occidental aquifer and the Las Tablas de Daimiel wetland

The Guadiana river basin has an area of 60,256 km², of which 55,412 km² are located in Spain and the remaining 11,600 km² in Portugal. The basin is shared between three autonomous communities in Spain: 48 percent is located within Castilla-La Mancha, 42 percent in Extremadura and 10 percent in Andalucía. The river is 810 kilometres long and the mean annual precipitation is 560 millimetres, with a mean evapotranspiration rate of 75 percent (CHG 2009).

The Upper Guadiana river basin is located between the headwaters of the Guadiana River in the Las Lagunas de Ruidera wetland and the El Vicario dam near Ciudad Real and has a surface of 16,130 km² (Cruces de Abia and Martínez Cortina 2000). The average flow at the El Vicario dam built in 1973 has been estimated at 400 Mm³ per year between 1931 and 1971, of which 300 Mm³ came from aquifer baseflow (Cruces de Abia and Martínez Cortina 2000). The climatic conditions in the Upper Guadiana river basin in La Mancha are typically semiarid, with hot and dry summers and short winters, long dry periods alternate with short wet sequences and produce an annual rainfall average of 415 mm (Figure 3.1) (Martinez-Santos and Martinez-Alfaro 2010; Martinez-Santos et al. 2008).

Figure 3.1 Inter-annual precipitation variability in Ciudad Real weather station (in mm)



Source: Based on data from AEMET.

The natural hydrogeological state of the Upper Guadiana river basin can be characterised by its interrelation between surface water and groundwater (Martínez Cortina 2001; Martínez-Santos et al. 2008). As described by Martinez Cortina and De la Hera (2002 in Llamas and Martínez Santos 2005b: 15), the dynamic equilibrium between surface water runoff, accumulated in small depressions of the terrain, “results in a series of lagoons and wetlands of unique ecological value.”

The Mancha Occidental aquifer – also called Aquifer 23 or Hydrogeological Unit 04.04 – is the main hydrological unit in the Upper Guadiana basin and is located entirely within the autonomous community of Castilla-La Mancha, covering an area of 5,500-km² (Figure 3.2). The aquifer system consists of: a highly transmissive Miocene aquifer with limestone and marl acting in an unconfined manner; a low-permeable Cretacic aquitard in the middle composed of limestone; and a deep impervious Jurassic aquifer with limestone and dolomite semi-confined by the middle aquitard. It is estimated that it has a natural storage capacity of 12,000 Mm³ before groundwater abstraction began (Martinez-Santos and Martinez-Alfaro 2010; Martínez-Santos et al. 2008).

The drainage system of the aquifer is naturally characterised by strong groundwater-surface interactions. Before intensive groundwater irrigation, the wetland constituted the natural source of aquifer discharge (Bromley et al. 2001) due to its impervious boundaries with paleozoic materials. The natural annual recharge of the aquifer has been estimated at around 592 Mm³ per year during the natural baseline period defined as before 1959 by Bromley et al. (2001). The aquifer is surrounded by neighbouring groundwater units such as the Sierra de Altomira and the Campo de Montiel aquifer units, contributing about 60 Mm³ per year of lateral recharge to the Mancha Occidental aquifer (Martínez-Santos and Martínez-Alfaro 2010).

Due to a series of dry years between 1974 and 1994, the water balance of the aquifer suffered a reduction of input by over 25 percent to 445 Mm³ per year. During the same period and as a result of the abstraction of groundwater for irrigation, abstraction volumes leapt 120 percent to a volume of 536 Mm³ per year (Bromley et al. 2001). Following the emergency provisions included in the 1985 Spanish Water Law, the aquifer was officially declared ‘provisionally overexploited’ in 1987 and ‘definitively overexploited’ in 1994 (Alvarez-Cobelas et al. 2001; Castaño-Castaño et al. 2008; Fornés et al. 2000). The disappearance of the iconic ‘*Ojos del Guadiana*’²⁹ and instances of burning peat, sporadic at first in the 1980s and endemic for more than a year in 2008-2009 indicated a critical situation of groundwater depletion in the aquifer (Moreno et al. 2011).

The Las Tablas de Daimiel wetland (Figure 3.2 and Photograph 3.1) is located at the confluence of the Guadiana River with the Cigüela River. It is a floodplain wetland in the semi-arid central plain of La Mancha in Castilla-La Mancha.

²⁹ Located around 12 kilometres northeast of Daimiel, the *Ojos del Guadiana* (Eyes of the Guadiana) are a natural water surfacing phenomenon caused by the combination of a depression of the terrain in the centre of the Mancha Occidental aquifer and a naturally high water table discharging into the surface (Martínez Cortina 2001).

The wetland covers an area of around 20 km² with a 13,000-km² catchment and a natural flooded area of 16.75 km² (Alvarez-Cobelas et al. 2008; Cirujano et al. 1996). Under natural conditions the hydrological system of the wetland is a combined river flooding from the Guadiana and Cigüela rivers with seasonal streams of groundwater discharge (Alvarez-Cobelas et al. 2008; Castaño-Castaño et al. 2008). The wetland was first classified as a hunting reserve in 1966 and a national park in 1973. From 1982 it has been designated a RAMSAR site, and from 1988 considered by the European Union as a special protection area for birds (Berzas et al. 2000). During the first half of the twentieth century the upper Guadiana river did not suffer any major surface changes and the inundated surface of the wetland in the 1960s is considered to be 25,000 hectares of which only 7,000 remain nowadays (Cruces de Abia and Martínez Cortina 2000).

Photograph 3.1 The Las Tablas de Daimiel wetland, La Mancha

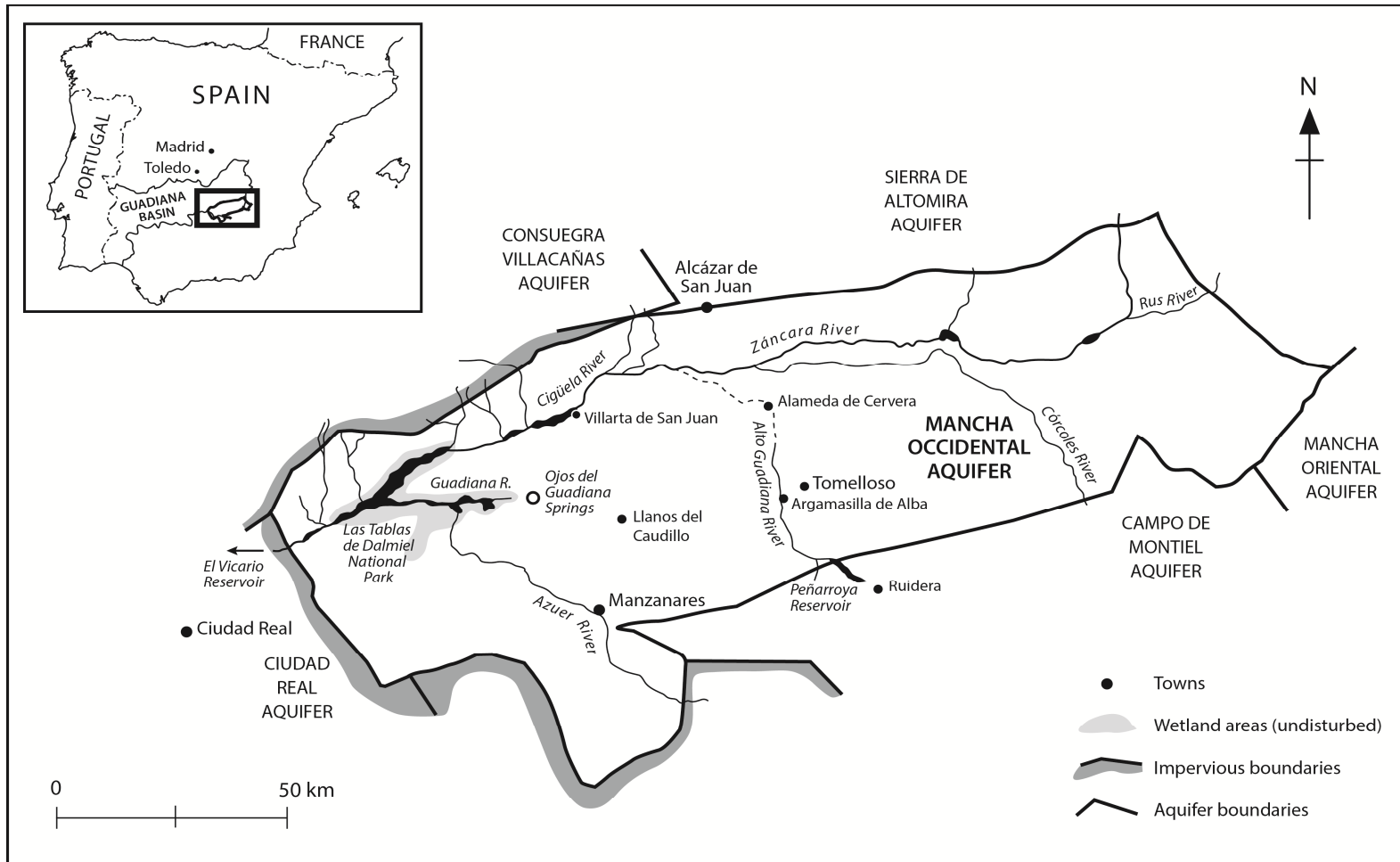


Source: Author.

Due to the development of irrigation for agriculture, surface and groundwater variations since the 1950s have resulted in the lowering of the water table and have

impacted on the balance between livelihoods and the environment in La Mancha (Martínez Santos et al. 2008). From the 1970s to the 1990s irrigated surface using groundwater increased from 34,000 hectares in 1973 to 130,000 hectares in 1987 (Bromley et al. 2001). Compared to a national average of 28 percent, in the Upper Guadiana river basin irrigation with groundwater accounts for 92 to 95 percent of the total water use in the area (Martínez Santos et al. 2008; Montoro Rodríguez et al. 2002).

Figure 3.2 Research area



Source: Adapted from Martínez-Santos and Martínez-Alfaro 2010: 173.

3.2.2 Historical groundwater regulation in Spain

Groundwater abstraction in Spain has historically been regulated according to the 1879 Water Law. This law, in use for 106 years until its revision in 1985, gave control of groundwater abstraction rights to the private owner of land or the well-driller. This formula established by the legislator aimed to ensure access to private property, promote consumptive uses and increase productivity of groundwater abstraction ventures (Maluquer de Motes 1983; Moreu Ballonga 2002).

Although the 1879 Water Law did not establish any controls or limitations for the volume of groundwater abstractions, groundwater abstraction permits were controlled by a series of decrees and ordinances. The 1879 Water Law established the Department of Mines (within the Ministry of Industry and Mines) as responsible for the control and management of groundwater. In order to regulate the use and abstraction of groundwater, the Ministry of Industry and Mines issued the Regulation of Mining and Metallurgical Police in 1934. This regulation established the corps of engineers from the Ministry of Industry and Mines with the authority to inspect and control boreholes.³⁰ Thus, each individual wishing to drill a well would have to obtain a permit at the provincial delegation of the Ministry of Industry and Mines, stating the characteristics of the well drilled and the type of technology used to abstract groundwater.³¹

³⁰ Although the Ministry of Industry and Mines had the legal mandate to regulate and legislate groundwater according to the previous 1849 Law of Mines (which included groundwater as part of the regime of competencies of this Ministry), regulation conflicts arose after the 1879 Water Law with the Ministry of Public Works and later with the Ministry of Agriculture. See Chapter 7 for a more detailed explanation of these regulatory conflicts.

³¹ This constitutes the dataset obtained at the Community of Irrigators of Manzanares.

The reform of the 1879 Water Law came in 1985 and one of its aims was to change the regime of groundwater private abstraction rights by declaring groundwater part of the public water domain. New groundwater regulation competencies fell under the Ministry of Public Works and various river basin agencies. Under this new legal framework, irrigators would need to acquire public concessions to abstract groundwater. However, special clauses found in annexes of the 1985 Water Law limited the regulatory effects of the law and granted a temporary grace period of 50 years or permanent private rights to groundwater abstraction users with already existing historical groundwater rights (Moreu Ballonga 2002; Fornés Azcoiti et al. 2005).³² This led to a lack of cohesion and implementation of the law within the system of groundwater abstraction rights. The subsequent legal chaos incentivised many farmers not to regularise their abstraction rights, creating a situation of non-legality for many groundwater wells (Molinero et al. 2011).

3.2.3 Selection of the study area

Following preliminary scoping studies in Spain, the Mancha Occidental aquifer, Manzanares and Llanos del Caudillo were chosen as case studies for this research. The aim was to find a site in Spain with increasing water stress and existing historical archives that would provide an accurate socio-political and hydrogeological context for the development of irrigation and agriculture. The existence of this aquifer in Spain's central plains, sustaining almost exclusively agriculture and irrigation, provided some characteristics that made it suitable as a research case study.

³² See Chapter 7 for a more detailed explanation of the legal codification of groundwater abstraction rights under the 1985 Water Law.

According to Martínez Santos et al. (2008), the effects of intensive pumping on the hydrological dynamics of the aquifer decreased the water table, causing a disassociation between the groundwater and surface water networks in much of the aquifer area. The fact that the Las Tablas de Daimiel wetland represents the main drainage point of the aquifer also makes it a convenient location to study the direct impacts of groundwater overabstraction on the environment. Additionally, the intensity of colonisation policies and irrigation plans developed in the same area by the National Institute of Colonisation (INC) suggest continuous state involvement through agrarian policies since the 1950s. The presence of the state in towns such as Llanos del Caudillo also affected the economic and agricultural development of the region through the settlement of farmers and the intensive use of groundwater for irrigation.

The geographical area of La Mancha is administratively located in the autonomous community of Castilla-La Mancha and is formed of three provinces: Toledo, Ciudad Real and Albacete. Although La Mancha is not an administrative delimitation per se, it epitomises the traditional depiction of a particular type of arid landscape³³ in Spain found in classical texts such as *Don Quixote de la Mancha*³⁴ (Photograph 3.2). This landscape continued to influence artists and writers of the

³³ In Arabic the toponym 'La Mancha' means "without water" (Pillet Capdepón 2002; García Marchante and Fernández Fernández 2000). In this barren land, two elements are constantly present through which the identity of the place has been established: the plain and water (or the lack of it). It has a single landscape unity, climatic and topographic and represents the largest plain in the Iberian Peninsula (García Marchante and Fernández Fernández 2000). Crow (2005: 4), in his description of Spain, points out that "the central tableland of Castile comprises approximately 60 per cent of the total area of Spain. [...] This Castilian *meseta* is not only the heart but also the citadel of Spain. It is a land of dryness, of treeless mountains, and of waterless plains [sic]."

³⁴ The book *Don Quixote* by Cervantes has direct references to the Guadiana river: "Your squire Guadiana bewailing likewise your misfortune was changed into a river of the same name, which, when it reached the surface of the earth, and saw the sun of the other sky, was so grieved at the thoughts of leaving you, that he sunk down into the bowels of the globe; but, as it was not possible for him to resist his natural current, he from time to time rises up, shewing himself to the sun and to the nations: he receives a reinforcement from the waters of the forementioned lakes, with which, and many others that join his stream, he enters Portugal in majesty and pomp [sic]" (Cervantes 2003: 484).

Generation of '98 such as Unamuno, Azorín or Machado (Ortega Cantero 1999, 2007).³⁵

Photograph 3.2 Landscape of La Mancha, Alcázar de San Juan



Source: Author.

During the initial stages of research, various academics with extensive knowledge were consulted in order to establish the suitability of the research site. Dr. Giorgos Kallis at the Institute of Environmental Science and Technology (ICTA) at the Autonomous University of Barcelona provided insightful initial theoretical comments, while Dr. Elena Lopez-Gunn and Prof. Ramón Llamas from the *Observatorio del Agua* (Water Observatory) at the Complutense University of Madrid contributed with extensive and first-hand knowledge of the site. Conversations with Dr. John Bromley from the School of Geography at the University of Oxford, who

³⁵ The Generation of '98 was a cultural and artistic movement which appeared in Spain at the turn of the century. As a movement, it alluded in its artistic expressions to the moral and social decline of Spanish society after the loss of the last colonies in Cuba in 1898. See Chapter 4 for a more detailed explanation.

has experience of the area, also helped me compare different potentially suitable sites in Spain. This initial scoping analysis showed that the Las Tablas de Daimiel wetland system and the Mancha Occidental aquifer offered a suitable study site based on existing historical data and recent hydrological studies. Previous work carried out by a research group co-led by Prof. Ramón Llamas at the Complutense University of Madrid, Dr. Luis Martínez Cortina from the Spanish National Geological Institute (IGME) and Dr. John Bromley at the School of Geography has compiled enough knowledge to allow me to contrast my research findings with already established research in irrigation, hydrological and environmental change in La Mancha.

As a whole, La Mancha encapsulates several social, political and environmental features making it a suitable area to research: (1) the intensity and rapid expansion of groundwater irrigation; (2) the almost exclusive dependence on groundwater for agriculture; (3) the change from traditional water lifting technologies to modern technologies to cope with the increase in irrigated land; (4) the direct intervention of the state through colonisation and irrigation plans in the area; (5) the direct impact of irrigation on the depletion of aquifer reserves and the subsequent desiccation of the Las Tablas de Daimiel wetland.

3.2.4 Detailed study area

Fieldwork for this research was located in Madrid and La Mancha. Towns in La Mancha where specific fieldwork was carried out include: Alcázar de San Juan, Alameda de Cervera, Argamasilla de Alba, Ciudad Real, Llanos del Caudillo, Manzanares, Ruidera, Villarta de San Juan and Tomelloso (Figure 3.2).

The towns of Alcázar de San Juan, Alameda de Cervera, Argamasilla de Alba, Llanos del Caudillo, Manzanares, Villarta de San Juan and Tomelloso are located within or close to what was designated by the Ministry of Agriculture and the INC in 1954 as, the Area of General Interest for Colonisation and Irrigation of La Mancha. The municipalities of Manzanares and Alcázar de San Juan were affected by INC land expropriation plans for the colonisation and irrigation of Sector I of La Mancha. Research in Manzanares included archive work at the Community of Irrigators, several interviews and also one transect walk. Research in Llanos del Caudillo included a sample of three interviews to settler-farmers and one transect walk. The headquarters of the *Comunidad General de Regantes del Acuífero 23* (General Community of Irrigators of Aquifer 23) are located in Tomelloso and here I conducted several interviews and carried out four transect walks. Ciudad Real is the administrative and political capital of the province where the headquarters of the *Confederación Hidrográfica del Guadiana* (Guadiana River Basin Authority) are located.

The town of Llanos del Caudillo was planned, designed and built by the state as part of the colonisation and irrigation programme of the National Institute of Colonisation in La Mancha.³⁶ As a consequence of this declaration in 1951, an area of 2,000 hectares was declared of national interest for colonisation and irrigation by the state. Through technical studies in 1952, the presence of groundwater for irrigation was established and work began on drilling exploratory wells. Expropriations from local landowners from Manzanares within the designated area followed, and in February 1953 the construction of the town began. Initially, 82 families of settlers

³⁶ See Chapter 5 for a detailed account of the planning and construction of Llanos del Caudillo.

moved in between February and March 1955 and in September 1955 an additional 38 families arrived in the town.

I also chose Argamasilla de Alba as a research site because it presents a mixed system of historical irrigation rights with superficial irrigation sponsored by the state, (coming from the Peñarroya Irrigation Scheme) and groundwater irrigation through wells. Moreover, I attended a conference in Ruidera to meet two of my key informants: Mr. Agustín Apio, President of the Community of Irrigators of Aquifer 23 and Sebastian Ruiz Constantino, Secretary of the Community of Irrigators of Manzanares.

3.3 Methodology

3.3.1 Design of research methods

The methodology of this study is based on a combination of archive research and qualitative interviews carried out during six months in Spain. The research emphasis was on assessing the effect of different state policies on the socio-political history of irrigation, land use, agriculture and agrarian change in La Mancha, considering the processes of groundwater abstraction technology change and their environmental consequences. This methodology was designed to focus on the process the adoption of groundwater abstraction technology particularly at the community level.

During the preliminary methodological assessment period, I reached the conclusion that overlapping archive research with qualitative methods would provide a more accurate approach to studying the phenomenon of groundwater irrigation in La

Mancha. In order to establish a successful dialectical juxtaposition between these two methods, archive work was collated and contrasted with generated quotes from key informant interviews and local farmers. Additionally, during the definition and initial stages of my fieldwork I used participant observation and non-structured interviews with farmers in two focus groups, one organised by the *Observatorio del Agua* at a seminar in Madrid and the other in Herencia (La Mancha) at the offices of the Community of Irrigators (Annex 1, Table 2).

Archive research focused on the study of irrigation communities established by the state in order to provide information on land change, agriculture and irrigation projects and infrastructures. A constant iteration process complemented the study of local archives in Manzanares and national ministerial archives in Madrid with qualitative in-depth interviews with farmers, academics and water managers.

Part of the research process included gathering historical data as a means of “establishing a baseline or background prior to participant observation of interviewing” (Marshall and Rossman 1999: 123). Archive research also helped me “supplement participant observation, interviewing and observation with gathering and analyzing documents produced in the course of everyday events or constructed specifically for the research at hand” (Marshall and Rossman 1999: 116).

Qualitative analysis mainly concentrated on the extraction of key quotations from interviews, which were then codified and arranged according to general themes. Each quotation and theme was then matched according to the question or hypothesis they would inform. As Marshall and Rossman (1999: 43) wrote: “although no qualitative studies are generalizable in the statistical sense, their findings may be transferable”. Qualitative methods were used with the purpose of “[delving] in depth into complexities and processes” and to “research on little-known phenomena”

(Marshall and Rossman 1999: 57). The sampling selection of interviewees was based on their professional experience established according to their age.³⁷ The objective was to find farmers that participated in the initial boom of irrigation in the early 1960s and 1970s but who also had experience of traditional norias in La Mancha.

The sampling strategy during the initial stages followed various typologies. Drawing on the typology described by Miles and Huberman (1994 in Marshall and Rossman 1999: 78), the sample strategy firstly included selecting interviewees through initial participant observation sessions. It focused on, “identifying cases of interest from people who know people who know what cases are information rich” (the so called snowball effect) (Marshall and Rossman 1999: 78). Additionally, it integrated opportunistic strategies following new leads that appeared during the interviews.

3.3.2 Methodology validation

The data gathered for this research included historical and longitudinal data both of which present some validation problems. As Bellaby (1991: 21) points out, when comparing historical and archive sources with real life accounts given by interviewees, I was presented with the fact that:

“histories or documents of life are not there waiting to be taken. They have to be composed. Like snapshots, they are not panorama but partial views. [...]

Each is constrained by the present purpose for which it is composed. Of the

³⁷ The assumption here was that the farmers’ experience and exposure to traditional irrigation technology would increase with their age. The average age of the farmers interviewed was 77 years.

immense range of past events in anyone's life, only some are relevant to each crucial purpose. [...] Thus, many accounts may be given of the same life. Triangulation becomes feasible.”

Validation was ensured through the triangulation of interviews with archive research and hydrogeological data related to the same research area (Table 3.1). As Bellaby wrote (1991: 21-22), triangulation becomes a way of seeking “cross-validation on matters of fact”. Additionally, triangulation allows the researcher “to use different viewpoints on the same reality in order to complete a panorama (where the accounts complement each other [...])” and “to discover a structure beneath the surface of the accounts in spite of apparent contradictions between them” (*ibid.*). During the design stages of this methodology, triangulation and cross validation between the three bodies of knowledge (archive data, qualitative interviews and hydrological data) proved essential to verify and contextualise the research findings (Table 3.2).

Data for precipitation, groundwater abstractions and groundwater table levels were collected from official sources at the Spanish Meteorological Agency (AEMET) and the National Institute of Geology and Mines (IGME). This helped contrast qualitative findings and quotes collected during interviews with scientifically sound data about the natural environment. Relevant quotes from interviews were used to highlight relevant aspects of research and illustrate the historical processes analysed recalled by testimonies.

The Manzanares data set added a third triangulation layer, providing localised data for the visualisation of the evolution process of technology use for groundwater abstraction in the municipality of Manzanares. Quantitative statistical analysis based

on a logistical regression model was carried out in order to validate the qualitative analysis of the Manzanares data.

Table 3.1 Data sources used for the research

<i>Data source</i>	<i>Data collection method</i>	<i>Type of data collected</i>	<i>Location</i>	<i>Dates</i>
Primary sources	Interviews	Qualitative personal data	Madrid, La Mancha	January to June 2011
	Exploratory trips	Preliminary qualitative data	La Mancha	August 2010 March 2011
	Participant observation	Preliminary qualitative data	Madrid, Herencia	March 2011 and May 2011
	Transect walks	Qualitative data, photographic evidence	Tomelloso, Manzanares, Llanos del Caudillo	June 2011
Secondary sources	Archives	Hydrological and hydro-geological data State-led colonisation and irrigation projects Agrarian census data	Ministry of Agriculture (General archive and archive), AEMET, IGME, National Geographic Institute	January to April 2011
	Archives	Groundwater abstraction technology data	Community of Irrigators of Manzanares	June 2011

Note: For more information on the interviews, participant observation and transect walks, see Annex 1.

Source: Author.

Table 3.2 Data validation and triangulation

<i>Parts</i>	<i>Triangulation methods</i>	<i>Data sources for triangulation</i>
<i>Data</i>	Iterative process Multiple data sources Quantitative analysis Statistical validation	Ministry of Agriculture Manzanares data set IGME AEMET Complutense University of Madrid
<i>Theory</i>	Multiple theory	Hybridity of mundane objects Political technology – Governmentality/Environmentality Social production of nature
<i>Methodology</i>	Multi-methods	Archive data Exploratory trips Qualitative in-depth interviews Transect walks Participant observation

Source: Author.

3.3.3 Methodological limitations

The need to generate data on the use and transformation of groundwater abstraction technology in La Mancha represented a challenge, largely due to the fact that such process had no been studied before. Focusing on this subject meant that I was compelled to make use of research methods that both produce data and gather new knowledge from direct sources and local archives. In this section, I present in more detail several methodological issues that arose during fieldwork, relating to the construction of historical narratives and the use of oral history and archives.

3.3.3.1 *Historical narratives*

During the exploratory phase of research, a series of in-depth and semi-structured interviews involving mostly open-ended questions, were planned in order to construct a unique historical narrative of the development of irrigation in La Mancha. Drawing on Bakker (2000), this method allowed me to gather evidence that supported inductive reasoning. Personal accounts from original settlers and farmers played an essential role as they were part of the untold story of those involved in the mechanisation and development of agriculture in this region. As a result, I was compelled to consider these personal narratives in order to retrace the history of the advent of irrigation in La Mancha. Of course, dealing with memory can sometimes be problematic as historical and time references are often difficult to pin down.

This methodology aimed to identify a common narrative between oral history and archive data in order to present in a continuous textual form, the historical events unfolding during my fieldwork. As Cronon (1992: 1349-1350) suggests, this method risks the simplification of complex issues, since in the process of writing stories about environmental change, “we divide the casual relationships of an ecosystem with a theoretical razor that defines included and excluded, relevant and irrelevant, empowered and disempowered [...] narrative remains essential to our understanding of history and the human place in nature.” Thus, historical events only make sense according to the order they are placed within a particular narrative.³⁸

The validity of personal narratives is often questionable and it is not always clear how valid they are for extrapolation and integration within a unique analytical

³⁸ A historical narrative is following Cronon’s description a sequence of actions “that begins, continues over a well-defined period of time, and finally draws to a definite close, with consequences that become meaningful because of their placement within the narrative” (Cronon (1992: 1367).

framework. However, as White (1980: 27) wrote, the real value of representation and narration of real events is that such a sequence responds to the desire to have real events display a coherence, integrity and closure, “of an image of life that is and can only be imaginary”. Any image of life, or what has also been called the 'illusion of sequence' (Ricoeur 1980), is culturally and socially represented in time and is “fundamental to the way we humans organize our experience” (Cronon 1992: 1368). It is for that reason that the motivation for telling *that* particular story makes sense in the eyes of the analyst: it is not a matter of a story or 'History' anymore but of 'histories' (Worster 1994: 14). These histories unfold in front of the eyes of the analyst as landscape to be understood and studied and as interactive histories telling “plenty of stories of human folly” (*ibid.*).

The series of personal accounts used in this research, represent different crucial moments in the evolution of groundwater management in La Mancha. I do not attempt to generalise from each case study, however, (Bakker 1998) but build my analysis and conclusions from the particular analysis of these cases. Emphasising Haydu's (1998: 351) point, the use of historical narrative, “can identify common patterns in sequences of events in two different periods [...] or can treat elements of each period as themselves events in a larger and longer sequence”. Thus, the use of historical narratives finds its justification in the study of the irrigated landscapes of La Mancha; to understand the development of particular groundwater abstraction technologies as part of a wider socio-natural process where irrigation and the environment are intrinsically bound with historical political state structures.

3.3.3.2 *The use of oral history*

The methodology developed for this research generated a specific kind of data. Through semi-structured interviews, informants recalled historical accounts of lived experiences. The use of such a method proved difficult in some cases due to the length time elapsed since the event being described. This raised the methodological limitations of oral history as data, i.e. history that has not been recorded. Oral history³⁹ arises according to Yow (1994: 4) from recorded in-depth interviews, “based on direct intervention by the observer and on the evocation of evidence.” Research has therefore to generate information – or evidence – as “the result of the interviewer's questioning” (Yow 1994: 5). For Yow, the life and live review that exists through the study of oral history reveals other and deeper kinds of information materials “that do not get into the public record”, or that otherwise would have been unknown without written accounts (Yow 1994: 11). For these reasons, oral history is to be treated as any other source of information. Thus, “[o]ral history testimony is the kind of information that makes other public documents understandable” and also reveals “daily life at home and at work – the very stuff that rarely gets into any kind of public record” (Yow 1994: 12).

Limitations of oral history lie mainly in the selection of the narrator and in the potential uses of retrospective data (Yow 1994). The ability to recall data is affected by a multiplicity of variables: the interviewees' health, the topic being considered, the phrasing of the question, etc. Since reminiscence is an important part of human memory, this is often prone to biases and manipulation which have to be taken into account by the analyst (*ibid.*). The subjective interpretation of life events is always

³⁹ Also called retrospective historic data, autobiographical memory or recall data.

subject to an agenda, by the narrator, interviewee and the interviewer/analyst. Through the interviewing process the narrator, “constructs a self or an identity” (Yow 1994: 173). The interviewer tends to seek continuity and narration in the interviewee's answers and for “the topics they choose to interject fit into the picture they have of their life so that it remains a comprehensible whole, with a limited number of themes” (*ibid.*). This presents an analytical problem: interviewees will sometimes simplify events for the sake of the interviewer's understanding which then might affect the results of the interview.

As Dex and McCulloch (1998) also make clear, there are a range of reliability and validity problems related to retrospective historic data. Event dates are the most difficult to recall and general reliability is lower in the cases of a longer recall period. However their research also indicates that this reliability varies according to subjects.⁴⁰ Studies on autobiographical memory suggest that long-term memory recall is a slow process that is, “generated from an underlying knowledge base and [...] constructed in consciousness” (Conway and Loveday 2010: 56). The subject thus constructs a specific narrative by integrating certain past episodes intentionally into a personal autobiographical knowledge (Conway and Loveday 2010). The voluntary retrieval of autobiographical memory, “requires constructive memory search” and “may fail because irrelevant information is sampled instead of relevant ones” (Pastötter and Bäuml 2010: 202-203). Thus, the accurate recovery of memories is

⁴⁰ Accuracy of oral history and recall data has been tested against archive data in the case of personal general and simple health retrospective data (Berney and Blane 1997). With specific interviewing techniques such as lifegrid interviews, recall data was proved to be 80 percent accurate after a period of 50 years. However data collection techniques present limitations in terms of the quantity of data that can be retrieved (only for simple factual information in the case of the lifegrid technique used in their research) (Berney and Blane 1997).

often particularly inhibited by the emotional content of past events (Pastötter and Bäumel 2010).⁴¹

To summarise, oral history has intrinsic value as a direct testimony of past personal experiences, although it is prone to subjective errors and bias both from the interviewee and the interviewer. Oral history accounts can however unveil the social and human dimensions within communities (Yow 1994). Through testimonies, the researcher is able to understand “the meaning of artefacts in the lives of people” (Yow 1994: 14), which can be addressed using complementary empirically generated data and theoretical tools. Additionally, that this type of data can generate validity problems is the result of the fact that, in the context of this study, there is no previous research to compare it with. Thus triangulation with other methods is needed to substantiate and validate any research findings based on oral history.

3.3.3.3 *Archive research*

The use of archive research is not immune from methodological limitations affecting the quality of data generated. Public archives are not neutral or objective and, particularly in the period studied in this thesis, formed part of the standard

⁴¹ Anthropologists have also addressed the problem of accuracy of retrospective data (e.g. Bernard et al. 1984). In their research, these authors suggest that accuracy is difficult for the simple fact that “[i]nformants are inaccurate; memory does decay exponentially with time. [...] And on top of all this there appears to be systematic distortion in how informants recall just about everything. Furthermore, recall may be effected by the subject of the study, by whether informants are aided in their recall in some way during the interview” (Bernard et al. 1984: 509). Thus, it is important to acknowledge “what the errors bound are for the instruments that we use to collect those data” (*ibid.*). Then it is possible to identify the level of accuracy that can be achieved with the instruments used “after making empirical and/or theoretical corrections” and knowing “whether any informant is sufficiently accurate to rely upon his or her responses” (Bernard et al. 1984: 512).

official doctrine and discourse of Franquism⁴². In spite of this, the use of official texts in research allows us to explore how activities within organisations are mediated, regulated, and coordinated (Smith 2001). The use of this type of factual document, however, presents uncertainties according to the type of document used to reflect and illustrate certain historical events. This responds to what Smith (1974: 259) has called, “the operation of formal organization”. As she wrote,

“the construction of social phenomena in their familiar and recognizable forms, *as they appear to us*, is in large part a product of the reporting and accounting procedures of formal organizations which in various ways provide for how the society is governed [Emphasis in original]” (Smith 1974: 257).

Factual information has to be contextualised within the set up of the “specific organizational contexts of interpretation”, ultimately depending “upon a social construction” (Smith 1974: 260-263). In this research, the potential ideological and bureaucratic biases included in the official INC archives were triangulated through direct engagement with members of the local community of farmers and irrigators in Llanos del Caudillo and Manzanares, as well as during other in-depth interviews.

An additional limitation related to the validity and consistency of this type of data relates to administrative and organisational changes in the structure of government. Competencies over water management have been shared in the past fifty years between different ministries: the Ministry of Public Works, the Ministry of

⁴² *Language note:* Franquism or ‘*Franquismo*’ in Spanish is the term used by historians to designate the political and ideological regime put in place by Franco during his dictatorship between 1939 and 1975.

Agriculture and the Ministry of Industry and Mines.⁴³ In this case, triangulation with other information sources, such as qualitative interviews, proved essential in identifying relevant narratives and key documents that could be used to prove or discredit them. Complementary sources from other ministerial archives (i.e. Ministry of Public Works; Ministry of Environment; Ministry of Agriculture) and different public research institutions (i.e. the IGME and the National Geographical Institute) also helped contrast and expand the findings generated at the archives of the Ministry of Agriculture. Secondary sources found in the libraries of the Complutense University of Madrid (i.e. Geography and History; Politics; Geology; Law) provided background reading to historically, socio-politically, economically and legally contextualise the processes of agriculture transformation, land management and irrigation in Spain and La Mancha.

3.4 Research methods

3.4.1 Theory and research methods

Political and institutional level data was obtained from secondary archive sources from the archives of the Ministry of Agriculture. This informed the study of irrigation and colonisation policies of the Franquist government in La Mancha and state involvement in the initial stages of groundwater irrigation. Archive research also helped gather information about specific plans affecting agriculture and irrigation in La Mancha and the construction of the town of Llanos del Caudillo.

⁴³ See Chapter 7 for a historical description of administrative and legal changes over groundwater management competencies.

Processes of technology adoption at the local level in La Mancha were analysed through quantitative data collated from local archives in Manzanares and qualitative in-depth interviews. The analysis of quantitative data was accompanied with quotations from interviews, both of which were used as a means of hypotheses testing. This study also complemented the more general data set generated at the ministerial archives, detailing the political, administrative and institutional aspects of colonisation and irrigation politics in La Mancha.

The social, economic and political effects of irrigation technology adoption at the community level were extracted from secondary academic sources. In-depth interviews helped define the historical socio-economic background of the community of farmers in La Mancha and supported the study of statecraft processes during the development of groundwater irrigation.

The study of environmental and natural responses to these socio-political and technological processes was based on both secondary data gathered during in-depth interviews in Madrid and in La Mancha and previously developed scientific research projects. Specific meteorological data on inter-annual variability of rainfall in Castilla-La Mancha was obtained from the Spanish Meteorological Institute. Hydrological information for surface and groundwater abstraction levels in the research area was found in scientific reports and data provided by the Spanish Institute of Geology and Mines.

3.4.2 Preliminary research

Preliminary research consisted of three exploratory fieldtrips to the research area and four qualitative interviews informing the design and development of hypotheses. Two participant observation sessions also helped design the data collection strategy and refine my research goals. One participant observation session with farmers and researchers was carried out during a research seminar organised by the Botín Foundation at the Complutense University of Madrid (23rd of March 2011) on groundwater common management. Here, I conducted three non-structured interviews with two experts on groundwater management and one farmer from La Mancha. The second participant observation session was conducted during a focus group with members of the Community of Irrigators in Herencia organised, during a fieldtrip with researchers from the Complutense University (25th of March 2011). A second exploratory visit to La Mancha (11th of March 2011) complemented the preliminary research with one non-structured interview with a farmer-irrigator from Llanos del Caudillo.

Participant observation during these conferences and seminars proved essential for the hypotheses building process. It helped contrast my own deductions and observations with direct observation of the participants. Additionally, this process helped me put into a discursive and social context their own contributions to contrast with those of their peers. Data gathered through semi-structured interviews was also used to build the framework of analysis and to inform and validate the historical narrative. It also represented a valuable source of key quotations used to illustrate the living conditions in the area and the different adoption methods of groundwater abstraction technology.

3.4.3 Ministerial archive research

Five months of research at the general archive of Ministry of Agriculture in Alcalá de Henares (Madrid) allowed me to access original historical documents on the development of agriculture and irrigation by the INC in La Mancha. The general archive of the Ministry of Agriculture is the historical archive containing all INC documents and files. In these archives I analysed secondary data sources to obtain a detailed view of the historical development of both the state-sponsored irrigation projects and the internal bureaucratic and administrative processes of state colonisation politics in La Mancha. The analysed data set consisted of 84 technical and administrative reports of colonisation plans in La Mancha; 60 boxes of internal communications from the Official Registry of the INC dating from 1949 to 1971; and 13 boxes containing the files of estates and land expropriated in order to build La Mancha's colonisation and irrigation project.⁴⁴

Findings from the general archives of the Ministry of Agriculture were complemented by visits to the library and archive of the central building of the Ministry of Agriculture in Madrid. This allowed me to gain access to additional documents, photographic archives of the INC as well as specific legislation documents.⁴⁵

⁴⁴ This data is referred to as 'Registry INC Correspondence' in the following chapters. The references given include the box number where the document was found as well as the file and document number used by the archivists at the General Archive of the Ministry of Agriculture.

⁴⁵ This study however is not meant to be an exhaustive study of the laws of colonisation and irrigation issued in Spain. The laws and decrees mentioned and analysed have been chosen for their intrinsic historical importance and their specific relevance to the colonisation of La Mancha.

3.4.4 The Manzanares data set

3.4.4.1 Description of the data set

Data for the longitudinal analysis of different methods of groundwater abstraction in La Mancha was found in the Archives of the Community of Irrigators in Manzanares.⁴⁶ The Manzanares data set consists of receipts of individual permits authorising the drilling of wells and abstraction of groundwater, issued by the Ministry of Industry and Mines between 1947 and 1985.⁴⁷ In these receipts, the Ministry stipulates the type of technology used by the owner of the well (i.e. noria or borehole); the owner's name; the farm or estate name; the dimensions or diameter of the well; the depth of the well; the presence of an engine in the well; the pump capacity; the type of energy used (electric or diesel); and the engine's power (Figure 3.3).

⁴⁶ The Community of Irrigators of Manzanares was created in 1989 including the municipality of Manzanares and Llanos del Caudillo. It comprises 12,253.18 hectares of declared irrigated land and 800 members (Lopez-Gunn and Hernández-Mora 2001; <http://agroforestal.geoscopio.com/empresas/manzanares/>, last accessed 13th of November 2012).

⁴⁷ The records for the use and abstraction of groundwater ('*Alumbramiento de Aguas Subterráneas*' in the original Spanish language) were controlled by the Ministry of Industry and Mines until 1985. According to the 1879 Water Law, groundwater was a natural resource legislated according to private law and overseen by the Ministry of Geology and Mines. After 1985 with the new Water Law, groundwater became part of the public domain (See Chapter 7).

Figure 3.3 Sample of registration receipts for well drilling permits issued by the Ministry of Industry and Mines

MINISTERIO DE INDUSTRIA SECRETARÍA DE MINAS Y ENERGÍA <u>Alcantarillado de Aguas Subterráneas</u> Forma N° 14-735 CONDOMINIO AGRICOLA SUBSISTENTE, S.A. Técnico: <u>AGRICOLA</u> Parqueadero de la Faja Fecha de petición: _____ Fecha de autorización: <u>13-5-75</u> Dimensiones de la obra o pozos: <u>Sección 0.40 Prof. 41 m.</u> Características del motor y bomba: <u>Motor de 5 c.v. y bomba vertical de 50.000 l/h.</u> Observaciones: _____ TOP. E. PINO, PRESIDENTE, CO-ORDINADOR LOCAL	MINISTERIO DE INDUSTRIA Y ENERGIA SECRETARIA DE MINAS Y ENERGIA <u>Alcantarillado de Aguas Subterráneas</u> Forma N° 14-735 CONDOMINIO AGRICOLA SUBSISTENTE, S.A. Técnico: <u>AGRICOLA</u> Parqueadero de la Faja Fecha de petición: <u>13-5-75</u> Fecha de autorización: _____ Dimensiones de la obra o pozos: _____ Características del motor y bomba: _____ Observaciones: _____ TOP. E. PINO, PRESIDENTE, CO-ORDINADOR LOCAL
MINISTERIO DE INDUSTRIA Y ENERGIA SECRETARIA DE MINAS Y ENERGIA <u>Alcantarillado de Aguas Subterráneas</u> Forma N° 14-735 CONDOMINIO AGRICOLA SUBSISTENTE, S.A. Técnico: <u>AGRICOLA</u> Parqueadero de la Faja Fecha de petición: _____ Fecha de autorización: <u>13-5-75</u> Dimensiones de la obra o pozos: <u>1 m. de 8 por 24 m. de Prof.</u> Características del motor y bomba: <u>Motor de 1/2 c.v. y bomba vertical</u> Observaciones: _____	MINISTERIO DE INDUSTRIA Y ENERGIA SECRETARIA DE MINAS Y ENERGIA <u>Alcantarillado de Aguas Subterráneas</u> Forma N° 14-735 CONDOMINIO AGRICOLA SUBSISTENTE, S.A. Técnico: <u>AGRICOLA</u> Parqueadero de la Faja Fecha de petición: _____ Fecha de autorización: <u>13-5-75</u> Dimensiones de la obra o pozos: <u>1 m. de 8 por 24 m. de Prof.</u> Características del motor y bomba: _____ Observaciones: _____

Source: Community of Irrigators of Manzanares.

Mr. Bernardo Roncero, the President of the Community of Irrigators in Manzanares, allowed me to extract the data from these receipts without compromising the identity of well owners. The archive is composed of 270 pages with on average 8 receipts per page, making a total of 2,147 permits, of which a total of 1,716 were considered valid (Table 3.3). In some cases the permits were only partial or incomplete (e.g. the date or the characteristics of the pump or depth would be unreadable or absent). From the main data set, 61 permits were discarded for having been either cancelled or unreadable and 309 for not containing the issue date. According to Bernardo Roncero,⁴⁸ it is assumed that these files contain around 80

⁴⁸ Bernardo Roncero, personal communication, 6th of June 2011.

percent of all water abstraction technologies in the Municipality of Manzanares.⁴⁹

These files also represent probably the most accurate historical inventory of modern water lifting technology for irrigation in Manzanares, a unique account of the evolution of norias and wells in La Mancha.⁵⁰

Table 3.3 Main characteristics of the Manzanares data set

<i>Years</i>	From 1947 to 1985
<i>Total number of permits</i>	2,147
<i>Total number of norias</i>	980
<i>Total number of boreholes</i>	977
<i>Total number of noria-boreholes (*)</i>	129
<i>Total non valid permits</i>	370
<i>Total valid permits</i>	1,716

Note: (*) The type of technology noria-well (called *noria-pozo* or *pozo-noria* in the original Manzanares data set) was not included in the analysis due to the lack of clarity of the drilling permits. Estimations to establish the type of technology registered in the permits were based on the specific characteristics detailed in each of the permits. The fact that permits registered for noria-wells were confusing or incomplete would have resulted in a loss of accuracy.

Source: Based on data from the Community of Irrigators of Manzanares.

In the original dataset the permits were organised alphabetically. After entering all the information into a data spread sheet, data treatment has been carried out on those records that presented at least the date of registration and the type of technology used (noria or borehole). The processing and analysis of the data was achieved through a mix of simple statistical techniques on Excel considering: general

⁴⁹ Studies on private groundwater abstraction rights and water legislation in Spain suggest that the number of registered wells at the Ministry of Mines is much lower. Moreu (2001) indicates that the majority of wells before 1985 were drilled 'illegally' and without authorisation from the Ministry of Mines. This was due to a lack of enforcement of the decree regulating these registrations (Decree of 23rd of August 1934), and the fact that this decree was inferior in the law hierarchy to the Water Law of 1879, which ruled over private groundwater abstractions and linked them to land property rights (See Chapter 7 for a further discussion of this issue).

⁵⁰ The study by Serna and Gaviria (1995) on groundwater abstraction in Daimiel is one of the few that includes historical data on the evolution of modern groundwater abstraction technologies in La Mancha. It contains an account of the total number of boreholes in Daimiel divided by type of fuel (i.e. diesel or electric) from 1948 to 1988. A total of 2,307 boreholes are accounted for, of which 1,955 (85 percent) are diesel and 352 (15 percent) are electric.

trends in water lifting technologies; accumulated numbers of water lifting technologies; and calculation of average values for each of the groundwater abstraction technology characteristics.

3.4.4.2 Statistical analysis of the data set

With the data gathered at the Community of Irrigators, a quantitative statistical model was designed in SPSS in order to validate the qualitative results. For this purpose, a logistic regression model was developed to predict the likelihood of different determinants in the registration of a certain type of technology (i.e. noria or borehole as the dichotomous dependent variable). As Press and Wilson (1978) point out, the choice of a logistic regression model to explain the relationship between a qualitative variable and a set of independent variables is based on the fact that some variables are dichotomous and others quantitative. Thus, the choice of a logistic formulation stems, “from [the assumption] that the explanatory variables are independent and dichotomous zero-or-one variables, or that some are multivariate normal and some dichotomous” (Press and Wilson 1978: 700). The adequacy of a logistic regression model in describing the relationship between the dependent and independent variables was ascertained through application of the Hosmer and Lemeshow Test (1980), designed to assess the goodness of fit for logistic regression models.

3.4.4.3 Limitations of the data set

Limitations for the extrapolation of information from this data set are linked to the fact that it is not possible to determine the number of registered norias that were being used during the period that is the focus of this study. It is also very likely that these records remain partial due to the lack of enforcement in registering wells before 1985.⁵¹ Some of the norias registered might not have been used when they were registered and it is possible that many were built a long time before the date of registration (e.g. in the case of a family owned noria registered once a family descendant inherited it).⁵² It is also possible that the owner of a noria would register it so that one day he or she could drill a new well using the noria shaft and therefore not have to pay the registration fee for a new well.⁵³

Additionally, it was not possible to establish from the Manzanares data set how many norias had been transformed into boreholes. It was only possible to make an estimation based on those files that explicitly mentioned if a noria was transformed into a borehole by stating two different shafts-section dimensions of the well.⁵⁴ Moreover, it was not possible to confirm how many of the registered norias were still

⁵¹ As one of the interviewees put it: “Play the fool ... I didn’t have the permit from Mines [for the second well]” (Interviewee 6, 2nd of June 2011, Tomelloso). This was also corroborated by José Ramón Aragón, who noticed that: “in the 1970s people were already drilling wells without going to [the Ministry of] Mines” (personal communication, 9th of August 2012).

⁵² As one of the interviewees put it: “We don’t know when the noria was dug, it must have been in inheritance. We had it all our life” (Interviewee 10, 2nd of June 2011, Alameda de Cervera). This was also corroborated by José Ramón Aragón (personal communication, 9th of August 2012) who said: “people would register their wells as norias in the Registry [of the Ministry of Mines] but they would be norias that had existed already for some time”.

⁵³ The only way to establish an estimated number of norias in use before the Manzanares data set is to compare it with the latest data available prior to the Manzanares data set, which is the 1918 Report on groundwater irrigation technology in La Mancha commissioned by the Ministry of Public Works. See Chapter 6 for detailed numbers of norias used in Manzanares prior the 1940s.

⁵⁴ A simple distinction between norias and boreholes was followed according to the measurements of the type of technology registered. Usually a noria would have a shaft measuring 3 metres by 1 metre (3x1) or 2 metres by 1 metre (2x1) and boreholes would normally have a standard diameter of 0.40 metres (Bernardo Roncero, personal communication, 6th of June 2011).

in use or the effect of time on the decay of the wells, norias or pumps as owners could have neglected or abandoned them.

Due to Spain's data protection laws, the complete set of files kept in the General Archives of the Administration is not public. Although the Manzanares data set remains incomplete, analysis of the records obtained at the Community of Irrigators in Manzanares represents the most accurate and detailed sample of the use of technology for groundwater abstraction in La Mancha. The uniqueness of these records enabled me to fill in the historical gaps and establish a continuous narrative of groundwater technology change in La Mancha. With these records I was also able to track at the local level the farmers' responses to state-led irrigation plans and technology innovation projects for groundwater abstraction.

For confidentiality reasons I was not able to extract from the archive the names of the estates where the wells would be located. This would have allowed a more detailed spatial analysis of the distribution of wells and norias within the municipality of Manzanares as opposed to a generic representation of the evolution of water lifting technologies. The lack of geographical coordinates for the land plots affects the accuracy of some of the findings. Thus, results showing the variability of depth of norias and boreholes could be affected by the location of the wells in the aquifer and by the depths of the water table in different locations within the municipality of Manzanares. However, the data set as a whole can still be used to show the general trend of technology adoption and changing characteristics of wells in Manzanares across time. The Manzanares data set depicts in general terms numbers of water lifting technologies, but is unable to provide a record of actual usage of these devices. We can assume that in the context of wells, the records bare a fair resemblance to reality. However, in terms of norias, it would be difficult to assume

that those in place were still in use in 1985 given the widespread use of modern boreholes and the decrease of the water table.

Records held at the IGME in Madrid include an official map from 1953 showing the location of wells in the area of La Mancha.⁵⁵ Although it is not possible to establish whether the map shows the total number of wells in use at the time, it is possible to indicate that the majority of wells used in the area of La Mancha were located around areas with low topography that were close to the water table (i.e. close to rivers and riverbeds). This suggests the dependence of traditional technologies on a shallow water table and the potential limitations of the data collected for this study, which might be affected by the stronger presence of such devices in these areas.

3.4.5 Interviews and transect walks

For this research a total of seventeen in-depth semi-structured interviews were conducted. Five interviews with relevant academics, experts and key informants in Madrid and in La Mancha complemented the set of interviews (Table 3.5 and Table 3.4 and Annex 1, Table 1). Access to key informants was obtained through personal contacts from the research group at the Complutense University of Madrid. Once in La Mancha, access to interviewees was granted by contacting the different local Communities of Irrigators.

⁵⁵ See Chapter 6.

Table 3.4 Qualitative semi-structured in-depth interviews

<i>Interview</i>	<i>Date</i>	<i>Location</i>
Interview 1	1 st of June 2011	Tomelloso
Interview 2	1 st of June 2011	Villarta de San Juan
Interview 3	1 st of June 2011	Villarta de San Juan
Interview 4	1 st of June 2011	Villarta de San Juan
Interview 5	2 nd of June 2011	Tomelloso
Interview 6	2 nd of June 2011	Tomelloso
Interview 7	2 nd of June 2011	Tomelloso
Interview 8	2 nd of June 2011	Tomelloso
Interview 9	2 nd of June 2011	Alameda de Cervera
Interview 10	2 nd of June 2011	Alameda de Cervera
Interview 11	2 nd of June 2011	Alameda de Cervera
Interview 12	3 rd of June 2011	Manzanares
Interview 13	6 th of June 2011	Llanos del Caudillo
Interview 14	7 th of June 2011	Argamasilla de Alba
Interview 15	7 th of June 2011	Argamasilla de Alba
Interview 16	8 th of June 2011	Manzanares
Interview 17	13 th of June 2011	Alcázar de San Juan

Source: Author.

Table 3.5 Key informants and experts interviewed

<i>Name</i>	<i>Position</i>	<i>Date</i>	<i>Location</i>
Luis Martínez Cortina	Researcher, IGME	13 th of April 2011	IGME, Madrid
Ramón Llamas	Professor, Faculty of Geology, Universidad Complutense de Madrid	12 th of May 2011	Universidad Complutense, Madrid
José Ramón Aragón	Department of Planning, Guadiana River Basin Authority	29 th of May 2011	Guadiana River Basin Authority, Ciudad Real
Agustín Apio	President, General Community of Irrigators of the Aquifer 23	1 st of June 2011	Community of Irrigators, Tomelloso
Bernardo Roncero	President, Community of Irrigators of Manzanares	6 th of June 2011	Community of Irrigators, Manzanares

Source: Author.

The structure of the interviews presented a mix of factual and non-factual questions. A second set of questions was aimed at evaluating the knowledge of the interviewee on agrarian issues, the social background of the interviewee and their personal experience in relation to the origin of irrigation in the area. The purpose of such a process aimed, as Marshall and Rossman (1999: 110) wrote, to “uncover and describe the participants' perspectives on events – that is, the subjective view is what matters.” Every interview included a standard disclaimer acknowledging the voluntary engagement of the interviewee in this research and the confidentiality of the data gathered during the interview.

The interviews generally consisted of a 30-45 minute talk with the subject. Towards the end of the interview, I would pose a series of more generic and closed questions, encouraging them to be more specific while also establishing a more homogenous qualitative dataset. Interviews aimed at gathering testimonial and first-hand knowledge and experience of the process of technology adoption, which I would contrast and compare with the findings from the historical and archive data set. No method of sound recording was used as I felt it would deter interviewees from answering my questions. In some cases such as during the transect walks the recording method would not have worked as the wind and meteorological conditions made the quality of the sound unsuitable for recording.

Five transect walks in the study area were also conducted with four farmers and two employees of an irrigation technology company in Manzanares (Annex 1, Table 3).⁵⁶ These transect walks, which took place either during the interview or after, were used as a way of physically locating the different groundwater abstraction technologies used by farmers in order to understand how they were used in the

⁵⁶ *Riegos Lozano* is a company based in Manzanares with more than 60 years experience in irrigation systems (<http://www.riegoslozano.com>, last accessed 10th of January 2013).

irrigated landscape of La Mancha. They also served to visually appraise the different methods of irrigation used and to engage and interact more closely with the farmers' environment.

3.4.6 Research limitations

The main limitation arising during the fieldwork phase was the lack of access to individual files of groundwater wells for reasons of data protection legislation. As proven on an exploration trip to the archives of the *Confederación Hidrográfica del Guadiana* (Guadiana River Basin Authority) in Ciudad Real, the River Basin Authority keeps a record of all declared wells according to the *Dirección General de Obras Hidráulicas* (General Directorate of Hydraulic Works) since it was established in 1985.⁵⁷ These records, which state the name of the well owner and basic characteristics (e.g. irrigated surface, capacity of the well), are kept in the River Basin Authority, which is not accessible to the public due to Spain's data protection laws. Partial access to primary data on groundwater abstraction permits is possible but the administration will only consider requests for individual files. A request for the consultation of a large number of files is not possible and the River Basin Authority denies the possibility of such a petition because of lack of personnel.⁵⁸

I also experienced accessibility problems with some of the interviewees. The necessity to plan most of the interviews through a facilitator (usually someone at the

⁵⁷ According to the 1985 Water Law, the '*Registro de Pozos*' is a census of all private and public concessions to abstract groundwater managed which is kept at the River Basin Authority. See Chapter 7 for a detailed description.

⁵⁸ A quick assessment of the data for registered wells in Llanos del Caudillo by one of the archive managers at the Guadiana River Basin Authority in Ciudad Real showed around 70 files which coincides with the 70 land plots registered for the Llanos del Caudillo land census (Archive manager, personal Communication, 30th of May 2011).

Community of Irrigators in each municipality) acting as a gatekeeper, affected the timing of the interviews and access to the interviewees themselves. Also, during some of the interviews I was faced with a lack of trust from my interviewees which could be attributed to the highly controversial and politicised topic of groundwater management in La Mancha. The farmers I encountered exhibited a distinct lack of trust in the Ministry of Environment and the River Basin Authority. Moreover, there had been many documented cases of robbery of electric transformers and copper cables from wells in the area (La Tribuna de Ciudad Real 2011).

3.5 Discussion

This chapter has introduced the research area and the main methodological characteristics used to collect data for this study. The research site represents a complex socio-natural system of rivers, lagoons and wetlands heavily impacted by agriculture and intensive irrigation. The existence of previous research and archive data on groundwater stress, and the development of technologies to abstract groundwater in Manzanares provide a relevant socio-political and hydrogeological platform from which to derive innovative insights into the development of groundwater-fed irrigation in La Mancha. Moreover, a legal system of defined private groundwater abstraction rights and a lax control system served to sustain the individual development of groundwater abstraction technologies by farmers. Additionally, the presence of state-led colonisation projects in La Mancha and Llanos del Caudillo constitute a historical context for the study of the role and impacts of the state in the development of irrigation.

As discussed in this chapter, the methodology used in this research facilitated the study of the role of the state in irrigation, focusing on different processes of technology adoption and the generation of groundwater socio-ecologies in La Mancha. However, the main methodological limitations examined here revolve around finding a coherent narrative within a wide array of fragmented oral and archive stories. This includes the danger of over-simplification and reductionism as well as the problematic dimension of the observer's own perception of the described events. The use of oral history presents the problem of the validity of memory and its usability as data for research. The task of building a consistent historical narrative was amplified by problems presented in the use of direct testimonies. In spite of this, direct quotes and first-hand testimonies from farmers and irrigators were essential in order to establish a veridical storyline about the development of irrigation in La Mancha.

Data triangulation from different sources also presented limitations due to the use of secondary archive data and the lack of consistent methods to establish its accuracy. Since historical data generated from these archives could be subject to inconsistencies and historical and political inaccuracies, triangulation (through multiple methods such as quantitative research and primary data collection) has been used to counteract such effects.

The use of a quantitative set of data extracted from Manzanares presented problems in terms of the validity and use of data. Some of the data proved difficult to analyse in order to infer general trends in the evolution from traditional to modern groundwater abstraction technologies, due to the fact that some of the records were partial or not detailed enough. The lack of geographical references in the files made it

impossible to establish a spatial analysis of the data and to base this analysis on detailed geographical image processing techniques (e.g. GIS).

The data set however remains unique, revealing new information related to the evolution of groundwater abstraction technologies in La Mancha. Due to time and funding limitations, the extraction of more in-depth stories through qualitative methods in the field was not possible. A longer stay amongst the community of farmers could have overcome the lack of trust from some of the informants. Moreover, an ethnographic based approach could have established a deeper and more longitudinal analysis of irrigation communities in La Mancha that would have strengthened the research findings with more personal stories.

Chapter 4 . Statecraft and the history of irrigation and colonisation politics in Spain

4.1 Introduction

This chapter explores the history of irrigation and colonisation politics at the state level in Spain. It explains how irrigation became to be seen as the perfect complement to colonisation politics as part of a wider set of agrarian political reforms in Spain serving distinct political and ideological purposes. During Franco's dictatorship between 1939 and 1975, colonisation became an essential part of the modernisation of the countryside. The second section of this chapter reviews the historical antecedents of colonisation politics in Spain, from the end of the nineteenth century to the Civil War in 1936. The third section examines the development and ideology of irrigation and colonisation politics in Franco's Spain and the different state building processes involved. This third section is divided into three main periods: the agrarian reforms of the post-Civil War period; Franco's irrigation and colonisation vision and politics during the 1950s; and Spain's moderate economic liberalisation in the 1960's. The final section includes an assessment of Franco's colonisation politics in terms of land surface and irrigated area.

4.2 Historical antecedents of colonisation politics in Spain

4.2.1 Agrarian reforms and colonisation in the nineteenth century

The antecedents of modern colonisation politics in Spain can be found in seventeenth and eighteenth century agrarian politics. This period was driven by a concern with depopulation of the countryside and the need to guarantee agrarian population growth and wealth (Monclús and Oyón 1988). As a result, an experimental project with new colonies was established in the Sierra Morena in Jaén, Andalucía (Carrión 1972; Robledo 1996). Following calls from politicians and statesmen like the Count of Aranda, Campomanes and Olavide, 26 new towns were built at the end of the 1760s with 10,240 new settlers, some of whom were Catholic settlers brought from Germany and the Netherlands (Giménez López 1993; Juárez Sánchez-Rubio and Canales Martínez 1988). King Charles III of Spain endorsed this project through which 50,197 inhabitants were eventually settled in these towns (Carrión 1972).⁵⁹

By the second half of the nineteenth century the word 'colonisation' began to appear in agronomic and political literature. The key issue was not to establish new towns but to colonise the land and ultimately transform the countryside through irrigation and hydraulic projects (Monclús and Oyón 1988). Private initiative was recognised by the state as necessary and a series of new legislations redistributed small land property.⁶⁰ At the same time, public land seizures⁶¹ helped develop an

⁵⁹ This initial colonisation attempt was mentioned by the politician and Regenerationist Joaquín Costa when he wrote that “for the first time more than 100 leagues of desert were conquered” something which represents “the vivid image of an ideal society as conceived, within reason, by the republicans and economists” (Costa 1911: 118). Author’s translation from original quote in Spanish.

⁶⁰ One of the first colonisation laws dating from 1854, was developed by Francisco de Luxán. In its preamble, the text argued in favour of new colonies, considering the agrarian colonies as “an element of social order and a powerful incentive to augment the population and extend the limits of

incipient agrarian capitalism in Spain (*ibid.*). Thus, building on the colonisation experience of the previous century, policies focused on the size of country estates as:

“a sufficient explanation for agrarian distress: as Charles III's experts had argued it created a 'superfluity of hands and lack of lands'. The breaking up of these latifundia was therefore seen as the solution of the agrarian problem in the south and west” (Carr 1966: 417).

Thus a key problem facing land reform at this time was that land plots were either too large or too small for economies of scale to function adequately. Colonisation projects aimed at reorganising this fragmented land property system by enforcing a small to medium farm model throughout the territory. Colonisation politics in the second half of the nineteenth century also aspired to establish colonies with a regenerative and moralising vision, fighting pauperism and underdevelopment with the goal of cultivating unexploited and unproductive land (Monclús and Oyón 1988). However, limitations to this approach quickly arose due to the fact that land property at this time had a very rigid and ‘non-modifiable structure’ (Monclús and Oyón 1988: 42). Moreover, the formation of large properties and land concentration occurred without a ‘physical reorganisation’ of the land itself (*ibid.*) or serious

agriculture” (Project of Legislation for the establishment of agrarian colonies, 1855, in Monclús and Oyón, 1988: 32). Author’s translation from original quote in Spanish.

⁶¹ The process of public land seizure (or land disentailment) in Spain (referred in Spanish as ‘*desamortización*’) occurred during the nineteenth century, starting first in 1798 under the reign of Carlos IV and concluding approximately 30 years later (García Sanz 1985; Vives 1969). This was facilitated by a series of state laws aiming at freeing land, “in a nation where property had been nontransferable for centuries because for the most part it belonged to corporate bodies or to the entailed nobility [sic]” (Malefakis 1970: 61). Thus the liberal state nationalised most of the estates and land properties belonging to the Church and different religious orders. In order to develop the cultivation of new land, traditional forms of land property had to be transformed. Legal measures aimed at suppressing the linkages between religious and aristocratic patrimonies so that rural and urban estates belonging to the state, the Church, military orders, and other religious organisations could be put on sale (Anes 1996).

investments from large landowners (Malefakis 1970).⁶² According to Naylor (1959) it was only at the end of the nineteenth century that land plot concentration began to be implemented by the state with rigid conditions about the minimum size, production revenues and also capital for the venture. As a result, policy shifted from reorganising existing plots to developing unpopulated areas of land (both commonly owned and controlled by municipalities), both of which presented better conditions to obtain the expected results from colonisation “without the imposition of necessary changes in land property structures” (Monclús and Oyón 1988: 42).

According to Ortega Cantero (1979), modern colonisation politics effectively began on the 29th of April 1860 when a Royal Decree opened up the possibility for the state to be part of irrigation plans. This decree acknowledged the necessity of capital to fund and develop land development plans outside the sphere of private entrepreneurs. This was later legislated in July 1883 by a law⁶³ granting permission to publicly fund, or subsidise through concessions to private companies, grand irrigation schemes (*ibid.*).

Another facet of colonisation at the time sought to develop the relationship between colonisation and the national boundaries of the state, exemplified by attempts to develop “an 'internal colonisation', mainly manifested through agrarian colonisation” (Monclús and Oyón 1988: 56). The foundation of the Geographical Society of Madrid in 1870 sought to collect information about the different territories

⁶² The Law of the 21st of November 1855 on the Colonisation of Public Lands and the Law of the 11th of July 1866 on the Promotion of Rural Population were aimed at incentivising the participation of private initiative. One of the objectives of the Law of Agrarian Colonies in 1855 was to ensure a more intensive exploitation of the rural space through concerted action with private initiatives and the acquisition of uncultivated lands. In spite of this, the first colonisation law left the success of this enterprise in the hands of private investors, only allowing land not owned by large landowners to be cultivated (Mangas Navas 1984). *Gaceta de Madrid*, 22nd of November 1855, No.1, page 53; *Gaceta de Madrid*, July 14th of July 1866, No.194, page 2; *Gaceta de Madrid*, 28th of August 1866, No.240, page 1-2.

⁶³ Law of Large Irrigation Schemes, also known as Gamazo Law, *Gaceta de Madrid*, 23rd of April 1885, No.113, page 224.

and explore the possibility of different commercial and political relationships between them (Vila Valentí 1977 in Monclús and Oyón 1988: 56). Agronomist and civil engineers appeared as a new class of professionals that had to deal not only with the technical and theoretical problems of new infrastructures but also with the broader social and economic scope of these interventions, now seen as inseparable (Ortega Cantero 1979).

4.2.2 The turn of the century: hydraulic politics and Regenerationism

The turn of the century brought the Restoration of the Bourbon monarchy after the Liberal revolutions of 1820 and 1840 (Carr 1966). The Restoration began with the crowning of Alfonso XII in 1875 following a coup d'état by General Arsenio Martínez Campos, and finished in 1923 with the dictatorship of Primo de Rivera. This was a time when, according to Gabriel Tortella (2000: 27), reformation was “thwarted by the corrupt and abusive practices of *caciquismo* (bossism) and *pucherazo* (election-rigging)”.⁶⁴ The loss of the last of the colonies in Cuba in 1898 represented the

⁶⁴ According to Moreno Luzón (1998), ‘caciquismo’ is the Spanish version of political clientelism or patronage and represents not an expression of a political class system but rather an expression of local politics and interests associated with economic structure (Varela-Ortega 1975). As defined by Gellner (1977: 3-4), patronage is a form of power, “a system, a style, a moral climate” which arises in “the incompletely centralised state, the defective market or the defective bureaucracy”. Chandra (2007: 86) uses the term patronage politics to refer “to that form of rent-seeking and corruption in which the returns to politicians take the form of votes rather than bribes.” Spain's cacique system has been described by Ringrose (1996) as an extra-official web of political patronage, influence and control reaching from the central powers in the Ministry of Government in Madrid to provincial and local party structures and bosses. This type of power for Varela-Ortega (1975: 124) “was not dependent upon group interests as such, but rather upon patronage that cut across class or group lines.” Small clienteles on the basis of personal favours provided at the local and provincial level supported this political system. This structure was then reproduced all the way to the top. It was a system that provided nominations for government positions, contracts, interfered with judicial proceedings, and above all rigged electoral results. Caciquismo is a form of personal relationship, 'a chain of small benefits' cutting across social collectivities and based on the common dependence on the administration and bureaucracy, wealth and social power linked economic power (Ortega-Varela 1975).

culmination of the decadence of the country and provoked a re-examination of the national conscience (Abellán 1973). Such critique was the main common attribute of the cultural and artistic 'Generation of 98' and the Regenerationists, an intellectual movement which aimed to scientifically explain and solve the causes of the perceived decay of Spain as a nation (Carr 1966).⁶⁵

The Restoration also signified for Nadal Reimat (1981) a turning point for the development and consolidation of hydraulic politics. As he points out, these 'hydraulic' Regenerationists were "obsessed with the ambition to make the desert flourish [...] in their appeal to the state they found an advocate in Gasset, owner of the most respected Madrid daily, *El Imparcial*." (Carr 1966: 423). Gasset, who later became Minister of Public Works, was responsible for the first National Plan of Hydraulic Works in 1902 in which 296 individual projects led to the irrigation of 1,469,222 hectares of land. Gasset also developed the first Law of Large Irrigation Works in 1911, which represented the first recognition of the importance of state intervention in public works. As Ortega Cantero (1979) points out, the 1911 Law also represented a turning point in hydraulic politics towards a more comprehensive and overarching irrigation politics.

As Carr (1966: 423) writes, at the turn of the century reformers of the Restoration "dreamt of a more radical redemption: the elimination of the semi-arid steppes by irrigation and the re-afforestation of the barren lands." The Regenerationist movement along with the Generation of '98 saw the transformation of a dry and

⁶⁵ Balfour (1997) highlights how the Regenerationist movement of national introspection emerged after the critical loss of the last colonies in 1898. It required a regenerative movement aiming at the recuperation of traditional values for the source of the crisis was the erosion of those. Such anger and pessimism was directed against the political system. The access to power of a much wider middle class surging after the industrial revolution was stopped by the established order and its social structures and privileges (the restoration of the Monarchy in 1875). The 1898 Disaster appeared as a crisis of identity with the national self-esteem at its lowest, and a crisis of legitimacy for the ruling classes had failed to protect the interests of the nation entrusted in them (*ibid.*).

thirsty Spain into irrigated land 50 times more productive (Carr 1966). As Balfour (1997: 89) put it, the symbolic dimension of hydraulic Regenerationism was searching for a:

“model of identity in an unchanging emotional landscape [...]. Castile and Quixote re-emerged as powerful icons of Spanish identity whereas they had become by implication somewhat discredited in the political discourse of the aftermath of the Disaster. [...]. Now Castile, especially the Castile of the middle Ages, re-appeared as a source of inspiration for a renewed Spain”.

Regenerationist figures such as the intellectual and politician Joaquín Costa, began preaching for a generalised programme of public works as a reaction to the liberal reigning regime in order to, “remake the geography of the nation and solve the agricultural as well as the social problem [of the nation]” (Ortega Cantero 1979: 36).⁶⁶ Hydraulic politics were seen as the sublimated expression of agriculture policy and more generally of the nation’s economic politics (Costa 1911). According to Regenerationist theses, irrigation was seen as the ideal solution for changing the landscape of the country where the state is the guarantor of infrastructures and funding. The Regenerationists wanted more than anything else the participation of the state in a general programme of public works and policies aimed at developing the country socially and economically (Ortega Cantero 1979). They also instigated colonisation as a decisive instrument to solve the problems of agriculture in Spain (*ibid.*).

⁶⁶ Author’s translation from original quote in Spanish.

A contradiction at the heart of Costa policy aims meant that he on the one hand wanted to regenerate national spirit by establishing a very strong public state, while on the other hand supporting the idea of traditional forms of land tenure and propriety. In terms of the latter, he worked to reinstate traditional collectivist land propriety in order to counter the negative impacts of various public land seizures, thus producing a new national space following the needs of small farmers (Ortega Cantero 1979). Nevertheless, the different forms taken by Spain's rural and industrial revolution at the end of the nineteenth century ultimately produced a capitalistic rural society structured around political clientelism (i.e. *caciquismo*) and the development of an incipient industrial and bourgeois class – both of which were far from Costa's original desires (Balfour 1997). Hence, most of Costa's theses were not appropriated by the ruling parties during the Restoration and it was not until Primo de Rivera's dictatorship that we see the first attempts to develop Costa's hydraulic and political ideals. During the Second Republic his ideas also found a convenient milieu to flourish (Ortega Cantero 1979) but it was not until Franco's dictatorship that Costa's hydraulic theses became fully developed (Pérez Escolano and Calzada Pérez 2008; Swyngedouw 1999, 2007).

4.2.3 Twentieth century agrarian politics

Building on these historical and ideological grounds, colonisation plans became intrinsically associated with agrarian reforms in the twentieth century (Ortega Cantero 1993; Robledo 1996). As Monclús and Oyón (1988: 75) make clear, the period between 1900 and 1939 is characterised as one of 'integral colonisation', which

was an indispensable complement to hydraulic politics but also as “an alternative to the feared agrarian reform” (Monclús and Oyón 1988: 76). At the time, agrarian reform was essential, especially because of an historic impasse caused by the agrarian crisis at the end of the nineteenth century (García Sanz 1985). Land plotting and land concentration^{67, 68} came to be seen as the technical solution to the problems of small properties and land fragmentation (Naylon 1959; Gómez Benito 1995).⁶⁹

As Robledo (1996) contends, the Besada Law in 1907⁷⁰ represents a major attempt to colonise and repopulate the country at the beginning of the twentieth century.⁷¹ As Carrión (1972: 65) suggests, the Besada Law pretended to “provide land to families without economic or labour means” yet “it only had communal lands and *propios* from the municipalities to allocate”.⁷² Thus, colonisation during this period became a tool in the hands of politicians used to control the rising tensions in the country side and aimed at “consolidating the foundations on which were to rise a numerous class of small owners [...] to fight against depopulation and the socialist impulse” (Robledo 1996: 10).⁷³

Colonisation precepts under the Besada Law lasted until 1926 and were managed by the *Junta Central de Colonización y Repoblación* (Central Junta of Colonisation and Re-population). As Robledo (1996: 11) writes, during these 20 years we can observe a change in the scope of the initial colonisation project and a tendency

⁶⁷ Also referred as ‘land consolidation’ by Naylon (1959).

⁶⁸ *Language note:* ‘*Concentración parcelaria*’ in the original Spanish language.

⁶⁹ The origins of such solution are to be found in several authors of the nineteenth and twentieth century (e.g. Jovellanos and Macías Picavea), serving as theoretical and doctrinal foundations for such politics (Gómez Benito 1995). In such origins, this author finds the justification for the remedy to minifundia as small farm exploitation (small property) but also as exploitation unit (land plotting) in social and economic terms.

⁷⁰ Law of Colonisation, *Gaceta de Madrid*, 8th of September 1907, No.251, pages 1009-1010.

⁷¹ In the end, only a few settlements and colonies were developed, including two in the area of La Mancha (south of Ciudad Real): Raña de las Lagunas and Horcajo de los Montes.

⁷² Author’s translation from original quote in Spanish.

⁷³ Author’s translation from original quote in Spanish.

for the state to reduce its direct role in the colonisation process. At the end of this period, the state was mainly allocating barren lands to settlers and merely fulfilling the task of land plotting. The results of this first phase of colonisation were thus very modest despite its long period of existence (1907-1927), largely because the state only had a few lots of public land at its disposal (Mangas Navas 1984).

The process of allocating property aimed to create a new class of small owners with the objective of increasing production and establishing a social consensus. Moreover, this process was seen by some reformists as “prevent[ing] the advance of anarchists and revolutionaries” (Monclús and Oyón 1988: 78).⁷⁴ As Monclús and Oyón (*ibid.*) point out, “property also had to accomplish a social function”. Thus the creation of small proprietors during the first half of the twentieth century was seen as at once a social, ideological and moral solution to unrest creating stable structures that supported the established order (Malefakis 1970; Monclús and Oyón 1988).

Along with land property reforms, hydraulic politics were also at the heart of the ‘technical reform of agriculture’ (Monclús and Oyón 1988). As indicated by Gómez Ayau (1961 in Monclús and Oyón 1988: 81), the state began to expand its interventions and include the “effective transformation into irrigation of irrigable land.”⁷⁵ Drawing on Gómez Ayau (1961 in Monclús and Oyón 1988), the 1911 Law of Public Works⁷⁶ (which included large irrigation schemes) united the role of the state with irrigation works and policies.⁷⁷ However, the real shift came, according to Mangas Navas (1984), with the agrarian reform policies during General Primo de

⁷⁴ Author’s translation from original quote in Spanish.

⁷⁵ Author’s translation from original quote in Spanish.

⁷⁶ Also known as the Gasset Law, *Gaceta de Madrid*, 12th of March 1911, No.71, pages 711-714.

⁷⁷ During the Second Irrigation Congress in 1918, colonisation appeared for the first time as a matter of significant importance “with its own entity”, a device that would help address demographic problems, land and agricultural planning whilst setting limits to property (Monclús and Oyón 1988: 83).

Rivera's dictatorship (1923 to 1929).⁷⁸ Following a royal decree on the 26th of July 1926⁷⁹ the General Directorate of Social Agrarian Action was created with the mandate and authority over colonisation. Two dispositions were also passed, the Royal Decree of the 7th of January 1927 and the Royal Decree-Law of the 9th of March 1928.⁸⁰ The Royal Decree of the 7th of January 1927 in its article 29, recognised as compulsory colonisable (Mangas Navas 1984: 287-288).⁸¹

“a) Those private estates located within irrigation areas that do not develop the necessary works to put into irrigation their lands according to the terms and deadlines regulated by the Royal Decree of the Ministry of Public Works on the 7th of October 1926. [...] c) The lakes, wetlands and swamps susceptible of being sanitised, whether they belong to the state, official corporations or individuals”.

As Monclús and Oyón (1988) suggest, during the third decade of the twentieth century increasing amounts of land surface were reclaimed by the newly created *Confederaciones Hidrográficas*⁸² (river basin authorities) and other associations such

⁷⁸ Primo de Rivera's infrastructure programme seized many of the Regenerationist plans, notably the irrigation schemes for the parched lands in the interior of Spain. Before him, as Herr (1971: 144) wrote, “there had been plenty of plans but no government permanent or strong enough to carry them out effectively. Primo de Rivera pushed forward their realisation, fulfilling dreams of the men of '98.” Chief Engineer Lorenzo Pardo, appointed by Primo de Rivera, rationalised Gasset's uncoordinated and indiscriminate irrigation plans and focused on “three regions most likely to benefit from irrigation: the lower valleys of the Ebro and Guadiana Rivers (the latter near Badajoz), and the plains of Valencia, where water could be piped across the divide from the upper Tajo basin. Under Primo de Rivera much of the Ebro River complex of dams was completed, augmenting both the acreage under irrigation and the output of electricity. The other remained for future regimes to take up” (*ibid.*).

⁷⁹ Gaceta de Madrid, 28th of July 1926, No.209, Pages 668-670.

⁸⁰ Its legal importance can be proven by the fact that the Constituent Parliament of the Second Republic converted these two royal decrees into laws on the 9th of September 1931 (Mangas Navas 1984).

⁸¹ Author's translation from original quote in Spanish.

⁸² The first *Confederacion Sindical Hidrografica* was created for the Ebro River on the 6th of March 1926, Gaceta de Madrid, 6th of March 1929, No.65, pages 1253-1255.

as the *Juntas Sociales de Riegos* (social irrigation boards) created during the dictatorship of Primo de Rivera. A general hydraulic policy framework was used to integrate and coordinate the irrigation of the land (*ibid.*). However, it was not until 1932 during the Second Republic (1931 to 1939) that the state had the legal capacity to implement such plans (*ibid.*). The Law of Irrigation Works of the 13th of April 1932^{83, 84} established for the first time that the state would execute all irrigation works and secondary networks, drainage, houses and services in the lower Guadalquivir valley (Monclús and Oyón 1988: 88).

Overall, during the twentieth century, agrarian colonisation politics shifted focus from the occupation of free or disentailed land by the state towards new forms of propriety and land use associated with a wider agrarian reform project. From this new trend, two colonisation tendencies emerged which appeared to be consolidated by the 1920s (Monclús and Oyón 1988). One, related to Costa's hydraulic politics, had a more technical and productive character and understood irrigation of new land as a way to improve the economic situation of the targeted area. The other had a more social and reformist orientation and saw land plotting and land concentration as a stabilising episode in socially conflictive rural areas (Monclús and Oyón 1988: 293). As a result, the *Instituto de Reforma Agraria* (Institute of Agrarian Reform) was created in September 1932 by the *Ley de Bases de la Reforma Agraria* (Law of Foundations of the Agrarian Reform) during the Second Republic⁸⁵ whose main objective was the suppression of feudal privileges.⁸⁶ The state was allowed to expropriate '*señorios jurisdiccionales*'⁸⁷ and also "[abolish] without indemnification

⁸³ *Language note:* '*Ley de Obras de Puesta en Riego*' in the original Spanish language.

⁸⁴ Gaceta de Madrid, 14th of April 1932, No.105, pages 336-337.

⁸⁵ Gaceta de Madrid, 21st September 1932, No.265, pages 2095-2102.

⁸⁶ *Language note:* Referred as '*supervivencias feudales*' in the original Spanish language.

⁸⁷ *Language note:* Refers to the land dominion over which a landlord has tax collection powers.

all of the privileges of the seigniorial rights” (Robledo 1996: 19).⁸⁸ Although these were the main objectives of the agrarian reform during the Second Republic, general water politics also became realigned with land colonisation projects in regional plans within the *Confederaciones Hidrográficas* (e.g. the Ebro Irrigation Scheme in the Ebro river basin) (Monclús and Oyón 1988).

4.3 Irrigation and colonisation in Franco’s Spain: ideology and state building

4.3.1 Agrarian politics during the Civil War

During the Civil War, one of the first measures adopted by the Junta of National Defence and the Burgos Government⁸⁹ was to neutralise and abolish the agrarian reform of the Republican Government (Barciela López and López Ortiz 2003). On the 28th of August 1936, a month after the military uprising, the Junta approved their first decrees against the Republican agrarian reform. These decrees halted the expropriation of estates without compensation to owners or lease tenants, a practice which had taken place under the Republican government (Robledo 1996). From October 1936 to January 1938, the *Junta Técnica del Estado* (technical state board) administrated estates that had previously been seized by the Institute of Agrarian Reform and guaranteed rent payments to land owners (Robledo 1996).

⁸⁸ Author’s translation from original quote in Spanish.

⁸⁹ *Language note:* Provisional government set up by Franco to rule in the regions 'liberated' from the Republican government by Franco's nationalist army.

In January 1938 the *Servicio Nacional de Reforma Económica y Social de la Tierra*⁹⁰ (SNREST) was created (Liceras Ruiz 1988). This service inherited the functions of the Institute of Agrarian Reform and was in charge of maintaining agrarian production in the 'liberated zones' as well as intervening in the management of agrarian estates (Robledo 1996). Within SNREST, the Service of Agrarian Recuperation became the “real executor of the task of re-establishment of the equilibrium of the Agrarian economy, destabilised by the Marxist devastation” (*Memoria del Servicio de Recuperación Agrícola* 1940 in Gómez Benito 1995: 99).⁹¹ Its mandate was to return land properties and estates that were either expropriated during the Republic or abandoned during the conflict, with the effect of erasing all signs of the precedent agrarian reform (Ortega Cantero 1993).⁹² The SNREST was also in charge of financially helping devastated areas after the war through: administering abandoned estates; harvesting crops; and taking care of livestock, land leases and machinery. It also oversaw the transformation of dry agriculture into irrigation, land allocation and access to land property (Ortega Cantero 1993). As Ortega Cantero (1993) makes clear, however, the creation of this service also represented the beginning of a shift towards nationalism in agrarian politics. Thus, as Monclús and Oyón (1988) also suggest, this period represented the beginning of the new era of agrarian politics in post-Civil War Spain.

Although most of these projects remained mere guidelines, the importance of these changes was discursively emphasised by the Falangist guiding principles of Franco's National Movement (Gómez Benito 1995). Thus, as Zorrilla Dorronsoro, a

⁹⁰ *Language note*: Translates as ‘The National Service of Economic and Social Reform of the Land’ in the original Spanish language.

⁹¹ Author's translation from original quote in Spanish.

⁹² According to Gómez Benito (1995), after the Civil War 70 percent of the properties were given back to their owners by the Service of Agrarian Recuperation.

prominent Falangist,⁹³ said “they took up the arms in order to, amongst other things, defend their position against these matters (of the agrarian reform) and especially in what had to do with the concept of property of the land” (Barciela 1986 in Robledo 1996: 31).⁹⁴ Still, agrarian politics during the Civil War suffered from a lack of definition and were largely focused on negating the reform ideology of the Second Republic (Mangas Navas 1990). Criticism by the newly created government of the previous Republican agrarian reform focused on its ‘so-called’ inefficient, utopian and anti-peasant system (Gómez Benito 1995). This criticism was also essential to legitimising the new Regime not only ideologically but socially also (Gómez Benito 1995; Ortega Canadell 2004). This became one of the cornerstones of what Gómez Benito (1995: 102) describes as, “the ideological and doctrinal construction of the social and economic reform of the land formulated by the initial Franquism”.⁹⁵ As Franco himself put it during a speech in Madrid in 1947:

“The Spanish countryside, it is sad to recognise, still lives in an important state of backwardness; not due to the lack of effort from its peasants but to a lack of technology and collaboration. The countryside cannot be, as before, the object of political speculation, but of work and truth, and in Spain we spent, sadly, more than half a century looking at the countryside through mean, divisive politics, forgetting the passive subject that is the farmer, and his welfare, agriculture.” (Francisco Franco 1947 in Del Río Cisneros 1975: 604-605).⁹⁶

⁹³ Zorrilla Dorronsoro later became the first director of the INC (National Institute of Colonisation) (Gómez Benito 1995).

⁹⁴ Author’s translation from original quote in Spanish.

⁹⁵ Author’s translation from original quote in Spanish.

⁹⁶ Author’s translation from original quote in Spanish.

The roots of this type of 'agrarian fascism' can be found in the ideals of the Falangist Movement built around the myth of the peasant and the ideology of peasant sovereignty (Alares López 2010).⁹⁷ This period was also characterised by the rediscovered discourse of *rurality*; the perfect justification for all political decisions affecting not only the countryside but also national politics (*ibid.*). This ideological context sustained the 'coexistence' between latifundia and minifundia while at the same time supporting the ideology of the Regime (Gómez Benito 1995).

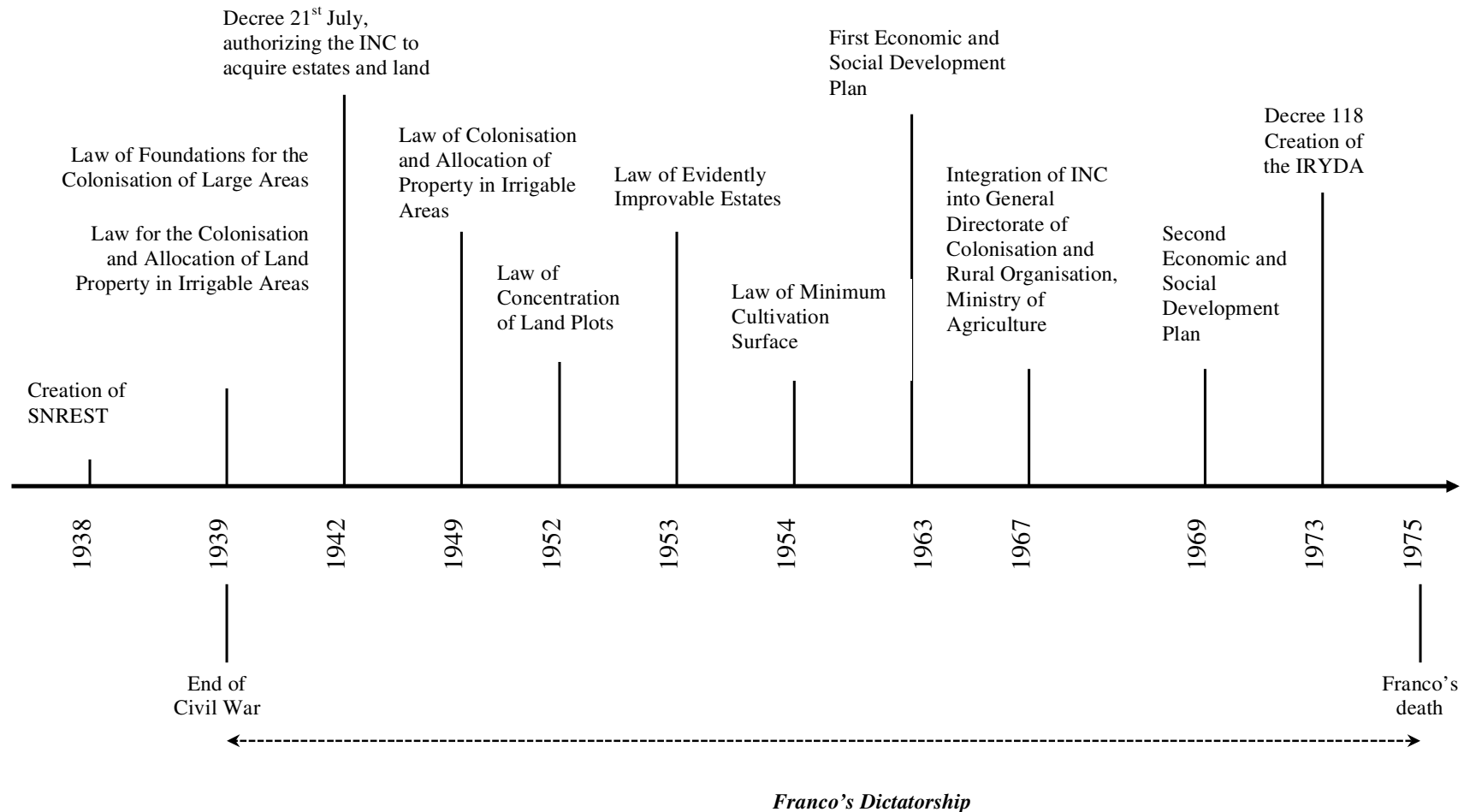
The creation of the National Institute of Colonisation (INC) replacing the SNREST came after the end of the Civil War in April 1939 by decree on the 18th of December 1939.⁹⁸ Its first task, as stated in its foundational decree was to “carry on the broad plans of colonisation which have to be developed according to the guidelines of the Movement”.⁹⁹ From this point on colonisation politics dominated agrarian politics and reform in Spain (Figure 4.1).

⁹⁷ Traditions, myths, history and symbols also participate in the ‘manipulation’ and ‘reconstruction’ reinforcing the process of nation and state formation (Smith 1993). Pitt-Rivers’ (1954) study in Spain highlights how the idea of a single ‘Castilla’ was produced as the only Spanish element of identity. The posterior construction of a totalitarian state consciousness in the twentieth century with Franco's dictatorship implies developing a local approach and highlighting the fragmentation and cultural specificities of its rural towns.

⁹⁸ Decree of 18th of October, BOE, 27th of October 1939, No.300, pages 6016-6018.

⁹⁹ *ibid.*

Figure 4.1 Chronology of colonisation laws after the Civil War



Source: Author

4.3.2 Agrarian politics in post Civil War Spain: the beginning of Franco's colonisation politics and ideology¹⁰⁰

As Gómez Benito (1995) suggests, in order to understand agrarian reform politics during Franco's dictatorship it is necessary to understand the economic and social context as well as the political nature of Franquism. Thus, Franco's regime appears as the result of a historical process of:

“crystallisation of the 'reactionary coalition' of the new landowning bourgeoisie with the hegemonic urban sectors, with an ideological and political nature and finally military, provided by the forces of the traditional agrarian union, allied with the Spanish bourgeoisie”.¹⁰¹

Additionally, its ideologists saw Franquism as a political system representing a “specific solution to the historical class structures generated by the development of capitalism” (Gómez Benito 1995: 25).¹⁰²

The Regime's foundational period, between 1939 and 1951, was also its most ideological and totalitarian with agriculture becoming an important aspect of a new

¹⁰⁰ See Figure 4.1 for a chronological reference of the colonisation laws mentioned in the following sections.

¹⁰¹ Author's translation from original quote in Spanish. Giner and Sevilla (1984: 115) describe Franco's political system, as “a complex political order, with deep historical, cultural and social roots in the country upon it was violently imposed, and where it lasted for nearly four decades.” These authors emphasise how Franquism resisted modernisation as an historical entity with a “remarkable degree of internal coherence and continuity” (Giner and Sevilla 1984: 115). Although the composition of the elites changed despite of the historical continuity of the Regime reflecting the “economic and political demands of the moment as well as to concealed factional struggles within the regime,” the power elites formed a “political class representing the interests of the industrial, financial, ad land-owning oligarchy as well as those of conservative sections of the middle classes” (Giner and Sevilla 1984: 116).

¹⁰² Author's translation from original quote in Spanish.

'rural fascism' ideology in Spain (Alares López 2010; Murviedro 1982). The regime was ruled by a class domination system whereby industrial, financial and landowning classes used political power and influence to control the different apparatuses of the state. These ruling classes had participated in the uprising against the Second Republic as they saw their privileges threatened by the revolutionary actions of the government (Gómez Benito 1995).

During this period, an important aspect of the ideological and political apparatus of the state was also the revision of the discourse related to agriculture, peasantry and latifundia.¹⁰³ As Alares López (2010) put it, nationalist-romantic ideals were sustained by subterfuge using specific policies that focused only on the economic characteristics of latifundia and minifundia. As Gómez Benito (1995) has added, this subterfuge avoided any direct attack on the accumulation of land, instead guaranteeing the social stability of the countryside and the defence of land ownership privileges.

Colonisation was another main element guiding agrarian politics after the Civil War in Spain. Its general objectives went beyond the mere re-organisation of land property and were associated with agrarian reform politics (Ortega Cantero 1993). Colonisation politics after the Civil War also intended to erase previous attempts at land ownership reform made during the Second Republic. This was

¹⁰³ According to Pascual Carrión (1972: 71) latifundium is an “estate of large surface”. In his study, Carrión classifies as large any estate with more than 200 hectares. His definition includes the amount of land a family would need to live but is also closely linked with the social function of land as an indispensable good for social and economic development. The productivity aspect of latifundia is an important element too. A latifundium has to be deficiently exploited, producing less than it could and not reallocating the benefits obtained from working the land amongst its workers. Since latifundia is about the social and economic function of the land, for Carrión an estate at the outskirts of a town (i.e. around two to three kilometres) of 64 hectares owned by one individual already does not perform the social role this same surface of land could do if it was owned by 40 or 50 owners. For that reason, “any estate of more than 100 hectares, susceptible of being cultivated, located within the vicinity of a town with more than 500 neighbours, has to be considered a latifundium, unless it is intensively cultivated” (Carrión 1972: 75). More than 3 kilometres outside a town, an estate of 200 hectares “susceptible of cultivation” or more is also considered as latifundia (*ibid.*).

achieved by rejecting previous reforms as essentially largely ideological, with little understanding of the economic dimension with the effect of persecuting one social class: the landowners (*ibid.*). As Ortega Cantero (*ibid.*) contends, colonisation politics after the Civil War aimed to reconcile hydraulic politics and re-organise property in rural areas; a process which was already underway but in a fragmented manner. Moreover, colonisation politics during Franco's dictatorship became the ultimate messianic task to tame and control the land, foster agrarian production and resettle families around newly developed irrigation plans (Naylon 1967; Ortega Cantero 1979, 1993). A strong relationship can be found between hydraulic politics and colonisation politics since the objectives and main arguments of water politics were one of the doctrinal cornerstones of the politics of colonisation (Ortega Cantero 1979).

Agrarian reforms in the post-Civil War period were characterised by state initiatives to protect large agricultural farms, which became “the indisputable pinnacle of the Spanish agrarian structure, without questioning its way of production, its legitimacy or forms of property” (Monclús and Oyón 1988: 294).¹⁰⁴ The main objective of colonisation politics was to extend irrigation in order to increase production. This would be attained, as Alares López (2010:68) wrote, by creating villages in new irrigation areas and overseeing the construction of a “regenerated farmer”. However, what was presented as colonisation policy had in fact a broader scope and included a wide array of agrarian transformations generally associated with large hydraulic works (Ortega Cantero 1993). The politics of colonisation after the Civil War also reengaged with republican hydraulic plans through the National

¹⁰⁴ Author's translation from original quote in Spanish.

General Plan of Hydraulic Works of 1933 drawn up by Chief Engineer Manuel Lorenzo Pardo (Figure 4.2).¹⁰⁵

Figure 4.2 Lorenzo Pardo's infrastructure and irrigation plans for the Guadiana River Basin in 1933



Note: The circled areas indicate planned irrigation works. The circled area east of Ciudad Real corresponds to the Peñarroya irrigation scheme and the circled area around Badajoz corresponds to the Badajoz Plan.

Source: Lorenzo Pardo 1933: 215.

The aim of Lorenzo Pardo was to create employment and fix population to the land:

“[The] fundamental idea consists of attributing to the new irrigation projects the function of driving the production, with the double objective of satisfying the national consumption necessities and provide desirable products for the export market; in one word, to solve jointly and harmonically the agrarian

¹⁰⁵ As it is written in the 1940 Plan of Public Works (Plan General de Obras Públicas. II. Plan de Obras Hidráulicas, Madrid, 1940, page 49). As Ortega Cantero (1993) point out, Pardo's Plan of Hydraulic Works influenced the general colonisation plans but was re-oriented accordingly after the Civil War.

aspect of the economic problem while offering means and time for the rest”
(Lorenzo Pardo 1933: 103).¹⁰⁶

In spite of this, the development of colonisation politics after the Civil War was presented as a “rectification of the agrarian reform initiated during the Republican period” (Monclús and Oyón 1988: 123).¹⁰⁷ However, as Monclús and Oyón (*ibid.*) point out, it was at its core and concept “a prolongation and amplification of the hydraulic and colonisation politics already formulated during the twenties and thirties”.¹⁰⁸ In the following extract of a speech in 1956 in Madrid, the dictator Franco talks about the INC and the task of improving the livelihood of those in the countryside by transforming dry land into irrigation:

“The creation of the National Institute of Colonisation gave us the instrument for the realisation of that desideratum of agrarian politics. The construction of large and small irrigation schemes, transforming sterile lands into gardens, and its division into land plots and colonisation have allowed us to tackle the problem of land allocation in a transcendental but also practical manner. It is not by allocating sterile land that we will satisfy the increase in farmers’ welfare, but by offering them productive land, transformed through the efforts of the state into bountiful orchards. It is only when a social problem arises that the state, using the law of land expropriation due to social interest, can solve the problems of dry farming. It is not a caprice of the established system, for the value of such dry land needed to sustain a family and the farming

¹⁰⁶ Author’s translation from original quote in Spanish.

¹⁰⁷ Author’s translation from original quote in Spanish.

¹⁰⁸ Author’s translation from original quote in Spanish.

implements to adequately cultivate it are several times higher than what is required for the transformation and costs of an ideal irrigated farm, with the aggravating element that dry farming fails and irrigation always succeeds” (Francisco Franco 1956 in Del Río Cisneros 1975: 230-231).¹⁰⁹

Immediately after the creation of the INC, the Law of Foundations for the Colonisation of Large Areas was enacted on the 26th of December 1939.¹¹⁰ Its purpose was to stimulate specific initiatives to transform dry land into irrigable areas of ‘high national interest’ with the support of the INC.¹¹¹ This law also created the *Sociedades de Colonización* (Colonisation Societies) assembling all potential private initiative for colonisation to “manage the operations assuming the rights and obligations the legislation attributed to the Communities of Irrigators” (Monclús and Oyón 1988: 129).¹¹² These societies also had the power to expropriate the lands of the owners that did not want to join the society.¹¹³

Following the Law of Foundations for the Colonisation of Large Areas, new procedures were approved in which the direct participation of the state was central. In the 1940s, the first of such measures was the Decree of the 23rd of July 1942¹¹⁴ authorising the INC to acquire estates and land voluntarily offered to the institute to transform them into settlements or for land plotting (Ortega Cantero 1979). This decree gave the INC “the functions of owner, entrepreneur and agrarian intermediary”

¹⁰⁹ Author’s translation from original quote in Spanish.

¹¹⁰ BOE, 25th of January 1940, No.25, Pages 628-634.

¹¹¹ The 1939 Law of Colonisation defined as areas of high national interest those that “transforming profoundly the economic and social conditions of vast surfaces of land, demand for its execution complex works which go further than the private capacity, and make necessary the technical, economic and juridical support of the state” (Mangas Navas 1990: 67). Author’s translation from original quote in Spanish.

¹¹² Author’s translation from original quote in Spanish.

¹¹³ These societies however were never formed due to “the lack of interest or incapability of the majority of landowners” (Monclús and Oyón 1988: 129).

¹¹⁴ BOE, 6th of August 1942, No.218, Pages 5819-5820.

(Mangas Navas 1990: 87).¹¹⁵ Additionally, according to Monclús and Oyón (1988), the 1907 Besada Law was also revisited and used to obtain landholdings from the municipalities at no cost.

The 1949 Law of Colonisation and Allocation of Property in Irrigable Areas¹¹⁶ represented a decisive step for the establishment of Franco's colonisation politics (Monclús and Oyón 1988). This law dictated that the state would be in charge of integral colonisation in the designated irrigable areas. The INC would also be able to determine which land would be expropriated within the defined irrigation sector and regulate the different types of public investment and work sponsored by the state in the designated colonisable areas.¹¹⁷ This law also established the development of the main technical instrument for the colonisation of irrigable areas: the General Plans of Colonisation according to the overarching 1939 Law of Colonisation of Large Areas. In general, therefore, the 1949 Law represented the acknowledgement that “private initiative is ineffective to attend the necessities of a growing population”.¹¹⁸

In 1949 another step in the colonisation process was taken with the Coordinated Plan of Works, which was to become the executive plan for the coordination of works in each colonisation sector (Monclús and Oyón 1988). The law stated that along with this plan, a special plan for the allocation of property would be drawn, classifying ‘reserve land’ and ‘excess land’ within the area of the project.¹¹⁹

¹¹⁵ Author's translation from original quote in Spanish.

¹¹⁶ BOE, 22nd of April 1949, No.112, Pages 1805-1812.

¹¹⁷ According to this law, a hundred percent of funding was given for works considered of “general interest for the area such as dams or official buildings”, forty percent for “works of common interest for the different hydraulic sectors” (i.e. networks of irrigation canals and drainage) and thirty percent of subsidised funds for “works of private interest” (Monclús and Oyón 1988: 131). Author's translation from original quote in Spanish.

¹¹⁸ Author's translation from original quote in Spanish. Preamble, Law of Colonisation and Allocation of Property in Irrigable Areas, BOE, 22nd of April 1949, No.112, in Mangas Navas (1990).

¹¹⁹ *Language note:* ‘Reserve lands’ were defined by the government as land kept by landowners in proportion to the original size of their properties and according to the number of descendants. ‘Excess lands’ were defined as land to be expropriated within the designated irrigable area (See Chapter 5 for a more detailed explanation).

This is “in reality a project of redistribution of property, indicating the surfaces the Institute will intervene in directly (expropriating, acquiring or transforming)” (Monclús and Oyón 1988: 165).¹²⁰

In spite of this legal framework, the INC's actions remained timid during this decade and were “limited to the establishment of certain 'colonised nucleus' understood as a decisive contribution to stimulate the private initiative” (Monclús and Oyón 1988: 130).¹²¹ This period, however, saw the growth of the INC's land patrimony through donations from latifundists using them as a way to get rid of estates with problematic leasings (Mangas Navas 1990).¹²² Such a move, mainly concentrated in Andalucía and Extremadura, was not expected by the state (as stated in the Decree of the 5th of July 1944), which had to extend the purchasing capacities of the INC and even issue public debt to acquire more estates (Mangas Navas 1990).

4.3.3 Colonisation and land ownership: the political and ideological respect for private property

During Franco's regime, the transformation of large areas into irrigation was presented as essentially contributing to the modification of the allocation of property by benefiting small and medium size farms. It was also aimed at transforming large extensions of land by incrementing agricultural production and making them more efficient (Ortega Cantero 1993). According to Gómez Benito (1995), the Falange's

¹²⁰ Author's translation from original quote in Spanish.

¹²¹ For another study, the politics of colonisation in the 1940s can be described as a 'failure' if we observe the modest levels of investment and land purchase and has been described as an “escape forwards”, “a mere propagandistic operation, without neither will nor real capacity to develop from a realistic point of view the colonisation plans” (EUA 1985b: 34). Author's translation from original quote in Spanish.

¹²² In 1944 the INC owned 222,642 hectares of land in Spain (Mangas Navas 1990).

political agrarian reform programme concentrated on individual access to land property, focusing specifically on a family patrimony. This objective aligned with the social-catholic doctrine of the Movement – a social justice imperative for the poor – while at the same time fulfilling the practical purpose of absorbing local social conflicts and preventing political subversion (*ibid.*). The Falange also included in its programme the “rationalisation of cultivation units, to suppress both the wasted latifundia and the anti-economic minifundia because of its meagre revenues” (Gómez Benito 1995: 80).¹²³ However, as Barciela López and López Ortiz (2003: 55) wrote, in the end the effects of such policies however did not represent a return to the land tenancy order before the Second Republic, but “established a whole new system of advantageous conditions for those who had supported the national side since the beginning, especially the large land owners.”¹²⁴

The formula adopted not only ideologically but also administratively by the Regime through the different agrarian reforms, stated that small family land patrimonies would coexist with medium and large property as different forms of agrarian exploitation while maintaining the 'unity of rural society' (Alares López 2010).¹²⁵ Ideologically as well as politically, “the principal virtue of the family patrimony is that it linked the institution of the family with private property, the two foundations of social order in both doctrines” (Gómez Benito 1995: 82).¹²⁶

¹²³ Author’s translation from original quote in Spanish.

¹²⁴ Author’s translation from original quote in Spanish.

¹²⁵ As quoted by Gómez Benito (1995: 81), José Antonio Primo de Rivera, founder of Falange, said in one of his speeches in 1935 that “the problem of the countryside is neither a matter of latifundia nor minifundia, but a matter of economic units of cultivation, for in some places latifundia is indispensable because only large cultivation can compensate the large costs required for the harvests to be good and, vice versa, there are places where minifundia is an estimable unit of cultivation”. Author’s translation from original quote in Spanish.

¹²⁶ Author’s translation from original quote in Spanish.

In Spain, the agrarian myth¹²⁷ used by Franco portrayed a revision of the ‘*noble savage*’ that was ideologically treated to suit the purposes of the regime. This type of populist discourse made use of themes such as the ‘working-class consciousness-displacing’ to construct an appeasing and calming image of the redefined farm owner whether rich or poor. This would also discursively displace any class categories such as “‘peasants’/‘cultivators’/‘farmers’” within a social context “where there is actually great variation in both relations and the scale of production” (Brass 2000: 21). In an extract from one of Franco’s speeches in at the 6th Assembly of Brotherhoods of farmers in 1957, it is possible to find some of these recurrent themes:

“If we aspire to a great Spain and if we want a free Spain, we have to raise Spain’s countryside from the routine and misery where it had fallen. [...] But in order to do that, more than cooperation between all of us, we need faith and everybody’s efforts, because you, who are involved in the constant battle against the tired land after having been cultivated for more than a thousand years, you, who suffer the degeneration of livestock, its selection also abandoned for many decades, you know that this cannot be changed in a few years, we need big sacrifices, continued and long efforts to change it” (Francisco Franco 1957 in Del Río Cisneros 1975: 612).¹²⁸

¹²⁷ As described by Brass (2000: 9), the agrarian myth “is a discourse about the desirability/feasibility and ‘naturalness’ of small-scale economic activity (peasant family farming, artisans) in the countryside. It is also supportive, therefore, of rural cultural forms/institutions based on this economic activity: namely, the family, village, regional, ethnic and religious identities which are perceived as being derived from Nature.” Such agrarian myth was used for populist purposes by popular and national movements as a way to reinvent “traditional folkloric concepts linking an ethnically-specific homogenous ‘people’ to a particular territory, thereby establishing a politico-ideological claim to its own rightful place/space” (Brass 2000: 12).

¹²⁸ Author’s translation from original quote in Spanish.

As Gómez Benito (1995: 88) contends, such discursive elements ideologically configured “a hierarchical and harmonic order of social classes in the countryside, trying to eliminate the destabilising factors of the system”.¹²⁹ Private property became integrated within the institutional structure of the 'organic' model of state enacted by colonisation laws such as the Law of Colonisation of Large Areas of 1939 (Preamble and Bases 17 and 23) and in other preceding pieces of legislation such as the Law of Colonisation and Property Allocation of Irrigable Areas of 1949 (*ibid.*).

That Franco's regime wanted to preserve private property ideologically and politically during this period had an effect on the type of properties being purchased and expropriated by the INC.¹³⁰ The state only purchased land willingly sold by its owners. Thus there was a gulf between the declarations of large projects made by the Regime and the sporadic colonisations that occurred in reality (EUA 1985b). Between 1942 and 1951 the state acquired 162,621 hectares through the INC of which only 16,580 hectares were part of the nationally declared irrigable areas (*ibid.*). Of these, only 9,886 hectares were laid with irrigation canals and *acequias*.¹³¹ As for the settlers, the INC had under its tutelage 25,212 settlers almost all of them in dry land farming areas (23,497) (*ibid.*).¹³²

¹²⁹ Author's translation from original quote in Spanish.

¹³⁰ See Chapter 5 for a discussion of the legal subterfuges landowners could use to retain land in the nationally designated irrigable area of La Mancha. In another region in Spain, Perperkamp (1979) describes how in the Ebro River Basin in Aragon, the INC respected the land owned by large landowners by reserving a specific amount of land and by paying large amounts for the expropriated land that compensated for the loss of expropriated land in the colonised area. The author Sánchez López (1980) comes to a similar conclusion after examining the colonisation of the Canal del Viar in Andalucía. In that area, the Preamble of the Colonisation and Irrigation Plan for the area acknowledged the need to respect the private property of large landowners and the necessity to establish incentives for the development of irrigation for those landowners by extending the minimum surfaces of reserved land.

¹³¹ *Language note:* Spanish term used for a type of traditional irrigation infrastructure to carry water. It consists of gravity conduits distributing water to the different fields through a system of open-air canals, aqueducts and pipes and operated at different stages by gates.

¹³² A study of the colonisation plan for the area of Badajoz in the province of Extremadura found out that of all 74,301 hectares transformed into irrigation, more than 50,000 ha, or 67 percent of the land, was still in the hands of their old owners. Exceptions made through the “special reserve” categories

The Regime also attempted to ‘ideologically cleanse’ the figure of the large landowner. As Gómez Benito (1995: 179) writes, the intention was to ideologically and discursively erase the figure of the “absent and revenue accumulating latifundia owner”. Norms were therefore approved which obliged large owners to improve farming and stimulate its good management (Naylon 1959). Administrative solutions for large landowners came in 1953 with the Law of Declaration of Evidently Improvable Estates¹³³ which emphasised the economic efficiency of agrarian exploitations and the technical improvement of their properties. In 1962, the mandate of the law was expanded with the Law of 14th of April 1962¹³⁴ which extended the transformation of properties to those also being leased (Gómez Benito 1995).

The Law of Minimum Surface for Cultivation in 1954¹³⁵ and the 1952 Law of Land Plot Concentration¹³⁶ further developed this ‘peasant ideology’. As Gómez Benito (1995: 177) suggests, these laws represent the true intentions of Franco's agrarian counter-reform: to stabilise and maintain the structures of land property in Spain since the land plot division “did not affect large properties but on the contrary a minor part and of poor quality”.¹³⁷ The Regime passed a number of measures that enshrined the right to private property with the aim of giving small farmers access to land. However, with these measures (e.g. expropriations and compensations for large land owners), the land plotting of small cultivation units became subsidiary and complementary to the large estates with interests in irrigation or dry land farming (Naredo 1978).

of the colonisation plans put aside large surfaces of land from the expropriating policies of the INC under the pretext that they were being transformed into irrigation by the owners (Baigorri 1978).

¹³³ BOE, 4th of December 1953, No.338, pages 7149-7152.

¹³⁴ Law 3/1962 of 14th of April complementary to land plot concentration. BOE, 16th of April 1962, No.91, pages 5095-5100.

¹³⁵ BOE, 16th of July 1954, No.197, pages 4841-4842.

¹³⁶ BOE, 23rd of December 1952, No.358, pages 6305-6307.

¹³⁷ Author's translation from original quote in Spanish.

Franco's programme stated that once the social and economic relationships which had existed before the Civil War and Republican agrarian reform were re-established, "the 'national' agrarian reform or the economic and social reform of the land had to be arranged with an absolute respect to private property" (Gómez Benito 1995: 105).¹³⁸ Having said that, the involvement of private owners with colonisation during the first decades of the Regime was not easy. According to a ministerial study on the history of colonisation, two reasons can explain the lack of private initiative of large landowners and their participation in colonisation politics. This study mentions "uncertainty in relation to the results of irrigation projects" (EUA 1985b: 41-42).¹³⁹ Such uncertainty was derived from historically negative experience, a lack of workforce in the countryside and serious problems related to the commercialisation of agricultural products, both nationally and internationally (EUA 1985b).¹⁴⁰

4.3.4 The 1950s: Franco's irrigation and colonisation vision¹⁴¹

Before the 1950s, attempts to encourage and develop agrarian reform and colonisation through private initiative had proven unsuccessful mainly due to a lack of involvement from landowners (Mangas Navas 1990). Therefore in the 1950s a new approach with a much more invested public role in colonisation was developed. Autarchy measures also encouraged the regime to accelerate its internal institutional

¹³⁸ Author's translation from original quote in Spanish.

¹³⁹ Author's translation from original quote in Spanish.

¹⁴⁰ Because of the adopted autarchic measures adopted by Franco's government as a result of the international isolation of Spain after the Second World War, colonisation politics aimed at increasing the internal productivity of agriculture and offer an economic response to the social problems the countryside suffered (Ortega Cantero 1993). This change drove the shift of hydraulic politics from the Republican aims of export and trade to the increase of irrigation for national consumption (Barciela López and López Ortiz 2003).

¹⁴¹ Although simplified, the division of colonisation politics in three major periods – post Civil War, 1950s and 1960s – largely follows the sequence established by Gomez Benito (1995).

development and to re-assess colonisation politics for economic and social reasons (Gómez Benito 1995). As Monclús and Oyón (1988) point out, the state used a more technical and modern concept of colonisation at the centre of colonisation politics, focusing essentially on social progress driven by economic transformation and development of the countryside. What was different about these integral colonisation plans was that they aimed at reconciling the re-organisation of rural space with the expropriation of lands to build new settlements (*ibid.*). This meant stabilising land ownership as well as bringing workers and infrastructure to new areas (Naylon 1959). The state played a predominant role in this initiative, guaranteeing expropriations and the development of projects that private initiatives could not have carried out.

The 1950s also represented the definitive union of hydraulic politics with colonisation politics and the revitalisation of the 1933 General Plan of Hydraulic Works,¹⁴² which according to Barciela López and López Ortiz (2003), had outlined the irrigation of more than 1,246,961 hectares of land. This had the effect of resuscitating the old Regenerationist hydraulic paradigm (Swyndegouw 1999, 2007). Additionally, between 1940 and 1963 the state had built 287 dams with 132 dedicated to supplying water for irrigation only.¹⁴³ What was called 'integral colonisation' of the territory is for Pérez Ecolano and Calzada Pérez (2008: 10) a coordinated action of different ministries and disciplines and was:

“not only going to develop a technical-agronomic rationalisation of the crops and the agricultural areas, but also a deeper transformation of the territory.

¹⁴² Established in 1933 by Manuel Lorenzo Pardo and approved during the Second Republic in 1939.

¹⁴³ The beginning of the 1950s decade also saw an important change within the Ministry of Agriculture with the replacement of Carlos Rein Segura by Rafael Cavestany as Minister of Agriculture in 1951. Rafael Cavestany was a fervid supporter of the state politics of irrigation. In his own words, he said when he took the role that “from now on we will ensure that not a single drop of water is lost in the sea” (Cavestany 1958 in Mangas Navas 1990: 139). Author’s translation from original quote in Spanish.

The framework of the project – the irrigable area – was the object of important works that would include from dams to *acequias*, secondary rural roads to connections with the rail network, or from isolated houses to colonisation towns.”¹⁴⁴

As Gómez Benito (1995) wrote, this renewed and more holistic colonisation mentality also incorporated a new dimension of colonisation politics: the connection through regional development plans of colonisation politics with regional development plans (e.g. the 1952 Law of Colonisation, Industrialisation and Electrification of Badajoz also known as the *Plan Badajoz*). This vision finally united Franco’s colonisation politics with the old Regenerationist hydraulic postulates. In 1947, Franco had already reflected about the social and visionary nature of this type of projects in one of his speeches in Barcelona:

“And today large national dams are a reality; waters that before died in the sea without providing any profit, devastating many times our rich pastures, are today a source of energy and irrigate our fields and large areas with newly irrigated crops, will very soon provide our national economy with what is essential to life” (Francisco Franco 1947 in Del Río Cisneros 1975: 604).¹⁴⁵

This decade also saw the beginning of land-plot concentration policies with the enactment in 1952 of the Law of Concentration of Land Plots.¹⁴⁶ Land concentration was presented not only as a “simple technical measure but as an integral

¹⁴⁴ Author’s translation from original quote in Spanish.

¹⁴⁵ Author’s translation from original quote in Spanish.

¹⁴⁶ BOE, 23rd of December 1952, No.358, pages 6305-6307.

policy which epitomises the programmatic norms of the Movement” (Gómez Benito 1995: 165).¹⁴⁷ However this law also had agrarian and economic implications. As part of the agrarian reform, the concentration of land plots was seen as the way of “breaking the structural difficulties which impede the development of the new agriculture” (Cavestany 1953 in Gómez Benito 1995: 169). Land plot concentration at this time reflected the country's need for modernisation and the adaptation of its economic structures to a new agrarian development as well as the ideological and political goals of its ruling elite (Gómez Benito 1995). It aimed at creating the minimum and sufficient conditions for farms to become productive and profitable, in harmony with private interests and public financial needs. Ideologically however, it shifted the vision of dealing with the problems derived from latifundia and large landowners to the issues of minifundia and the lack of productivity of small estates (Barciela López and López Ortiz 2003). The law also carried multiple territorial, social and juridical improvements while concentrating property and transforming it into irrigation “with the channelisation of rivers, sanitisation of land, electrification, and improvements in crops, livestock drinking points, and livestock paths” (Sanz Jarque 1961 in Gómez Benito 1995: 173).¹⁴⁸

Land plot concentration legislation in the 1950s also began a new era in colonisation politics in Spain. The move towards land plotting and land concentration responded according to Ortega Cantero (1993) to a more modern and rational approach of the economic benefits of colonisation. Land plot concentration was seen as the best initiative to favour the economic integration of agriculture and link it with the general development of the country (*ibid.*). In 1953, the idea of 'proprietors' instead of settlers was put forward by Leopoldo Ridruejo Ruiz-Zorrilla (1953 in *ibid.*)

¹⁴⁷ Author's translation from original quote in Spanish.

¹⁴⁸ Author's translation from original quote in Spanish.

indicating a conscious move in the development of a discourse of rural capitalism with the introduction of new legislation on land property.

The 1952 Law also furnished each owner with:

a) A 'closed plot'¹⁴⁹ with a minimum amount of land in one plot equal to previous surface owned; b) the concentration of land plots cultivated by a single farmer, whether or not they belonged to the same owner; c) access to new land plots with roads; d) to plan the land plots easily enough to be cultivated by one farmer from its property.

This land concentration was considered urgent and the INC gained the power to acquire more estates whenever the land plots would not reach the minimum surface required for them to be cultivated (Naylon 1959). The concentration of land plots followed according to Gómez Benito (1995: 173) the grouping of inefficient land plots from a single owner in areas with a high concentration of land leases or “other indirect forms of land tenancy”.¹⁵⁰ As Gómez Benito (1995: 175) pointed out, the effects of these land plot concentration policies were a ‘true agrarian revolution’. They reduced the number of plots owned by each farmer but also increased the surface of farms by erasing borders and uniting smaller plots. However, according to Barciela López and López Ortiz (2003), the results of these policies were in some areas tenuous due to the intrinsic respect of private property by Franco’s Regime. Thus, the economic effects of these policies such as the increase of productivity per plot and the creation of larger properties benefited owners that had the economic means to do so (*ibid.*).

¹⁴⁹ *Language note:* Referred as ‘coto redondo’ in the original Spanish version.

¹⁵⁰ Author’s translation from original quote in Spanish.

In 1954 the Law of Minimum Cultivation Surface was promulgated.¹⁵¹ As Gómez Benito (1995: 175) wrote, this law was another of the key elements establishing the size of new farm units, “created for the concentration and conservation of land plots and to prevent fractures in new small land properties”.¹⁵² At the same time, land plot concentration was used as the tool to solve the other big problem of Spain’s countryside: the existence of atomised small land plots impeding economies of scale in agriculture (Gómez Benito 1995). However, as Gómez Benito (1995) contends, this law did not solve the problem of land allocation amongst small groups of large properties; it only established the minimum size of land plots for single families but did not allocate the land evenly and therefore maintained the structures and the system of co-existence of latifundia with minifundia.

4.3.5 The 1960s and 1970s: agrarian reforms, technocratic policies and the end of Franco’s dictatorship

In the early 1960s agriculture represented 18 percent of Spain’s Gross Domestic Product and employed 35 percent of the total active population (IBRD and FAO 1966). During this decade the most prominent efforts for the development of agrarian colonisation politics in Spain were led by a new group of technocrats in Franco’s government trying to liberalise the country’s economy. The presence of these technocrats in the state’s high offices questioned the previous autarchic measures and followed the suggestions of the international community of donors about liberalising Spain’s political economy (Mangas Navas 1990).

¹⁵¹ BOE, 16th of July 1954, No. 197, pages 4841-4842.

¹⁵² Author’s translation from original quote in Spanish.

In 1962, a report on the economic development of Spain issued by the International Bank of Reconstruction and Development (IBRD) and the Food and Agriculture Organisation (FAO) criticised colonisation policies and the hydraulic projects associated with them (IBRD 1962). The report also questioned the social benefits and high costs of such operations; the economic risks associated with the plans; and the financial profits coming from irrigation projects (*ibid.*). The report recommended that land concentration had to be accelerated and that the scope of colonisation plans had to be reduced to the mere implementation of irrigation infrastructure only in cases where sufficient revenues from the investment could be guaranteed (Ortega Cantero 1993).

The IBRD and FAO report considered as positive from a financial point of view the different irrigation projects being developed by the government (Mangas Navas 1990). The report also viewed irrigation works as an “important method to increase the revenues from agriculture” but that could be complemented with “more research activities, services of agrarian extension and expand the education of the farmers” or new development in seeds and mechanisation (IBRD 1962: 55).¹⁵³ The report also highlighted the high costs of irrigation projects and other public works and mentioned the need to evaluate the financial viability of future irrigation projects being drafted by the state. This evaluation would be done “in order to establish a new order of priorities” as well as to concentrate public efforts on a limited number of projects “as long as they provide higher benefits in relation to their cost and a higher capital revenue in comparison to what could be obtained with alternative uses of that same capital” (IBRD 1962: 56).¹⁵⁴ The report mentioned in a similar way that colonisation was only benefiting “a limited number of people” and warned about the

¹⁵³ Author’s translation from original quote in Spanish.

¹⁵⁴ Author’s translation from original quote in Spanish.

fact that “other measures exist to increase the rural welfare at a larger scale.” Irrigation had to be included only when it was “intrinsically justified from an economic point of view” (IBRD 1962: 57). Nonetheless, the report praised land plot and land concentration policies as an interesting measure to increase agrarian revenues and economic returns in agriculture and mentioned the need for larger budget allocations. Mechanisation of agriculture also had to be promoted through state funding and public credit along with the removal of import taxes on such items in order to increase production and revenues (IBRD 1962).

Following the recommendations of the IBRD and the FAO, agrarian reforms began timidly following the first National Plan of Social and Economic Development (*Plan de Desarrollo Económico y Social*)¹⁵⁵ approved in 1963 for the period 1964-1967. Based on these recommendations, the Spanish Ministry of Agriculture created the *Comisaria del Plan de Desarrollo* (Development Plan Commission) in order to implement the National Plan of social and economic development. This Commission accepted the guidelines and recommendations of the IBRD and FAO and introduced restrictions in the budget of the Ministry of Agriculture (EUA 1985b). Thus, as Mangas Navas (1990) points out, the ascension of this new group of technocrats and civil servants affiliated to Opus Dei in Franco's government represented first the confinement and then the marginalisation of traditional colonisation politics during the 1960s and 1970s.¹⁵⁶

¹⁵⁵ Law 194/1963 of 28th of December. BOE, 31st of December, No. 313, pages 18284-18286.

¹⁵⁶ Historically since the end of the Civil War, the more political Falangist organisations and groups maintained a strong but quiet ideological dispute with the organisations linked to the Catholic Church within Franco's government. This was translated into the co-optation of certain political sectors and ministries within the government by different political and ideological groups (Gómez Benito 1995). The presence of Falangist groups was predominant within the Ministry of Agriculture and other ministries such as Housing. In 1957 however the Falangist groups lost against the technocrats and only kept the Ministry of Work in the last period of Franco's government (Mangas Navas 1990).

Along with this technocratic move, a structural change within the INC was also under way, where the social motives of the first colonisation period,

“linked with the poverty and under-development of certain rural areas and the need to stop the migration processes [...] were replaced by economic motivations. The objective was not to establish the largest number of settlers but that the newly developed farms became profitable and that settlers became real entrepreneurs” (EUA 1985b: 143-144).¹⁵⁷

In 1967 the structure of the INC was merged with the General Directorate of colonisation and Rural Organisation within the Ministry of Agriculture (Mangas Navas 1990) and in 1973 the Institute of Agrarian Reform and Development (IRYDA) replaced the INC.¹⁵⁸ The creation of the IRYDA aimed at centralising all legal and technical colonisation and irrigation instruments. Additionally during this period, the IRYDA’s support to agriculture changed from a type of direct development of colonisation plans to the indirect intervention in agriculture with the concession of agrarian credits to farmers for the development of new irrigation techniques, infrastructures or new technology (Bosque Maurel 1984).¹⁵⁹

The 1970s saw the end of the dictatorship with the death of Franco in November 1975. This period also saw the end of the transition towards democracy in 1978 with a new democratic constitution, which respected and ensured autonomous regional political powers. The new democratic constitution approved by Parliament and by popular referendum in 1978 organised the state administratively and politically

¹⁵⁷ Author’s translation from original quote in Spanish.

¹⁵⁸ The *Instituto de Reforma y Desarrollo Agrario* (IRYDA) was officially created by Decree 118/1973 approving the Law of Agrarian Development and Reform, BOE, 3rd of February 1973, No.30, pages 1990-2026.

¹⁵⁹ See Chapter 7 for a more detailed explanation of state subsidies for agriculture and irrigation.

under central and autonomous governments. This represented the transference of most competencies attributed to the IRYDA to newly created regional ministries of agriculture. These autonomous governments were created as a way to respect previous historical nationalist aspirations for some of the regions in Spain while breaking with almost forty years of centralised government (Bukowski 1997; Colino 2008).

4.4 Discussion

4.4.1 An assessment of Franco's colonisation politics in Spain

A general assessment of Franco's colonisation politics in Spain can lead to inaccuracies depending on the source used and divergences can be found when comparing some of the most thorough research projects in the history of colonisation.¹⁶⁰ In terms of total surface area colonised and irrigated by the state, a first set of authors (Villanueva Paredes and Leal Maldonado 1990) has established that 1,402,999 hectares were planned to be irrigated in Spain as a result of colonisation policies during Franco's regime between the years 1940 and 1985. Out of this total land surface, 556,258 hectares were to be directly developed by the state and 734,453 hectares transformed by private owners. Ultimately, however, only 42.4 percent of planned irrigated hectares were irrigated. Public intervention after the Civil War through the INC meant the irrigation of 510,000 new hectares of privately irrigated land with the support of the state and 481,000 hectares directly irrigated by

¹⁶⁰ These would be the studies by Mangas Navas (1990), Monclús and Oyón (1988), Ortega Cantero (1979), Villanueva Paredes and Leal Maldonado (1990).

state projects. As Villanueva Paredes and Leal Maldonado (*ibid.*) point out, the increase in irrigated land from 1939 to 1983 is around 35 and 50 percent. The regional distribution of these plans is however uneven, with three river basins – e.g. Ebro, Guadiana and Guadalquivir, making up 72 percent of all new irrigation projects (*ibid.*).

However, a different set of authors has established the total surface of irrigated land by the state (the INC and the Department of Hydraulic Works jointly) at 568,221 hectares between 1939 and 1971. Of that surface, the INC would be directly accountable for 90,9367 hectares of 'ameliorated irrigation' (Ortega Cantero 1979). This figure is similar to the one presented by Monclús and Oyón (1988) of 79,178 hectares of irrigated land directly by the INC. For Monclús and Oyón (*ibid.*), the total impacted irrigated surface coordinated or participated by the INC was 867,462 hectares.

For other authors such as Mangas Navas (1990) between 1939 and 1973 the INC-IRYDA directly irrigated 979,053 hectares; 289,204 hectares of ameliorated irrigation; built 295 settlements and 30,165 houses; reclaimed 43,000 hectares of wetlands and swamps; and 254,753 hectares of projects in dry land (Mangas Navas 1990: 204). Data by Mangas Navas (Figure 4.3) however shows large fluctuations in the number of hectares acquired by the INC and IRYDA between 1947 and 1977. This indicates an inconsistent policy of land acquisition instead of a constant process of land expropriation linked to a firm colonisation and irrigation policy. As mentioned above, land colonisation was affected by structural problems concerning land plotting, availability of land, and the respect of private property. As Monclús and Oyón (1988: 171) point out, these problems arose from the difficulties of “completing a full

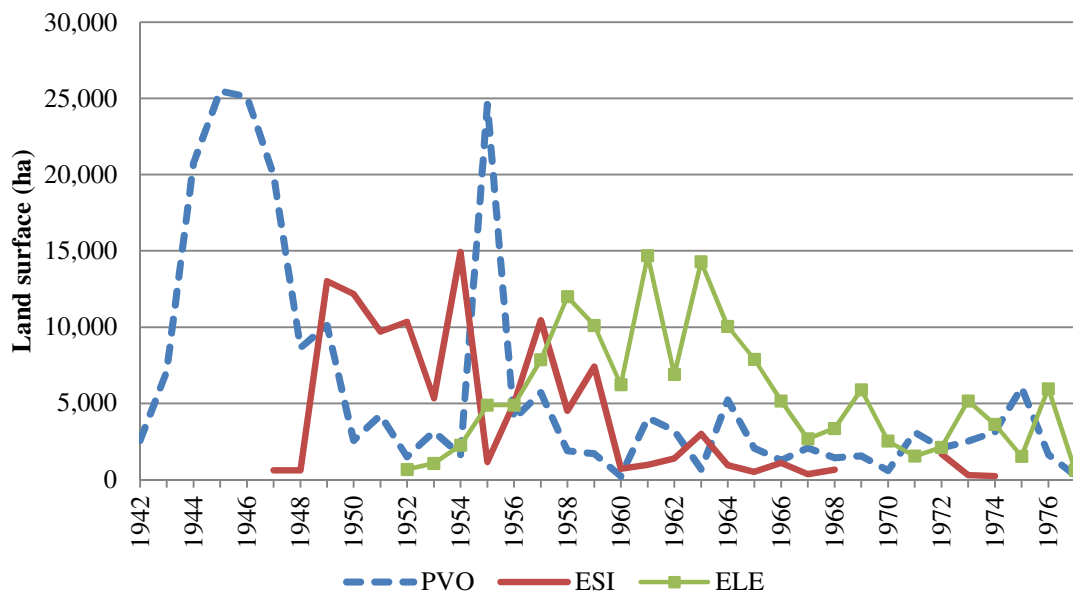
reorganisation of land plotting” due to the existing property structure, which determined “the amount of land that had to remain in reserve”.¹⁶¹

According to Figure 4.3, land purchases were at their highest rate in the early years of the INC (from 1939). The acquisition of land by the INC through voluntary offers during this first period confirms the liquidation of privately owned land assets due to the necessity of landowners to dispose of liquidity during the period immediately after the Civil War. In the early years of the INC (1939 to 1950), the lack of success of colonisation politics was also due to a lack of private participation. Private owners did not trust state colonisation plans, especially due to “the chaotic agrarian politics of the new state”; “an incoherent approach”; and “the inadequacy of the plans with the economic and political reality of the time” (Barciela López and López Ortiz 2003: 63).¹⁶² A second peak phase of land acquisition between the 1950s and early 1960s coincides with an intense period of large colonisation and irrigation plans by the INC, this time mainly through the expropriation of private land. As a result of internal political changes and international influences (i.e. the IBRD and FAO report in 1962), the land expropriation and purchasing activities of the INC decreased drastically during the second half of the 1960s and especially in the 1970s.

¹⁶¹ Author’s translation from original quote in Spanish.

¹⁶² Author’s translation from original quote in Spanish.

Figure 4.3 Land purchase and expropriation by the INC-IRYDA in Spain, 1942-1977



Note: PVO: Purchase of land after voluntary offer; ESI: land expropriation after declaration of national social interest; ELE: expropriation of land 'in excess'.

Source: Based on data from Mangas Navas 1990.

Another widely quoted consequence of Franco's colonisation politics is the benefits they introduced for large landowners (Alares Lopez 2010; Bosque Maurel 1984; Gomez Benito 1995; Ortega Cantero 1979). Despite its populist proclamations, the ideological and political contradictions of colonisation and irrigation politics carried out by the INC brought a timid confrontation with large landowners (Alares Lopez 2010).¹⁶³ Colonisation politics did not directly affect many families (until 1975, 24,047 settlers had been established in irrigated areas, with a national average of 6.1 hectares per settler) (Bosque Maurel 1984), due to the fact that the INC would purchase instead of expropriate most of the land declared for irrigation and also due to different legal loopholes, most landowners were able to keep part of their land in the

¹⁶³ As Raymond Carr wrote (1966: 29): "[i]nternal colonisation' was the remedy of Catholic reformers, who wished to aver to threat to social stability inherent in a flight to the towns, and of agronomists who realised the dangers of a mere redistribution of the lands. [...] To be successful resettlement policies needed an agency with extensive powers of expropriation and great capital resources for investment in irrigation. Private bodies would provide neither and radicals increasingly turned to the state. Its only response was a trickle of laws from 1907 onwards which neither gave adequate powers against landlords nor sufficient capital for resettlement."

declared areas to be irrigated. Landowners around the colonised areas would also benefit from infrastructure built by the state such as roads and railways (*ibid.*). Prone to internal political and economic changes experienced by Spain in the 1960s with the arrival of religious technocrats in Franco's government, the discourse of heavy intervention of the state in agrarian reform suffered a slow transformation towards liberalisation, although it retained some of the elements of control through subsidies and price regulation (e.g. fuel for agriculture) (Alares Lopez 2010).

4.4.2 The historical context of Franco's irrigation and colonisation politics

This chapter has described the historical evolution of irrigation and colonisation politics at the state level in Spain. These policies are intertwined with liberal reforms, democratic governments and dictatorships and present an intricate relationship between colonisation politics, irrigation and agrarian reforms since the nineteenth century. These policies are also intrinsically connected with different state-building stages in Spain when agrarian political reform played a pivotal role in the definition of economic and political structures affecting society.

This chapter has also presented past attempts by governments and politicians to use colonisation and irrigation according to their own political and ideological interests. Colonisation and irrigation politics became the expression of change sought in Spain during the Restoration period, influenced by the discourses and political programmes of a generation of influential politicians such as Joaquín Costa. His postulates continued to influence the ideological framework of hydraulic politics and colonisation during Franco's regime.

After the Civil War, agrarian politics adopted a stronger ideological turn, epitomising the quest for legitimacy of the new dictatorial Regime. Within this new political context, colonisation and irrigation policies emerged after the 1930s imbued with a much wider and deep sense of social duty: the land as well as the subjects had to be transformed. A new rural landscape had to be built through land plot concentration and land re-allocation. During Franco's dictatorship a dual system of agrarian ideological discourse and political reform emerged which complemented each other. However, a structural contradiction based on the ideological empowerment of the peasant classes through the creation of structures of agrarian capitalism was combined with legal changes in land property regime, the respect of private property and the privileges of the land owning classes.

Overall, Franco's colonisation experience was not very successful. It lacked realistic objectives and tangible results mainly because it was imbued with ideology since its very creation. Its implementation remained partial or symbolic (Gómez Herráez 1999) and the fact that agrarian reforms were also aimed at perpetuating the land property structure did not help with the real transformation of dry land into irrigation. Colonisation also exhibited practical contradictions as the definition and allocation of land ownership was overruled by explicit willingness from the Regime to maintain the interests and privileges of the large landowning classes. The fact that land property structure remained mainly unchanged was part of the ideological and foundational pact drawn after the Civil War with the landowning classes.

During the decade of the 1960s, liberalising recipes suggested by the IBRD aimed at altering the course of Spain's economy and agriculture, influenced a group of government technocrats. The INC was dissolved and replaced by a new organisation and different decrees and state-sponsored credits helped small farmers

modernise their farms and increase their productivity. These credits granted to farmers to invest on new irrigation structures were in high demand and the state had to extend various credit lines to the IRYDA in order to continue promoting farmers' private initiative in irrigation. At the end of the period studied in 1982, the IRYDA had been granted more than 86,000 million pesetas by the state to promote private irrigation.¹⁶⁴

In the next chapter, the case study of the colonisation town of Llanos del Caudillo will be used to exemplify the different state colonisation policies in Spain. The case of Llanos del Caudillo is used to highlight the different material and symbolic structures used by the state to create a new community around the colonisation and irrigation plans in La Mancha and the use and emergence of new groundwater abstraction technologies sustaining irrigation and agrarian change in this area.

¹⁶⁴ See Chapter 7 for a detailed analysis of state-sponsored decrees to promote private irrigation.

Chapter 5 . The creation of irrigation communities and subjects in Llanos del Caudillo, La Mancha

5.1 Introduction

This chapter explores the material and political aspects of state-sponsored irrigation and colonisation policies in La Mancha. It analyses the rationale behind the colonisation of Llanos del Caudillo and scrutinises the activities of the INC with the abstraction of groundwater for irrigation in the 1950s. Focusing on the conceptualisation of colonisation and irrigation politics as both infrastructures and political practices enabling the creation of individuals and space, this chapter exemplifies the duality of publicly sponsored irrigation technologies (i.e. material and political) in La Mancha in the 1950s. This chapter also explores the production of a new agrarian polity: the creation of a new community and subjects originating out of the politics of colonisation carried out by Franco's government in La Mancha. Additionally, it reflects on the emergence of specific modern technologies for groundwater abstraction and its uses for agriculture within the designated colonisable area of La Mancha.

The second section of this chapter introduces the process of colonisation of Sector I in La Mancha and the development of technology by the INC to abstract groundwater for irrigation in Llanos del Caudillo in the early 1950s. The following section reviews the colonisation of Llanos del Caudillo and the processes set up by the state to create irrigation subjects (i.e. the settlers) and irrigated landscapes in La

Mancha. This section also describes the design and building process of Llanos del Caudillo and the construction of the settler's community as a new socio-political space in the countryside. The last section examines the development of agriculture in Llanos del Caudillo, the control of agrarian production by the INC and the pricing of water.

5.2 Irrigation and colonisation in La Mancha

5.2.1 The colonisation of La Mancha

5.2.1.1 The INC in La Mancha

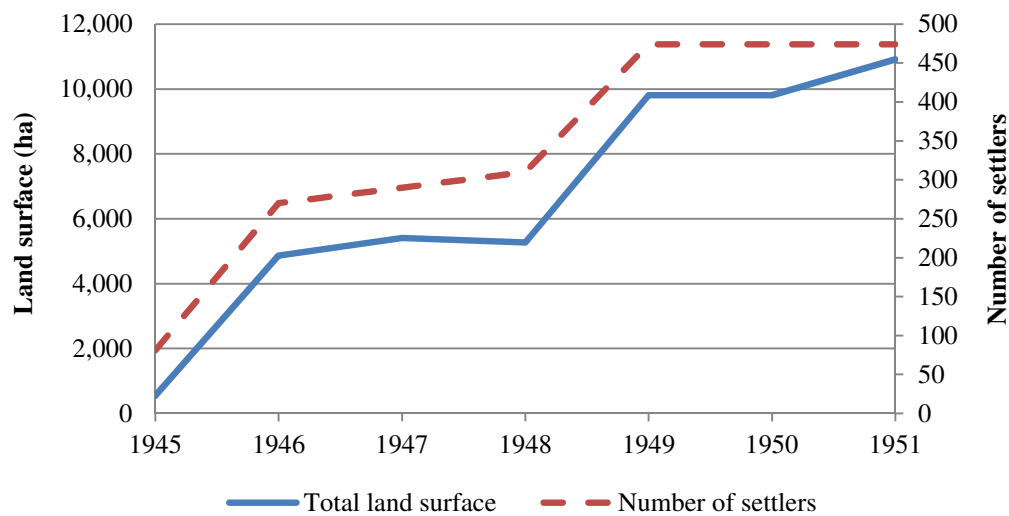
The INC was established in 1939 after the Civil War with the purpose of addressing three main problems affecting the countryside in Spain (EUA 1985b):

- (1) The lack of capital to complete irrigation works laid out by the *Confederaciones Hidrográficas* with secondary networks;¹⁶⁵
- (2) The lack of capital to develop irrigation projects, e.g. new terraces for agriculture, new jobs for farmers and settlement of new inhabitants;
- (3) The need for irrigation training for new, mainly dryland farmers.

Until 1951, the INC owned 6 estates with 474 settlers and a total land surface of 9,811 hectares in the province of Ciudad Real. Out of these 9,811 hectares, 9,801 hectares were used for dry land farming (Figure 5.1).

¹⁶⁵ Following a report by the IRYDA, “the majority of dams and canals built could not be used for lack of secondary infrastructure that would carry the water to the land plots” (EUA 1985b: 136). Author’s translation of original quote in Spanish.

Figure 5.1 Total land surface owned by the INC in Ciudad Real Province and number of settlers (1945-1951)



Source: Based on data from Mangas Navas 1990.

The INC's colonisation rationale in La Mancha followed the identification of unemployment of farmers and agrarian workers as the major social problem in the area, with "400 workers without work during six consecutive months, and another 600 workers temporarily unemployed during three months per year" (INC 1952a: 15). According to the same report, "the solution to this social problem will find its most adequate solution with the future irrigation plans in the Area of La Mancha" (*ibid.*). In order to proceed with the colonisation of the area, the report also mentioned that,

"given the fact that studies carried out in the area of La Mancha in Ciudad Real to determine the presence of groundwater have been satisfactory, and also given the fact that there are groundwater abstractions for irrigation already in the same area, and that the future irrigated land will have to absorb such an exceeding workforce, it is evident to assume that the aforementioned irrigated lands of Sector I in the Municipal Term of Manzanares will be

adequate to solve the existing social problem, with the admittance as settlers of the small farmers or temporary agrarian workmen from Manzanares” (*ibid.*).¹⁶⁶

Following the General Law of Colonisation of the 26th of December of 1939, on the 27th of April 1951 the INC declared of national interest for colonisation¹⁶⁷ an area of 49,500 hectares in La Mancha.¹⁶⁸ On the 9th of January 1953, the colonisation area of La Mancha was drawn with Sector I comprising 2,000 hectares of irrigable land (INC 1954b). The decree approving the General Plan of colonisation for Sector I in La Mancha was issued on the 27th of November 1953¹⁶⁹ and the Construction and Work Plan for Sector I was approved on the 21st of December 1954.¹⁷⁰

5.2.1.2 Land expropriation for colonisation in La Mancha

Following the 1949 Law of Colonisation and Allocation of Property in Irrigable Areas, the INC was allowed to expropriate land included in the designated irrigable area. Three different categories of land were established: land in excess; land

¹⁶⁶ Author’s translation of original quote in Spanish.

¹⁶⁷ BOE, 4th of May 1951, No.124, pages 2068-2069.

¹⁶⁸ The process of colonisation in La Mancha also included a second major irrigation intervention: the Peñarroya Irrigation scheme. As opposed to Sector I in La Mancha which used groundwater for irrigation, the Peñarroya Irrigation Scheme was designed to use surface water from the Peñarroya Dam through a series of irrigation canals and acequias. The irrigation and colonisation plans of Peñarroya represented 10,229 hectares of dominated surface susceptible to be irrigated with the project, with in the end 8,176 hectares effectively irrigated and 7,351 hectares 'in excess' to be expropriated and allocated to settlers with the purpose of transforming a vast surface of dry land into irrigation and to relieve the social problems of the area related with the cultivation of vines and its price volatility in order to obtain crops with more constant prices (INC 1960). Following the Decree of the 26th of July 1956, the irrigable area of the Peñarroya Dam was designated and was declared of high national interest for its colonisation. The designated area is located within the municipalities of Campo de Criptana, Tomelloso and Argamasilla de Alba. At the time of the Declaration of High National interest of the area of Peñarroya, a dam 8 kilometres upstream had already been built with a capacity of 47.5 Mm³ and a height of 32.5 metres (INC 1960).

¹⁶⁹ BOE, 17th of December 1953, No.351, pages 7436-7440.

¹⁷⁰ BOE, 26th of December 1954, No.360, pages 8512-8513.

in reserve; land excluded (Table 5.1) (Monclús and Oyón 1988). The definition of the area of La Mancha as ‘of national interest for colonisation’ and the establishment of Sector I for its colonisation meant that land from the municipalities of Manzanares and Alcázar de San Juan had to be expropriated.

Table 5.1 Definition of the different categories of land in the colonisable areas

<i>Category</i>	<i>Definition</i>
Land in ‘excess’ (<i>en exceso</i>)	Land to be expropriated within the designated irrigable area
Land in ‘reserve’ (<i>en reserva</i>)	Land kept by landowners as a proportion of the original property size and according to the number of descendants. The INC would provide help and subsidies for its transformation into irrigation
Land ‘excluded’ (<i>exceptuada</i>)	Land not affected by irrigation plans. These land plots were to be kept privately by their owners, and included dry lands, those already irrigated or in the process of being transformed into irrigation (e.g. with an existing well)

Source: Monclús and Oyón 1988.

The structure of land ownership in Sector I was described by a technical report drawn up by the INC (1954b) as “quite fragmented in terms of land plots, especially if we consider the fact that the large properties do not always happen to form a closed plot but in several occasions are the sum of different plots not adjacent to each other” (INC 1954b: 5). The sector effectively had a total surface of 1,992.8 hectares with 1,896.3 irrigable hectares and 96.5 non-irrigable hectares (Table 5.2).¹⁷¹

¹⁷¹ Of the total surface, the majority belonged to individual owners “except two small land plots, one belonging to the Chaplaincy of Andrés Gallego (Bishop of the Priory of the Military Orders) and the other one to the National Institute of colonisation, where it had its offices” (INC 1954b: 4-5).

Table 5.2 Landowners with estates located in the designated Sector I of La Mancha

<i>Type of land property</i>	<i>Number of owners</i>	<i>Surface (ha)</i>
<i>Estates belonging to the state</i>		
<i>Total</i>	1	17
<i>Estates belonging to private owners</i>		
Less than 5 ha	41	1,975.7
Between 5 and 25 ha	15	
Between 25 and 100 ha	8	
Larger than 100 ha	9	
Total	73	

Source: Based on data from INC 1954b: 4-5.

On the 27th of January 1954, the Provincial Official Bulletin in Ciudad Real and the newspaper *Lanza* announced expropriation rules and deadlines for landowners to claim for exemptions (INC 1954b: 2). After the deadline to present all required documents expired on the 3rd of March 1954, 45 forms had been submitted, of which 44 were from direct cultivators and one from a leasing farmer (INC 1954b). In order to expropriate, the INC had divided the land into four different types (*ibid.*):

- (1) Lands in estates having been 'excluded' in its totality;
- (2) Lands in estates the owners of which are direct cultivators and have applied for the 'reserve' of land;
- (3) Lands with owners not having applied for the 'reserve' of land;
- (4) Lands belonging to state organisations and Pious Foundations.

Landowners were allowed to apply for the provisional category of 'excluded' land if they could demonstrate that they had a well for irrigation or had been irrigating in the past. The provisional status could be upgraded to a permanent status five years after

the declaration of colonisation if the cultivation exceeded a certain degree of intensity (established as being thirty *quintales*¹⁷² of wheat per hectare).¹⁷³ Then, the INC established rules to calculate the 'reserve' of lands (Table 5.3) excluding land plots with the Institute's own buildings and also an estate belonging to the Church.¹⁷⁴

Table 5.3 Rules for the calculation of the 'reserve' of land by the INC in La Mancha

<i>Rules to calculate the 'reserve' of land</i>	<i>Formula</i>
1) Owners directly cultivating the land with a final or provisional surface 'not excluded' of 6 hectares or less	Total 'reserve' or adjudication to the owner
2) Owners directly cultivating the land with a final or provisional surface 'not excluded' between 6 and 30 hectares	'Reserve' of 6 hectares
3) Owners directly cultivating the land with a final or provisional surface 'not excluded' larger than 30 hectares	'Reserve' of the fifth part of the land surface
4) Extension of the 'reserve' land calculated according to the previous norms	Difference between the number of hectares obtained multiplied by the number of legitimate or legitimated children of the owner times 6 and the 'reserve' already applied following norms 1, 2, or 3
5) 'Reserve' of vines	The totality of land surface with vines planted before the declaration of national interest of the area, whatever the surface, being completed with the application of norms 1, 2, 3, or 4
6) Extension of reserve for the owners beneficiaries of provisional 'exception'	'Reserve' of land surface equivalent to what would have been cultivated with vines before the declaration of national interest of the area

Source: Based on INC 1954b.

After assessing the landownership structure of Sector I, the INC concluded that land structure presented,

¹⁷² Language note: 30 *quintales* = 3,000 kilograms (1 *quintal* = 100 kilograms).

¹⁷³ BOE, 17th of December 1953, No.351, pages 7436-7440.

¹⁷⁴ The estate owned by the Chaplaincy of D. Andrés Gallego was being leased for its cultivation but could not be allocated to anyone for its tenancy was still being decided as part of a new treaty on Chaplaincies and Pious Foundations between the Vatican and Spain (INC 1954b).

“a very irregular distribution of lands in 'reserve' and in 'excess', due principally to the fact that the Sector presents a high level of land plotting and to the fact that the majority of the owners have claimed the 'reserve' of lands due to the presence of vines. According to Rule 5, the 'reserve' of land is limited to the vines plots, allowing scarce flexibility in the delimitation of the 'excess' of land and of the land plots” (INC 1954b: 11).

The 1949 Law of Colonisation allowed landowners affected by the INC's expropriations to declare in 'reserve' or 'excluded' large areas of land. This was made possible by a series of legal loopholes, which included building wells or acequias to justify their use for irrigation before the declaration of expropriation of the area (Monclús and Oyón 1988).¹⁷⁵ Landowners also received subsidies from the INC for the development of irrigation in properties that were exempt from expropriation for having already planted vines (Rule 5 of the 'reserve' of land) or for having irrigation systems already in place (Romano Serrano 2005). After the administrative procedures and appeals for the 'reserve' of land from landowners, 910.79 hectares were declared in 'reserve' in Sector I according to these rules. In total, the INC expropriated an area of 1,082.4 hectares for the colonisation and irrigation of Sector I in La Mancha (INC 1954b: 12) (Table 5.4).

¹⁷⁵ Following the INC's expropriation plans, some landowners received generous compensation for the expropriation of their land. The General Plan of Colonisation established the maximum and minimum prices to be paid to landowners ranging between 2,000 peseta/ha (approximately 180 USD in 1954 with the currency exchange rate peseta/USD in 1954 = 10.95. Carreras de Odriozola and Tafunell Sambola 2006) and 30,000 peseta/ha (approximately 2,740 USD. *ibid.*). In Sector I, 17 landowners received payments of around 10,000 peseta/ha (approximately 910 USD. *ibid.*), which represented in some cases payments of 200,000 pesetas (approximately 18,260 USD. *ibid.*) up to 735,000 pesetas (approximately 67,120 USD. *ibid.*) (Romano Serrano 2005).

Table 5.4 Surface colonised by the INC in Sector I of La Mancha

		<i>Surface (ha)</i>
<i>Irrigable surface</i>	Original land in 'excess'	1,726.70
	Land provisionally 'excluded'	137.0
	Subtotal	1,863.70
<i>Non irrigable surface</i>	Town	19.20
	Unusable land, roads and edifications	78.13
	Acequias	31.80
	Subtotal	129.13
<i>Total</i>	Total	1,992.83
	Total land declared in 'reserve'	910.79
	<i>Total effectively colonised and irrigated in Sector I</i>	<i>1,082.04</i>

Source: Based on INC 1954b.

5.2.2 Irrigation infrastructure and groundwater abstraction for the colonisation of La Mancha

5.2.2.1 The colonisation of Sector I of La Mancha

The colonisation area of La Mancha was originally divided into three sectors but only Sector I and II presented “the optimum conditions for its irrigation due to the fact that no land movement was required, limiting its preparation to the works of permeabilization and the removal of stones” (INC 1950: 15). Sector I was initially divided into 34 sub-sectors, representing an enclave of 21,000.26 hectares between the municipalities of Manzanares, Argamasilla de Alba, Alcázar de San Juan, Herencia and Arenas de San Juan (INC 1950). After the procedures for land expropriation were complete, the dimensions of Sector I stood at 7 kilometres wide (East-West) and around 5 kilometres long (North-South) (INC 1955a). In one of its

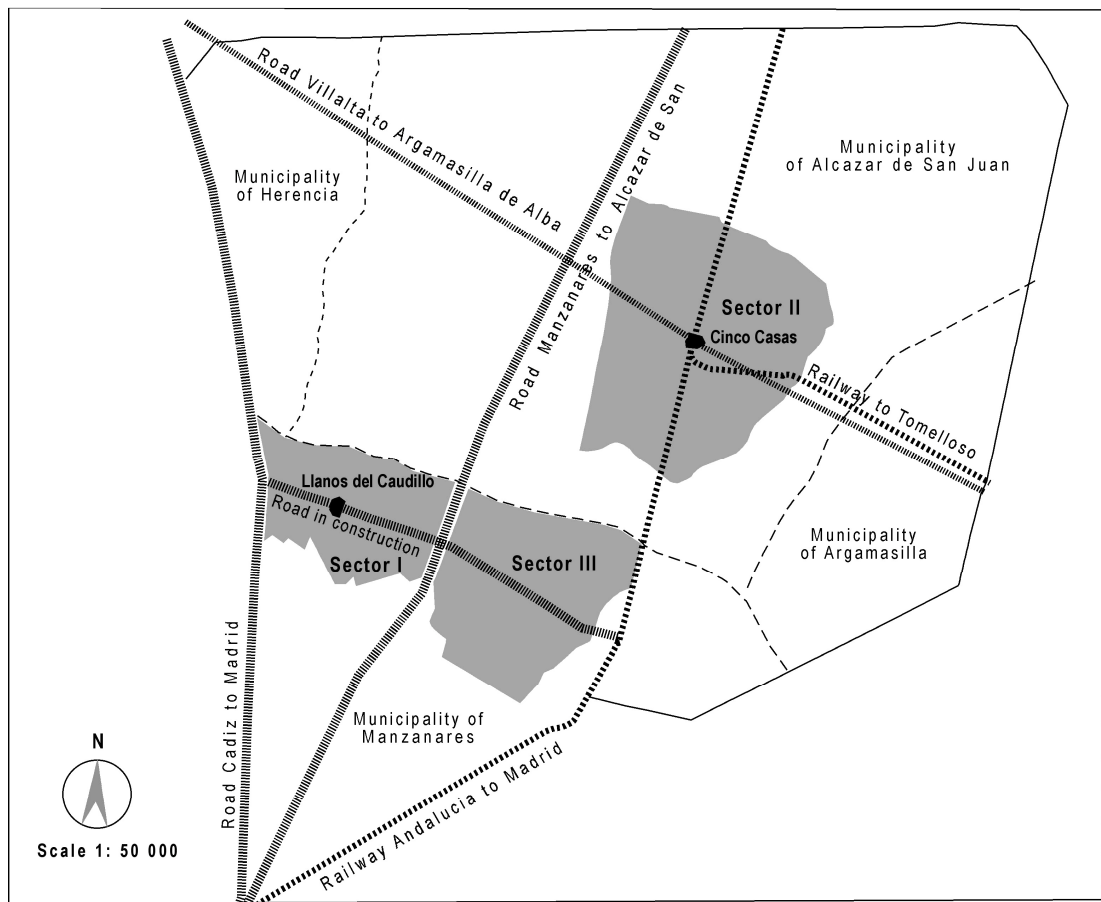
first technical reports, the INC outlined the different phases for the colonisation of Sector I of La Mancha (*ibid.*):

1. Drilling of boreholes for abstraction of groundwater;
2. Land plot design and topographical study of the sub-sectors following the sequence in which they will be irrigated;
3. Installation of groundwater abstraction pumping stations;
4. Irrigation project for Sector I, with design of rural and secondary service roads;
5. Project for rural buildings annexed to cultivated lands;
6. Occupation of the affected estates;
7. Execution of the works;
8. Establishment of settlers and distribution of cultivation areas to their owners.

The construction of the new town started in 1954 following the General Plan of Colonisation of La Mancha on the 27th of November 1953. Llanos del Caudillo¹⁷⁶ was planned as one of nine colonisation towns built in the province of Ciudad Real by the INC (Romano Serrano 2005). In La Mancha the INC planned two towns: Llanos del Caudillo in the municipality of Manzanares, and Cinco Casas in the municipality of Alcázar de San Juan (Figure 5.2).

¹⁷⁶ *Language note:* the toponym ‘Llanos del Caudillo’ literally means Plains of the Leader. ‘Caudillo’ referred popularly to the dictator Francisco Franco as the political and military leader of the Spanish people.

Figure 5.2 Colonisation sectors in La Mancha



Source: Author based on INC 1956a.

5.2.2.2 Irrigation infrastructure for the colonisation of La Mancha

When the expropriation, allocation, and 'reserve' of land was complete, the INC drew up the 'Plan for the initiation of irrigation and colonisation works of Sector I of the Area of La Mancha' in February 1954 (INC 1954a). This plan divided Sector I into 23 sub-sectors, each irrigated by one well (Figure 5.3 and Table 5.5). The irrigation network of acequias and roads was designed according to the following requirements (INC 1954a):

1. To bring water to all land plots;
2. To provide a constant supply of 20 litres of groundwater per second to every irrigated land plot;
3. To plan the slope of the acequias with an intake 25 centimetres above the ground in every land plot;
4. To plan and build complementary irrigation networks such as aqueducts, intakes, siphons and overflow channels;
5. To ensure good links of roads and paths between the new town and the different wells;
6. To ensure access between the national road from Madrid to Andalucía and the road from Manzanares to Alcázar de San Juan and the different areas of Sector I;
7. To preserve different means of access through the old rural roads before colonisation of the Sector;
8. To connect all wells with secondary roads and with the main road of Sector I;
9. To preserve old rural roads within Sector I and ensure Sector I is linked to outside areas.

Figure 5.3 Colonisation Sector I and Llanos del Caudillo, La Mancha



Source: Author based on INC 1955a.

Table 5.5 Summary of infrastructures for the irrigation project of Sector I – La Mancha

<i>Sub-sectors</i>	<i>Well capacity (l/s)</i>	<i>Total surface (ha)</i>	<i>Irrigable surface (ha)</i>	<i>Number of land plots irrigated</i>	<i>Flow (l/s/ha)</i>	<i>Acequias (m)</i>	<i>Density of acequias per ha (m)</i>	<i>Rural roads (m)</i>	<i>Density of rural roads per ha (m)</i>	<i>Type of irrigation</i>	<i>Extension of secondary water network and ditches(1957)</i>	<i>Comments</i>
101	60	69.04	67.21							sprinklers		
102	100	86.99	85.20	13		2090	24.53	2,520	29.57	gravity irrigation		
103	60	60.81	59.62	8		1310	21.97	1,400	23.48	gravity irrigation		
104	60	47.97	47.41	8	1.25	638	13.46	657	13.85	gravity irrigation		
105	100	95.90	93.05	15	1	2184	23.47	3,613	38.83	gravity irrigation		
106	160	119.68	116.83	19	1.35	2472	21.16	3,419	29.26	sprinklers	Yes	
107	60	61.29	60.30	10	1	1052	17.45	1,237	20.52	gravity irrigation		
108	100	91.56	89.63	14	1.11	1460	16.29	967	10.79	gravity irrigation	Yes	
109	60	55.29	53.15	9	1.128	1282	24.12	1,324	24.91	gravity irrigation		
110	100	71.11	69.59	12	1.35	1910	27.45	1,724	24.78	gravity irrigation		
111	100	75.04	73.45	12	1.35	1312	19.22	1,695	23.08	gravity irrigation	Yes	
112	60	56.51	55.10	9	1	690	12.52	308	5.59	gravity irrigation		
113	100	89.95	88.31	15	1.1	1865	21.11	1,440	16.31	gravity irrigation		
113a		78.50	76.33	13		2295	27.96	1,195	15.22	gravity irrigation		Modified in 1959
114	100	72.66	70.80	12	1.41	2277	32.16	1,572	22.2	gravity irrigation	Yes	
115	100	92.72	90.60	15	1.103	1733	19.13	2,215	24.45	gravity irrigation	Yes	
116	100	87.92	86.34	14	1.1	1223	14.16	2,152	24.92	gravity irrigation		
117	160	124.27	121.75	20	1.25	2056	16.89	2,772	22.77	gravity irrigation		Modified in 1959
117a		58.72	57.25	10		610	10.38	1,280	21.79	gravity irrigation then sprinklers in 1972		
118	60	50.69	49.68	8		1240	24.96	1,350	27.17	gravity irrigation		
119	100	85.40	83.64	13		2380	28.45	1,920	22.95	gravity irrigation		
120	100	83.84	81.57	13	1.1	1355	16.61	2,903	35.59	gravity irrigation		
121	60	59.67	58.47	10	1	1137	19.44	1,838	31.43	gravity irrigation	Yes	
122	60	55.60	54.28	9	1	798	14.7	1,541	28.39	gravity irrigation		
123	100	70.87	68.89	11	1.35	2593	37.64	2,336	33.91	gravity irrigation	Yes	
124		35.58	34.66	6		535	15.03	450	12.65	gravity irrigation		Created in 1959 after modifying subsector 117

Source: Author based on data from INC 1953c; INC 1953d; INC 1953e; INC 1954c; INC 1956b; INC 1957b; INC 1959.

Additionally, the INC established a means of categorising infrastructure in order to benefit from different degrees of public investment by the state. Following article 1 of the decree approving the Plan of Colonisation of La Mancha, the Ministry of Agriculture established that the following works would be considered of '*general interest*' (and therefore fully funded by the state) (INC 1954a):

- a) High voltage lines and electric transformation station
- b) Main road of Sector I
- c) Drinking water supply, sanitation and road paving in the new town
- d) Construction of the social building in the new town
- e) Planning and construction of the streets and road in the new town

According to the same decree wells, groundwater abstraction infrastructure equipment, buildings of power generators, networks of acequias (Photograph 5.1), roads, and rural road planning were considered by the INC '*works of common interest*' (40 percent of its investment value was funded by the INC). Moreover, the construction of settler houses, ditches in land plots, and other mobile elements for irrigation with sprinklers were considered by the INC '*works of private agrarian interest*' (30 percent of its investment value funded by the INC). As also specified by the INC in the plan of colonisation for Sector I, each settler would receive an individual unit for cultivation comprising 6 hectares and 0.5 hectares for a private vegetable garden (*ibid.*).

In order to carry out these works, Minister Rafael Cavestany worked to leverage funds from the United States reconstruction programme for Spain for the

Ministry of Agriculture and the INC. Following the McCarran Amendment,¹⁷⁷ special funds were used in La Mancha to level the ground for irrigation plots (Photograph 5.2) for an amount of 4.4 million pesetas¹⁷⁸ and in 1960 for groundwater test drilling in Sector I for an amount of 391,167.01 pesetas.¹⁷⁹ According to Alejandro Torrejón, general director for colonisation:¹⁸⁰

“Cavestany would get whatever financial means required; then we got some very substantial funding from the Institute of Housing for colonisation towns ... we are talking about the beginning ... because later, at the end, nothing; the first years, with Cavestany. After, Agrarian Credits for local colonisation; [...]; we used American funds, which were very important [...] there was an office in the American embassy, I don't remember the name, the Agrarian Office, which was for ... the inspectors to control how we spent their money [sic]” (EUA 1985a: 17).¹⁸¹

¹⁷⁷ The Mccarran Amendment, also called Public Law 778, was named after anti-communist Senator Pat Mccarran and was part of the 55 million dollar fund voted for by the US Senate to help finance Spain's reconstruction after the Madrid Pacts, shipping American agricultural commodities and surpluses. This pact also included funds for defence support, technical assistance, and foreign material and technology (Calvo-González 2006). As studied by Swyngedouw (2007), Franco's government benefitted from an internationalist geo-economic and geo-political alliance articulated through the integration of Spain in the US-led Western Alliance against the Soviet Union.

¹⁷⁸ Registry Correspondence INC, Box 946, File 25220, Document 68, General Archive, Ministry of Agriculture.

¹⁷⁹ Registry Correspondence INC, Box 1456, File 25220, Document 47, General Archive, Ministry of Agriculture.

¹⁸⁰ Replaced in 1965, Decree 2070/1965, 21 of July. BOE, 22nd of July 1965, No.174, page 10350.

¹⁸¹ Author's translation from original quote in Spanish.

Photograph 5.1 Acequia in Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

Photograph 5.2 Ground levelling by the INC in La Mancha, 1950s



Source: Archive, Ministry of Agriculture.

5.2.2.2 *The potential of groundwater for irrigation in La Mancha*

In its first preliminary report on the colonisation of La Mancha, the INC highlighted the potential of groundwater for agriculture.¹⁸² In a 1945 report on the implementation of colonisation laws in the province of Ciudad Real, the INC noted the large proliferation of wells and irrigation networks built privately without funds or help from the state. The engineers from the INC were “struck by the infinity of wells existing in the province of Ciudad Real, some of them abandoned and some others functioning” (INC 1945: 4).¹⁸³ The conclusions of this report mentioned that the construction of wells had “to be favoured as much as possible” and that the INC would have to install more sophisticated technology “in all the wells with norias helped by the Institute” (INC 1945: 6).¹⁸⁴ Estimates by the INC in 1950, following the observation of existing wells in the Municipality of Manzanares, indicated that the irrigation potential of groundwater abstraction is “huge”. The possible abstraction of 20,000 to 25,000 litres per second in wells distributed regularly around the area had the potential to sustain the irrigation of approximately 25,000 hectares of land (INC 1950: 11). Following the social and ideological need to “create wealth with the irrigation of new areas in all of the national territory”, the INC,

“had considered necessary in 1950 to study the county of La Mancha in Ciudad Real and to consider, in light of previous geological studies,

¹⁸² The lack of studies on groundwater capacity of the area had already been mentioned by previous documents. General studies on the development of irrigation and hydraulic infrastructure carried out in 1933 by Chief Engineer Manuel Lorenzo Pardo reflected the unknown characteristics of groundwater in the area and mentioned the important irregularity of the Guadiana River flow possibly due to the “regulatory effect of the Manchegan plains and to the underground origin of a large part of its waters” (Lorenzo Pardo 1933: 96). Author’s translation from original quote in Spanish.

¹⁸³ Author’s translation from original quote in Spanish.

¹⁸⁴ Author’s translation from original quote in Spanish.

abstracting important groundwater flows, and responding to the desires of the Ministry of Industry and Commerce to use electric energy from the thermal station of Puertollano to lift the water”¹⁸⁵ (INC 1952b: 1).¹⁸⁶

In the same report from 1952 the INC also mentioned that,

“according to the possibilities of groundwater abstraction for the irrigation of the vast surface of the region, a report was commissioned by the Institute of Geology and Mines about the subterranean hydrology of the north-western region of the province of Ciudad Real” (*ibid.*).¹⁸⁷

Following the conclusions of this report, and concurring with the studies made by the INC about the potential for groundwater abstraction in the area, the Ministry of Agriculture submitted the declaration of national interest for the area of La Mancha to the Council of Ministers, who approved it by decree on the 27th of April 1951 (*ibid.*).¹⁸⁸

The initial study by the INC of the groundwater potential of La Mancha also included a list of exploratory interventions aimed at testing the groundwater abstraction potential of Sector I of La Mancha. The INC separated its work into two phases: the first comprising the exploratory drilling of wells; and the second

¹⁸⁵ See also Chapter 7. The Thermal Station of Puertollano was owned by ENCASA, the publicly owned monopoly company in charge of the production of synthetic fuel in Spain (San Roman and Sudria 2003).

¹⁸⁶ Author’s translation from original quote in Spanish.

¹⁸⁷ Author’s translation from original quote in Spanish.

¹⁸⁸ BOE, 4th of May 1951, No.124, pages 2068-2069. The Ministry of Agriculture included the INC’s findings in this decree by stating in its preamble that different geological studies seem to corroborate the idea that underneath the area of La Mancha exists an underground reservoir of ‘appreciable capacity’.

consisting of the preparation of the wells for irrigation. Below is a more detailed account of the first phase according to the INC (INC 1952b: 2):

- Digging two wells with a 2-metre diameter until arriving at the first aquifer layer; then drilling a borehole with a diameter of 0.40 metres to explore the successive aquifer layers, with the purpose of studying the ground structure and learning about the depth and permeability of the different aquifer layers. The purpose of this intervention was to ascertain the capability of the aquifer for groundwater abstraction in order to establish more accurately the location of future boreholes and areas of intervention.
- Drilling 18 boreholes in Sector I of La Mancha.

Exploratory drilling in the 18 designated points began on the 1st of July 1951 (Table 5.6),¹⁸⁹ digging holes 25-metre deep and 2 metres wide. Once that depth was reached, test drilling was carried out in four of the holes in order to study the different layers of the ground, reaching a depth of 52 metres.¹⁹⁰ Once the first layer of water was reached, INC technicians suggested drilling a borehole of 0.40 metres in diameter and introducing a vertical pump in order to facilitate the excavation and abstraction of water.¹⁹¹ According to the Correspondence Registry of the Archives of the INC, 22

¹⁸⁹ In the INC's Correspondence Registry, a document dated from the 22nd of June 1951 stated that it had not been possible to issue a budget for the exploratory drilling of the boreholes since the depth of the drilling and the thickness of the different layers of the aquifer were not known and could only be estimated approximately. The works started after having done a restricted bid between three different companies from Alcázar de San Juan, Daimiel and Herencia (the estimated budget stated in this document was for 290,710.59 pesetas, all paid by the INC). Registry INC Correspondence, Box 467, Document 9, 22nd June 1951.

¹⁹⁰ Registry INC Correspondence, Box 467, Document 9, Extension of credit, 18th June 1952, General Archive, Ministry of Agriculture.

¹⁹¹ Registry INC Correspondence, Box 467, Document 51, General Archive, Ministry of Agriculture.

pumps and power generation sets were acquired by the INC on the 10th of November 1952 for the elevation of groundwater in Sector I of La Mancha.^{192, 193}

Table 5.6 Status of wells in Sector I – La Mancha, 22nd of December 1953

<i>Well number</i>	<i>Water depth</i>	<i>Total well depth</i>	<i>Test drilling</i>	<i>Partial depth test</i>	<i>Total depth test</i>	<i>Approximate flow (l/s)</i>	<i>Comments</i>
101	-18.20	-23.60	yes	yes	yes	60	Completed
105	-17.70	-24.95	yes	yes	no	90	Close to completion
106	-17.40	-21.50	yes	yes	no	110	Not completed, 160 l/s will be obtained
107	-16.80	-22.00	yes	yes	no	50	Close to completion
108	-18.90	-26.30	yes	yes	no	110	Not finished, 160 l/s will be obtained
109	-18.60	-22.40	yes	yes	yes	60	Completed
110	-17.30	-23.50	yes	yes	yes	100	Completed
111	-17.30	-26.50	yes	yes	yes	100	Completed
112	-17.40	-20.20	yes	yes	no	60	Not completed
114	-18.60	-26.00	yes	yes	yes	100	Completed
115	-18.20	-28.30	yes	yes	yes	100	Completed
116	-18.50	-31.00	yes	yes	no	100	Completed
117	-16.80	-22.60	yes	yes	no	60	Not completed
120	Abandoned						
121	-17.70	-23.20	yes	yes	no	15	Not completed
122	-18.70	-24.40	yes	yes	no	30	Not completed
123	-17.35	-21.20	yes	yes	no	60	Not completed

Source: Based on data from Box 643, File 25221, Document 508, General Archive, Ministry of Agriculture.

After the exploratory drilling tests by the INC began (Table 5.6 and Photograph 5. and Photograph 5.3), the Ministry of Agriculture issued a decree on the 5th of February 1954 declaring the works, research and abstraction of groundwater

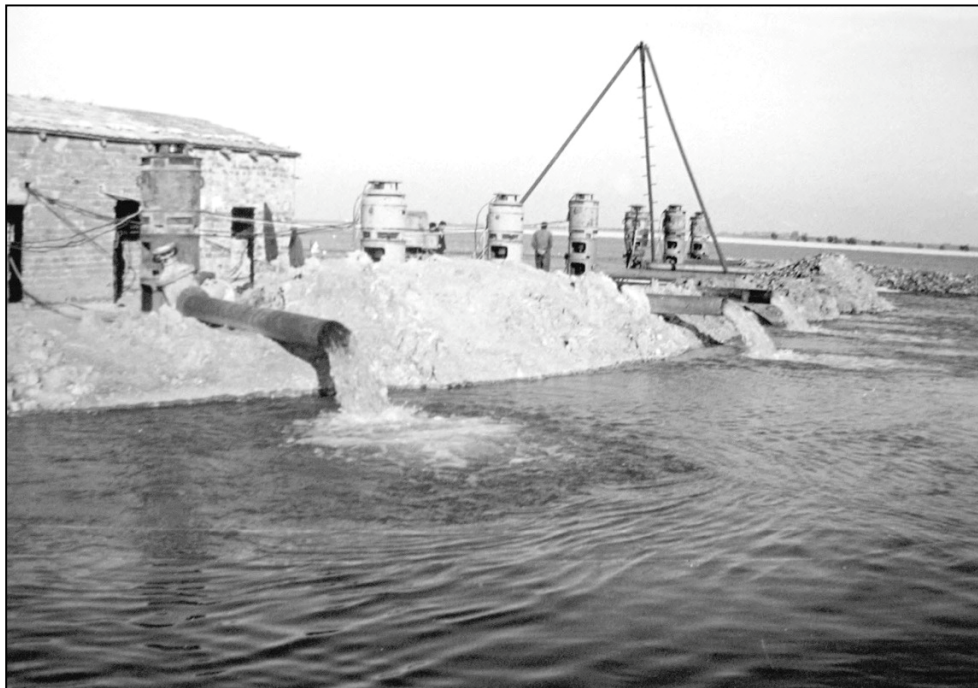
¹⁹² Registry INC Correspondence, Box 3472, General Archive, Ministry of Agriculture.

¹⁹³ The credit petition by the INC included 12 electric pumps with vertical axis with an elevation capacity of 100 litres per second. Two other sets of pumps with horizontal axis with 100 litres per second capacity were also ordered along with 6 sets of electric pumps with vertical axis with a capacity of 60 litres per second. Another 2 electric pumps with horizontal axis and capacity to abstract 60 litres per second complemented the order made to Worthington pump maker. The bidding was published on the BOE on the 12th of November 1952 and the works ended on the 12th of September 1956. The total credit issued by the INC for the acquisition of 22 sets of pumps and power generators for Sector I of La Mancha amounted to 3,561,229.21 pesetas. Registry INC Correspondence, Box 1552, File 252211, Document 155, General Archive, Ministry of Agriculture.

conducted by the INC of national interest following Base 19 of the 1939 Law of Colonisation of Large Areas.¹⁹⁴ Following this law,

“Article 1. The works, facilities and constructions carried out by the INC for the study and abstraction of groundwater for the sole purpose of irrigation will be declared of high national interest, according to the Base 19 of the Law of the 26th of December of 1939 of Colonisation of Large Areas. [...] Article 3. The water abstracted by the INC as a consequence of these exploratory investigations will be owned by the INC which, in the case of not using it, will have the right to transfer it to private individuals after the payment of a fee established according to the flow and costs of abstraction as well as other costs derived from the abstraction works.”

Photograph 5.3 Test drilling in La Mancha, 1950s



Source: Archive, Ministry of Agriculture.

¹⁹⁴ BOE, 16th February 1954, No.47, page 891. Author's translation from original quote in Spanish.

Photograph 5.4 Drilling with percussion technology in Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

As a result of these exploratory tests, the INC concluded that,

“it would be feasible to abstract water from the first liquid layer, which is 3 to 4 metres thick, something that requires the drilling of the already opened wells to the depth of the first layer found. This will require the use of powerful pumps working on a regime of 200 litres per second since the works will be carried out underneath the layer of water. [...] At the same time, baring in mind that the terrain being drilled consists of fissured and very hard limestone, pneumatic hammers powered by compressors will be needed”.¹⁹⁵

¹⁹⁵ Author’s translation from original quote in Spanish. Registry INC Correspondence, Box 467, Document 51, General Archive, Ministry of Agriculture.

Overall, the internal correspondence of the INC indicates that the Institute carried out the first drilling tests and studies in order to validate the hypothesis that a vast subterranean reservoir of water existed under the plains of La Mancha.¹⁹⁶ This led to the conclusion that potential irrigation through groundwater abstraction wells (Photograph 5.4) would be feasible and successful due to the immense and shallow groundwater reserves.

Photograph 5.4 Electric transformation station for a well in Llanos del Caudillo



Source: Archive, Ministry of Agriculture.

Due to the fact that drilling of boreholes required special technology, it is plausible to say that such a capital intensive and technically complex operation could only be

¹⁹⁶ Statement mentioned in the Preamble of the Decree of 27th of April of 1951 declaring of high national interest the colonisation of La Mancha, BOE, 4th of May 1951, No.124, pages 2068-2069, and in the Preamble of the Decree of 9th of January of 1953 establishing the norms of the irrigation colonisation of La Mancha, BOE, 2nd of February 1953, No.33, pages 734-735.

carried out by the Ministry of Agriculture through the INC. The testimony of Ángel Martínez Borque, director of the INC in 1965¹⁹⁷ reflects on this matter:

“The Institute also carried out a very important task with respect to groundwater [...] early in the 1950s [...] they brought many litres of water [to] La Mancha [...]. There were also frictions with the Geological [Institute] then, big, of course with Mines [the Ministry]. [...] But Mines had not done any water drilling ... they had not drilled a single metre ... it was the Institute” [sic] (EUA 1985a: 52).¹⁹⁸

5.3 Colonisation and statecraft in Llanos del Caudillo: the creation of subjects and space

5.3.1 The creation of new irrigation subjects: the settlers

As part of the ideological and doctrinal plans of colonisation politics, the creation of 'new subjects' acquired a prominent place amongst Franquist propaganda through the different irrigation schemes by the INC. Franco's colonisation politics were the result of a long historical process of doctrinal development. This started in 1855 with the first law of agrarian settlements and ended in 1932 with the Law of Irrigation Works (*Ley de Obras de Puesta en Riego*) (Mangas Navas 1990). As Gómez Benito (1995: 228) points out, such a doctrine of colonisation consisted of:

¹⁹⁷ Appointed in 1965 and replaced in 1967, Decree 2074/1965 in BOE, 22nd of July 1965, No.174, page 1035 and Decree 3205/1967. BOE, 13th of January 1968, No.12, page 512.

¹⁹⁸ Author's translation from original quote in Spanish. Later in the 1979 the IGME issued the first hydro-geological studies of aquifers in Spain under the National Plan of Groundwater Studies (*Plan Nacional de Investigación de Aguas Subterráneas*) (www.igme.es, last accessed 11th of February 2013).

“a) A theory of the agrarian transformation as a 'maturation' process of irrigation systems, i.e., a theory of the contingencies of irrigation; the accelerating or slowing factors of such maturation; the 'time' needed to attain the predicted optimum levels; the intervening agents and the regional contexts, and, b) a theory of the sociocultural transformation of the settler, or what we call process of ‘social construction’ of the settler or colonisation of the settler, and of the social framework – new communities settled in the new towns – where their activities are developed”.¹⁹⁹

As Gómez Benito (1995: 275) points out, colonisation went further than agrarian reform to, “surpass it with another formula with 'more amplitude' and according to the new reality of the Spanish countryside, give it a 'technical-economic' dimension”.²⁰⁰ Thus, colonisation acquired a new dimension beyond the political, becoming not only discursively embedded in every level of political and social structure but helping to create socio-political institutions also (Naredo 1978). Additionally, colonisation plans also reproduced hierarchical relationships for the settlers in the form of foremen and a bureaucratic state (*ibid.*).

Colonisation politics also consisted of a specific ideology of peasantry and rural society. This ideology included the idea of the sovereignty of the peasant (defined as a small owner and direct cultivator with a small family patrimony) as crucial in enabling the construction of a new rural social and economic class and structure (Murviedro 1982; Naylor 1959, 1967). It was around this idea that the development and industrialisation of the countryside was to be organised. Fascism

¹⁹⁹ Author's translation from original quote in Spanish.

²⁰⁰ Author's translation from original quote in Spanish.

found in the peasant-farmer the essence of the Spanish national race and found in the newly re-established colonisation politics the opportunity to justify its integral regeneration of the countryside (Alares Lopez 2010).

This doctrine was played out alongside bureaucratic changes (e.g. the creation of the INC) seen as a way of establishing spatial and territorial order “prior to the modification of the agrarian infrastructure” (Gómez Benito 1995: 286-287). As Gómez Benito (*ibid.*) wrote, colonisation became a technique to transform agrarian and economic planning through irrigation as well as to urbanise the countryside through new settlements: “a technique of social transformation, both at its individual and communitarian dimension.” Colonisation was used by politicians and technocrats as a political device to structure social and economic relations in the countryside. The creation of settlers and land plots thus responded to the ideal of creating a hierarchical and disciplinary space in the countryside. According to Murviedro (1982), fascist agrarian ideology required settlers to become new members of society imbued with the task of cultivating the land, embracing a new lifestyle and building a new rural society that would maintain the purity of the peasant race and countryside. They would also become 'primordial' agents of colonisation through their careful selection and tutelage by the state (Gómez Benito 1995).

The colonisation process began with the selection of suitable subjects to participate in the programmes. The settlers were selected at the local and provincial level after close scrutiny by selection committees appointed to supervise this process. Selection committees reflected local political power since they included the mayor of the town, the secretary of the Brotherhood of Farmers, the commandant of the local post of Guardia Civil,²⁰¹ the town doctor, the priest and two respected landowners or

²⁰¹ *Language note:* Spanish state police.

cultivators designated by the mayor and the chief of the Brotherhood (Gómez Benito 1995; INC 1955b).

Moreover, the INC oversaw the training and education of new settlers. Since they all came from dry land farming areas irrigation was a new practice for many (Romano Serrano 2005). The INC was therefore responsible for teaching them the new irrigation practices and techniques. The decree creating the INC on the 18th October 1939 also established a special Section for the education of settlers with a mandate to train farmers and future settlers in specially created School-Farms.^{202, 203} A Ministerial Order of the 29th of November 1941 also authorised the INC to create and/or subsidise the construction of Centres of Settler Selection. Equally, the General Directorship of the INC approved additional norms of settler selection in an information booklet published on the 17th of October 1942. According to these rules, minimum conditions for settlers required by the INC were (Mangas Navas 1990: 95):

- a) To know how to read and write
- b) To be older than 23 years or graduated from the Army and under 50 years
- c) To be married or to be a widow with children
- d) To be a farmer
- e) Not to be in possession of inherited physiological defects
- f) To be in possession of acceptable moral and conduct standards

From the 31st of December 1942, Norms of Exploitation set up by the INC, established administrative contracts with all new settlers with the effect of binding these individuals to the state. After 1945, land plotting and cultivation became, “the

²⁰² *Language note: ‘Granjas-Escuela’ in the original Spanish language.*

²⁰³ Article 12 of the 1939 decree creating the INC, quoted in Mangas Navas 1990: 94.

two basic concepts through which the relationship between the INC and its settlers was to be established”. As such, settlers were obligated to form syndicalist groups which would maintain “the economic and social relationship between all the plot owners” (Mangas Navas 1990: 97). The settlers were also contracted to pay 51 percent of their crops and harvest back to the state in order to compensate for the initial investment the INC had made in building the town and the colonisation sector.²⁰⁴

The Regime's own propaganda magazine *Vida Nueva*²⁰⁵ which was distributed to settlers in every colonisation town, claimed that the INC provided settlers with health services and sanitation, bringing an end to former insalubrious life conditions in the countryside. The magazine glorified life in the countryside, praising the 'sacrifices' settlers were making for their country. It commended rural life, tradition and folklore while exalting the work of the INC in modernizing the countryside and agriculture. One quote from magazine in March 1956 states:

“The land will be yours ... Look around you. The land that surrounds you has changed profoundly; remember that only yesterday this land was like the one you see far away; on it livestock grazed or, when it was possible, it would be covered by meagre cereal crops that sometimes could be harvested and other times not. Now the land is crossed by acequias, roads, drainage systems, it is geometrically drawn into terraces, water shines under the sun and a new town is born and you live in it.” (*Vida Nueva*, March 1956).²⁰⁶

²⁰⁴ The annual amortisation interest was also regulated by the INC and was established as 3.5 percent in Llanos del Caudillo (Romano Serrano 2005).

²⁰⁵ *Language note*: Translates as *New life* in English.

²⁰⁶ Author's translation from original quote in Spanish. *Vida nueva*. Hojas de comunicación entre el Instituto Nacional de Colonización y sus colonos. Archive, Ministry of Agriculture.

5.3.2 The selection of settlers for Llanos del Caudillo

Settlers for Llanos del Caudillo were recruited through a rigorous selection process. Selection rules were sent to town halls and brotherhoods of farmers in Villarta de San Juan, Manzanares, Alcázar de San Juan, Herencia, Argamasilla de Alba, Alamillo, Tomelloso, Bolaños de Calatrava. The INC had a particular preference for towns such as Manzanares, Argamasilla de Alba and Bolaños de Calatrava since it was in these locations that sought after tradition and knowledge on irrigation could be found (INC 1955b). Ultimately, selection committees received 351 applications and 178 were accepted (Table 5.7).

The INC also established the minimum conditions for every candidate wishing to become a settler in Llanos del Caudillo (Table 5.8). The settlers' application process was supervised by a selecting committee consisting of an INC engineer, the mayor, the doctor, a civil servant from the town hall, two representatives from the Brotherhood of Farmers and two other farmers. The committee evaluated each application along with a professional and health report as well as a report from the Guardia Civil stating any past political activities and potentially dangerous ideological tendencies of the candidates (Romano Serrano 2005).

In addition to the standard conditions, four additional ones were taken into consideration by the selection committees for Llanos del Caudillo:

1. To own land in what had been designated as Sector I of La Mancha with a surface of less than 6 hectares, having renounced to 'reserve' the land or not having applied for it.
2. To be leasing land in any of the estates included in Sector I

3. To be married or widower with children, giving preference to those with a larger number of children
4. To know how to read and write

Table 5.7 Geographical origin of applicants for settler in Llanos del Caudillo

<i>Town</i>	<i>Number of applicants</i>	<i>Fulfilling minimum conditions</i>	<i>Number of settlers</i>
Alamillo	49	32	31
Alcázar de San Juan	4	4	4
Argamasilla de Alba	70	56	16
Ballesteros de Calatrava	7	5	7
Bolaños de Calatrava	7	7	7
Herencia	69	54	27
Las Labores	14	14	2
Malagón	1	1	1
Manzanares	14	8	8
Mestanza	27	21	22
Montiel	15	7	
Pedro Muñoz	3	2	3
Pozuelo de Calatrava	4	3	4
Tomelloso	31	26	28
Villar del Pozo	2	2	2
Villarta de San Juan	25	14	14
Villarrubia de los Ojos	1	1	1
Viso del Marqués	8	6	1
Total	351	263	178

Source: Based on data from INC 1955b.

Amongst these additional conditions, the INC's General Rules on the selection of settlers emphasised that priority should be given to those applicants with proven knowledge of irrigation techniques (INC 1955b). According to the applicants' selection reports in Sector I, in 1955, 84 candidates were unsuccessful following the 6 main conditions established by the INC (Table 5.8).

Table 5.8 Number of unsuccessful settler candidates for Llanos del Caudillo

<i>Condition</i>	<i>Description</i>	<i>Unsuccessful candidates</i>
a.	To live in the province of Ciudad Real	1 candidate
b.	To be a direct cultivator, without land or with a land plot small enough to not be able to constitute a typical family unit	8 candidates
c.	To be 23 years old or older, having served in the Army or exempt from Military Service	0 candidates
d.	To be younger than 50 years old	16 candidates
e.	To demonstrate acceptable moral qualities and conduct	46 candidates
f.	Not to have any inherited physiological defects or physical defect that would not allow the candidate to do agricultural work	11 candidates
Other	For possessing enough means to sustain themselves	2 candidates
Total		84

Source: Based on data from INC 1955b.

Following the selection process, forms of social control were exercised over the settlers through both an initial 5-year tutelage period and a rigid social hierarchical structure within the town. During the 5-year tutelage period settlers had to follow a strict plan of cultivation set up by the INC, defining productivity levels per month and year and different production targets accordingly. As a result, in 1954 the INC issued the Plan of Irrigation and Colonisation of Sector I in La Mancha which stated that the production target to be attained during the 5-year tutelage period was to be, “of an intensity defined by the index of gross sold production, which was set for Sector I in the Area of La Mancha as 30 *quintales*²⁰⁷ of wheat per hectare” (Chapter 2, article 2 in INC 1954a). The established quota for sharecropping to be given to the cooperative was to be 35.5 percent of total production with 3 percent interest on the value of the land and livestock amortised through new livestock rearing (INC 1954a).

²⁰⁷ Language note: 30 *quintales* = 3,000 kilograms (1 *quintal* = 100 kilograms).

This system also followed a rigid socio-economic hierarchical structure whereby the settler was directly supervised and controlled by the foreman, who was in turn supervised by an agricultural technician.²⁰⁸ The technician, who was in charge of all the settlers in the town, was then supervised by an agrarian engineer in charge of the whole irrigation sector (Oyón 1985; Romano Serrano 2005). This social hierarchy was reaffirmed through differences in housing. As Romano Serrano (2005) wrote, four types of houses were built dividing the inhabitants of the town into four categories: settlers, agrarian workers, business owners and civil servants or servicemen (teachers, doctor, priest). As indicated in Table 5.9 the differences in salary for engineers and foremen indicates the social and economic distinction of these two professions. Once the 5-year period of tutelage was complete, the settler was able to start repaying the amortisation of the investment made by the INC with revenues from crops and harvest. This process would normally take between 15 and 25 years except, not including the value of the house which would take up to 40 years to repay (Oyón 1985).

Table 5.9 Costs of INC staff and technicians for Llanos del Caudillo (year 1955)

<i>Personnel</i>	<i>Salary (pta/year)</i>
1 Agricultural technician	42,000
4 Agricultural foremen	73,000
1 administrative	12,775
12 well mechanics and 2 electricians	9,093
1 Warehouse manager	12,775
1 Acequero (*)	8,740
2 guards	7,500

Note: (*) Technician in charge of the maintenance and repair of acequias.

Source: Based on data from INC 1955a.

²⁰⁸ *Language note:* 'Périto agrícola' in the original Spanish language.

Following Romano Serrano's (2005) ethnography of the town of Llanos del Caudillo, we know that the first settlers arrived in the town around the 21st and 25th of April 1955 whilst the town was still under construction. Direct testimonies transcribed by this author mention the poor living conditions in the town at this time, with no running water or electricity, no wood for the fire, and houses without doors or windows. According to this author,

“the socioeconomic origin of the first inhabitants of Llanos was very similar: before their arrival, all the settlers had worked in some way in agriculture. [...] The large majority were farmers without land that worked as day labourers for some 25 pesetas per day, leasing temporarily a small plot of land or working as *gañanes*²⁰⁹ in their bosses' houses” (Romano Serrano 2005: 23).²¹⁰

Photograph 5.5 View of two settlers and Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

²⁰⁹ Language note: Farmhand in Spanish.

²¹⁰ Author's translation from original quote in Spanish.

5.3.3 The construction of the settler's community: creating a new socio-political space in La Mancha

The process of creating new irrigation subjects ran concurrently with the construction of a whole new social space: the colonisation town (Photograph 5.7). As Monclús and Oyón (1988) pinpoint, the agrarian colony designed in the second half of the nineteenth century had become an agrarian social laboratory by the beginning of the twentieth century. Thus, designs and plans for agrarian farms represented the consolidation of techniques of power and control through panoptic designs (*ibid.*).

Colonisation policies also created a new 'sense of place' in the words of Donald Worster (2004), which stabilised local communities of peasants and farmers through hard work and land ownership. Family for the new fascist ideology was one of the pillars of the state therefore it was perceived that the development of small family owned agrarian farms would encourage and sustain these values and help fight the communist threat in Spain (Ryan 2009).²¹¹

²¹¹ A parallel can be drawn about the Great Plains of the United States. As Worster wrote (2004: 171), family was seen as an “important force against instability, excessive individualism and outside influence”.

Photograph 5.6 Aerial view of Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

As stated by Romano Serrano (2005), the planning and design of the town responded to a very specific ideology about the rural community and its social relations. In this newly designed space, the rural neighbourhood unit was understood as the basic organisational element of the new countryside (Alvaro Tordesillas 2010).²¹² As part of a new politics of 'space domination', discipline and control, the INC created new services in the towns and assimilated the lifestyle of the towns and villages to that of the cities. This was achieved by utilising urbanised discourse instead of the classical agrarian and farming terms to describe those activities in the settlements (Ortega Cantero 1979). New facilities and social services were built such

²¹² The concept of a 'basic rural neighbourhood unit' as an urban planning ideal based on the ideas by Clarence A. Perry influenced the construction of the early new towns by the INC and was incorporated in its Circular No.246. The 'neighbourhood unit' was defined as an urban environment established around main communication and transport links, and including within its boundaries all the facilities needed for the autonomous development of the community (Alvaro Tordesillas 2010).

as sports grounds, parks, gardens, libraries, bars and community and cultural centres along with more traditional churches (Monclús and Oyón 1988).

As Rabasco (2009) wrote, the type of rational architecture²¹³ used in planning the towns reflected the power and rule of Franco's regime. Hygiene, order, planning and regulation of the urban space in these enclaves was established in the 1930s. By 1940s the colonisation settlements appeared as 'nuclei of agrarian production' and were aimed at purporting a specific morality in its housing plans (Monclús and Oyón 1988: 369). Thus, the civilising mission of the settlements was established through 'the formal character of the settlement' (Monclús and Oyón 1988: 393).

Colonising also meant both reorganising the infrastructure of the countryside and urbanising certain areas through linking new towns by road. Both of these programmes were generally defined by a unitarian mentality of valuing agrarian space (Alares López 2010; Monclús and Oyón 1988). Moreover, there was a direct connection between the techniques and policies of colonisation. As Monclús and Oyón (1988: 204) point out, techniques used for the development of the countryside, "act as mediators and contribute to the definition of the nature of each colonisation project". Thus, there is "an explicit declaration to organise rural life [...] with the objective of reproducing the ideal 'village', the rural idealised 'municipality' [...] maximal expression of the traditional agrarian order" (Gómez Benito 1995: 304).²¹⁴ In this way, the rational design of the town became a metaphor for the purity of its inhabitants and the National Movement (Romano Serrano 2005).

²¹³ Rationalism as an architectural style was developed during the twentieth century with a focus on the scientific, structural and functional means employed in the construction of building (Tournikiotis 1999). It also became a prominent architectural style in fascist Italy during the 1920s and 1930s and part of the political apparatus and discourse of the fascist government praising the modernisation of architecture along with that of society (Doordan 1983).

²¹⁴ Author's translation from original quote in Spanish.

Colonisation was also part of a wider politics of agrarian reform, which sustained the development of rural areas with new infrastructure (e.g. roads, railway stations). Moreover, it fixed and established a permanent population of settlers on the territory by giving them access to land property. The objective was to make them be part of the agrarian workforce but also to reproduce the hierarchy of inequality linked with land ownership (minifundia vs. latifundia). However, as Gómez Benito (1995: 333) contends, due to the small impact and magnitude of colonisation and land plotting, colonisation politics did not question the existing social order, but on the contrary, contributed “to its stability and reproduction, maintaining the traditional system of relations and the political subordination of the small farmer with or without land”.²¹⁵

As a result, colonisation and land plot concentration can be seen both as an instrument and as a process. As an instrument, they became part of the wider politics of agrarian reform aimed at the social transformation of Spain’s countryside. This would be implemented through specific crop planning techniques (rural development agronomics) and the organisation of the agrarian space (new farms and land plots). As a process, colonisation represented a socio-economic and cultural change both at the individual level (the construction of the settler identity) and at the community level (new towns). These two levels became part of a doctrine of social change and modernisation framed by the Regime around an ideological discourse of rurality and peasant sovereignty (Gómez Benito 1995). Therefore, colonisation was not only a group of policies aimed at developing the countryside and making it more productive through the establishment of irrigation projects. It was also an ideology behind the development of the country and its people. It fabricated a whole new rural polity, new

²¹⁵ Author’s translation from original quote in Spanish.

socio-political and economic structures and set off the uses of groundwater for irrigation.

As another extract of the magazine *Vida Nueva* reads:

“Spain exists through its rural towns. These rural towns being born in Spain due to the work of the INC are spacious towns, clean, of modern living, according to our time, and incorporating a modern sense to the permanence of man on the labouring fields” (*Vida nueva*, March 1956).²¹⁶

5.3.4 Designing and building Llanos del Caudillo

According to Rabasco (2009: 23), towns built by the INC “opened up new avenues for experimentation in the field of urbanism and architecture”. The design of towns was limited by a lack of construction materials, simplicity in the town layout, and austere economic measures and had to incorporate moral and doctrinal standards epitomised by colonisation policies (Rabasco 2009) (Photograph 5.8).

²¹⁶ Author’s translation from original quote in Spanish. *Vida nueva. Hojas de comunicación entre el Instituto Nacional de Colonización y sus colonos*. Ministerio de Agricultura, Instituto Nacional de Colonización, Archive, Ministry of Agriculture.

Photograph 5.7 Street view in Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

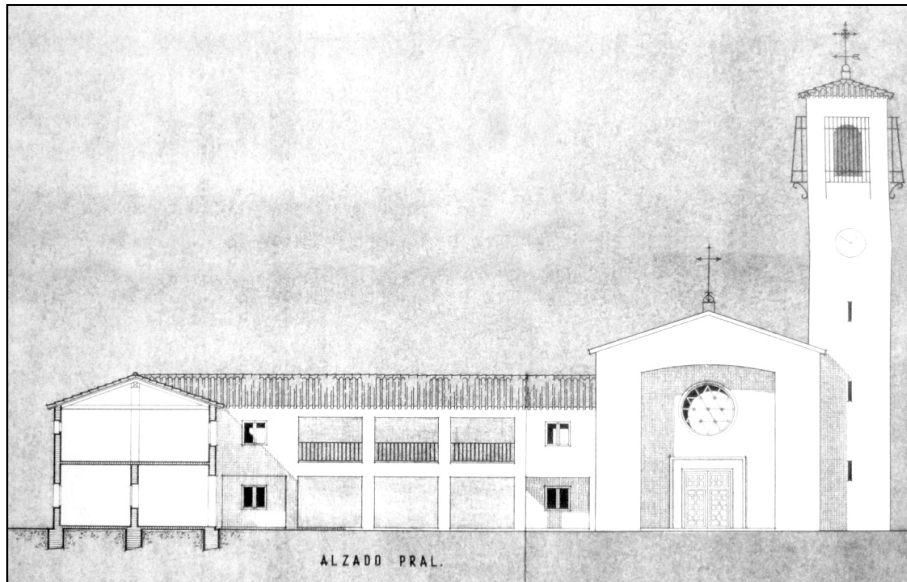
Following the 1955 Cultivation Plan for Sector I, the INC planned to irrigate 720 hectares divided into 15 sub-sectors in Llanos del Caudillo (INC 1955a).²¹⁷ Settlers occupied the sector in two phases: phase 1 – the arrival of 82 families of settlers between February and March 1955; and phase 2 – an additional 38 families joining in September 1955. Initial funding for the construction of the town was provided in 1955 by the INC. 10 percent of the funding was provided as a lump sum, 40 percent constituted a refundable loan from the National Housing Institute and the remaining 50 percent was made up of a loan from the Institute of Credit for the National Reconstruction.²¹⁸ The design and layout of the settlers' houses followed rationalist guidelines with different buildings positioned around a single urban nucleus with the aim of developing a particular style of 'popular architecture' (Flores

²¹⁷ The sub-sectors to be colonised first were sub-sectors 101, 102, 103, 105, 106, 108, 109, 110, 111, 112, 114, 115, 116, 117, 119; of which 101, 103, 108, 119, 102, 110, 112, 114, 105, 109, 111, 106 were finished in 1955 (INC 1955a).

²¹⁸ Registry INC Correspondence, Box 844, File 25221, Document 64, General Archive, Ministry of Agriculture.

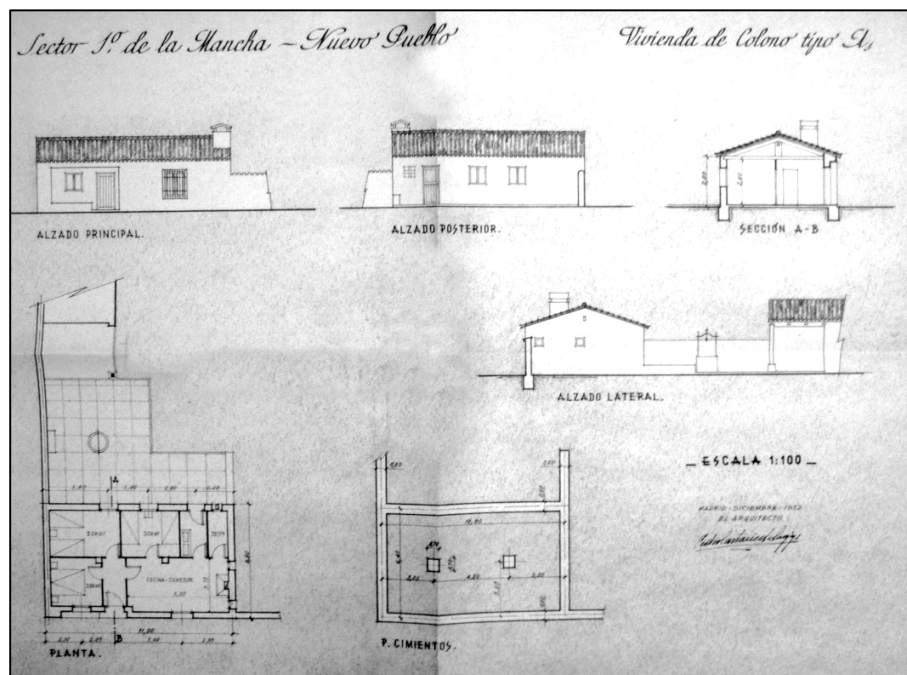
Soto 2010) (Photograph 5.8 and Photograph 5.9). This style focused on ensuring modern living conditions for the settlers (i.e. drinking water and sanitation, salubrious housing and living conditions, access to communication roads) facilitating the 'moral rehabilitation' of the population (Flores Soto 2010). Additionally, the town of Llanos del Caudillo was built in the middle of Sector I so the irrigated land plots would be equidistant from the town (INC 1953a).

Photograph 5.8 Blueprint for the church and adjacent buildings in Llanos del Caudillo



Source: General Archive, Ministry of Agriculture.

Photograph 5.9 Blueprint for a set of settler houses in Llanos del Caudillo



Source: General Archive, Ministry of Agriculture.

The design and provision of essential services encouraged the development of a social and communitarian life around the town, thus ensuring the permanence of the settlement. Socialisation of settlers and adoption of modern urban life was also a priority in new colonisation towns (Oyón 1985). The design of the town had therefore to reflect the main aspects of the new national-catholic way of life of Franco's regime, characterised by family, property and cooperation. Similarly, the town served to represent a cornerstone of the agrarian transformation and the increase in productivity of the countryside (*ibid.*).

The development of towns such as Llanos del Caudillo created new agrarian geographies and re-shaped communal structures in the areas where irrigation projects were built (Romano Serrano 2005; Swyngedouw 2007). Inside the town social structures and cultural life were also dominated by national colonisation politics. The Falangist movement controlled the establishment and management of social and communitarian structures within the town, and the *Casa del Movimiento* (House of the

Movement)²¹⁹ delivered courses on culture, society and farming techniques to the settlers (Romano Serrano 2005). Women were separated and attended in another part of the building where they were taught moral and family values as the pillars of family and social unity (Gómez Benito 1995).

The construction of the town was carried out in two phases. The first construction phase began in February 1953, during which 102 houses for settlers were built following 12 different designs of 3, 4 and 5 bedroom houses divided in one or two floors. Ultimately the INC built 82 houses with 3 bedrooms, 15 houses with 4 bedrooms and 5 houses with 5 bedrooms, with the size of the houses varying between 74.3 and 129.05 m² (INC 1953a). The town occupied a surface area of 19.19 hectares, with 12.57 hectares of constructed buildings and 6.62 hectares of public buildings, streets and squares (INC 1956a). Drawing on Oyón (1985), for the INC the house represented the colonisation unit: the place where family, tradition and work unite and sustain social and communitarian life. Each house included a living room, bedrooms, courtyard, a larder and a dry lavatory while the agricultural and working area of the house included the stables, granary and porch (INC 1953a). In December 1953, the original project for the town was revised and 67 new houses with 3 bedrooms, 11 houses with 4 bedrooms and 4 houses with 5 bedrooms were built. According to the revised project, the town had a total of 184 houses (Table 5.10) (INC 1953b).²²⁰

²¹⁹ *Language note:* The '*Casa del Movimiento*' was a social, political and cultural centre in every town in Spain representing the Dictatorship's national political doctrine.

²²⁰ During the second phase of the construction of Llanos del Caudillo, a project for the supply of drinking water in the town was approved in July 1956 and in October 1957. This included a design of the sewage system, comprising 4 septic pits concentrating the sewage from dry latrines in each house. Due to technical difficulties, the plan to build a general sewage system for the town was abandoned and instead individual septic pits were built in every house (INC 1957a).

Table 5.10 Buildings in Llanos del Caudillo (1956)

<i>Type of building</i>	<i>Number of buildings</i>
<i>Private buildings</i>	184 houses for settlers
	24 houses for workers
<i>Public buildings</i>	Church and offices for <i>Acción Católica</i> *
	Priest's house
	Town hall
	Clinic and doctor's house
	3 houses for teachers
	3 schools
	Social community centre
	Cooperative
	5 shops for artisans

Note: (*) *Acción Católica* was a catholic organisation created in 1926 under the auspices of the Church in charge of the religious and moral education of society. After the Civil War it became part of the religious and institutional apparatus of the state (Montero García 1999).

Source: INC 1956a.

5.4 Agriculture and water in Llanos del Caudillo

5.4.1 Agricultural production in Llanos del Caudillo

Through the development of irrigation in La Mancha, the INC planned the increase of cropping intensity during the annual crop rotation in each land plot. Additionally, the INC promoted crops such as cereals and fodder crops (e.g. barley, alfalfa) with large national and international market demand. The INC also planned to plant vegetables and fruits and unsuccessfully attempted to encourage the cultivation of tobacco in La Mancha (Peperkamp 1972).

Agriculture production was highly centralised, regulated and controlled by the INC through different procedures. Upon arrival, settlers were given a cultivation kit,

which included different tools, seeds and livestock for their agricultural use in the land plots (Table 5.11).

Table 5.11 Settlers' cultivation kit

<i>Mechanical equipment</i>		<i>Total value (pta)</i>	<i>Value per settler (pta)</i>
Cart (1 for 4 settlers)		6,000	1,500
Plough		800	800
Land grille (1 for 2 settlers)		1,000	500
Cultivator		650	650
Instrument for sulfurization (1 for 5 settlers)		600	120
Yoke		80	80
Tree lance		20	20
Plough strap		70	70
Yoke strap		280	280
Steering wheel		20	20
Total			4,040
<i>Livestock</i>		<i>Total value (pta)</i>	<i>Value per settler (pta)</i>
Labour	2 cows	10,000	10,000
Rent	1 pregnant sow	1,000	1,000
Total			11,000

Source: Based on data from INC 1955a.

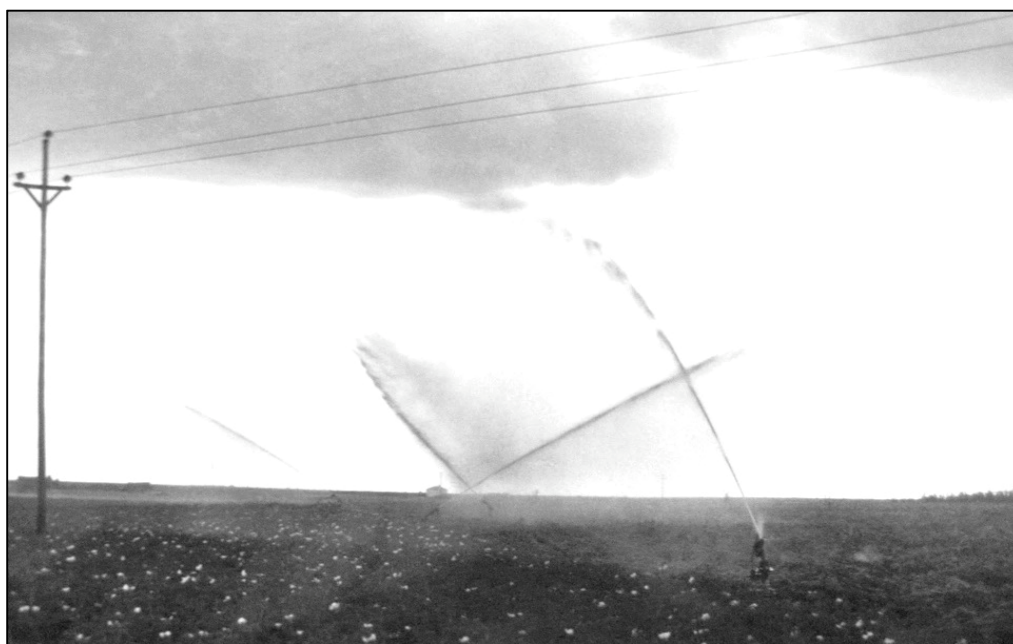
The INC divided each irrigation plot into 4 different sub-sections (called 'hojas'), each with a specified crop rotation sequence, cultivation and harvest for winter and summer crops. Table 5.12 shows a four-section cropping system and the allocation of land surface for each crop as well as the irrigation timing. During the initial 5 years tutelage period, each family of settlers was allocated an irrigation plot and specific crop cultivation regime, irrigation and watering schedule (Table 5.13).

Table 5.12 Cultivated crops per irrigation section

<i>Winter crops</i>	<i>Section n° 1 Wheat</i>	<i>Section n°2 Barley</i>	<i>Section n°3 Vetch, hay/Vetch, grain</i>	<i>Section n°4 Potatoes</i>
<i>Surface (ha)</i>	1.15	1.15	1.15 (0.60) (0.55)	1.15
<i>Percentage of surface</i>	19.1 %	19.1 %	10 % 9.16 %	19.1 %
<i>Summer crops</i>	Fallow land	Beans Millet	Tobacco Fallow land	Maize
<i>Surface (ha.)</i>	1.15	1.15 (0.55) (0.60)	1.15 (0.60) (0.55)	2.30
<i>Percentage of surface</i>	19.1 %	9.16 % 10 %	10 % 9.16 %	38.2 %

Source: INC 1955a.

Photograph 5.11 Sprinkler irrigation in Llanos del Caudillo, 1950s



Source: Archive, Ministry of Agriculture.

Table 5.13 Monthly allocation of irrigation frequency for Llanos del Caudillo (per settler and land plot)

<i>Crops</i>	<i>Monthly allocation of irrigation</i>									<i>Water volume per land surface</i>			<i>Surface (ha)</i>
	<i>March</i>	<i>April</i>	<i>May</i>	<i>June</i>	<i>July</i>	<i>August</i>	<i>September</i>	<i>October</i>	<i>Total number of waterings</i>	<i>Month of maximum consumption</i>	<i>Annual consumption (m³)</i>	<i>Average volume of water (m³)</i>	
Wheat		2	1					1	4		2,600	650	1.15
Barley		1	1					1	3		1,800	600	1.15
Vetch, Hay		1	1					1	3		1,800	600	0.6
Vetch, Grain		1	1					1	3		1,800	600	0.55
Potato		1	3	2					6		4,200	700	1.15
Alfalfa		1	2	3	3	4			13	3,000	9,750	750	1.15
Vegetables	1	1	1	3	5	6	6	2	25	3,600	15,000	600	0.25
Beans				1	3	5	3		12	3,500	8,400	700	0.55
Millet				1	3	4	3		11	2,800	7,700	700	0.6
Tobacco				1	3	3	1		8	2,100	5,600	700	0.6
Hybrid maize					2	4	2		8	2,800	5,600	700	1.15
<i>Total annual water consumption</i>											64,250	7,300	

Source: INC 1954a.

Sector I in La Mancha also included two pilot irrigation plots for sprinkler irrigation tests (sub-sector 101 and 106) (Photograph 5.11) and as such sub-sector 106 became a pilot irrigation plot in June 1956.²²¹ Equally, in 1958, the INC tested the cultivation of hybrid maize in two different irrigation plots around well 109, with 0.35 hectares cultivated.²²²

By 1957, agrarian production in irrigated plots faced a number of problems. According to the Committee of Plot owners of Llanos del Caudillo, a reduction of the sharecropping of wheat and other summer crops was requested to the INC on the 16th of September 1957.²²³ The INC responded by emitting a report noting that the settlers of Llanos del Caudillo were in a precarious economic situation, “largely because of the meagre harvest obtained the past year, given the adverse meteorological conditions during the previous summer.” Crop harvest were also adversely affected in the initial years by an insect plague (*Etiella zinckenella*)²²⁴ which attacked beans and soy. In 1957, this plague caused “a significant decrease in early crops and, in case of not being able to plant the later crops, will represent a global loss of around 30 to 40 percent of the harvest.”²²⁵ The poor quality of the soil was also responsible for the lack of productivity of land plots. During construction works, the INC had to level the ground by removing the superficial and more fertile layers of soil and exposing the deeper and poorer strata. It would take a few years for these layers to acquire the nutrients to become more suitable for agriculture (Romano Serrano 2005). Due to

²²¹ Registry INC Correspondence, Box 1072, File 252216, Document 80, General Archive, Ministry of Agriculture.

²²² Registry INC Correspondence, Box 1212, File 252216, Document 49, General Archive, Ministry of Agriculture.

²²³ Registry INC Correspondence, Box 1071, File 252214, Document 9, General Archive, Ministry of Agriculture.

²²⁴ The insect *Etiella zinckenella* is a type of pod-borer seed eating Lepidoptera known to damage a variety of leguminous crops (Singh and Dhooria 1971).

²²⁵ Registry INC Correspondence, Box 1071, File 252214, Document 9, General Archive, Ministry of Agriculture.

these problems, the INC reduced the harvest sharecropping to 55 percent for beans, soy, cotton and maize. Given the fact that this produced an imbalance in the settlers' sharecropping accounts, the INC decided to extend the tutelage period "for a period of time that could be established more accurately once the yields of the planted crops will be known exactly."²²⁶ Table 5.14 shows the difference between the INC planned to harvest in 1957 and the real harvest for some crops.

Table 5.14 Agricultural production in Pilot Irrigation Sub-sector 106 (as of June 1957)

<i>Crop</i>	<i>Expected production by the INC (kg/ha)</i>	<i>Real production (kg/ha)</i>
Wheat	2,000	500
Barley	2,000	1,636
Vetch		Used as organic fertiliser
Cotton	800	61
Maize	3,800	4,284
Millet		827
Alfalfa		Cultivated in Autumn

Source: Registry INC Correspondence, Box 1072, File 252216, Document 80, General Archive, Ministry of Agriculture.

Strict deadlines imposed on agricultural production were often a source of conflict between settlers, foremen and the INC (Romano Serrano 2005). As several documents prove, in some cases the INC initiated procedures to expel settlers from Llanos del Caudillo due to non-compliance of cropping targets and personal offences against foremen.²²⁷ In other cases, settlers were made to leave the town for not meeting production quotas and deadlines established by the INC.

²²⁶ *ibid.*

²²⁷ In the case of settler Marcelino Morales Castellanos, the INC registered an expulsion request on the 24th of July 1956 for disobedience of cultivation orders and personal aggression offences against a foreman. The settler presented an appeal on the 4th of January alluding 'non voluntary motives': "due to the interest of the settler to advance the harvest [...] motivated by the desperation and own interest

The fact that settlers could not reach the expected production targets set by the INC was a major cause for the continuous exodus of families from colonisation towns (Ortega Cantero 1972; Peperkamp 1972). On February the 23rd 1957, 8 settlers in Llanos del Caudillo abandoned Sector I due to difficulties in the cultivation and exploitation of their land plots.²²⁸ Then in December 1958 an additional 25 settlers abandoned their plots and houses.²²⁹ By September 1959 however, the INC had already replaced them with 25 new settlers.²³⁰

With the advent of additional modern agricultural technologies and the mechanisation of the countryside, the 6-hectare irrigation plots for farmers became too small and non-productive. As a result, in 1971 the INC expanded the plots to 9 hectares (IRYDA 1980). Moreover, stringent re-payment conditions to the Ministry of Agriculture meant emigration of younger generations out of Llanos del Caudillo (Romano Serrano 2005). In view of this situation, the IRYDA gave the descendants of settlers in Llanos del Caudillo priority in the acquisition of land plots abandoned by other settlers so that they could increase their cultivation surface and obtain better productivity and economies of scale. As Romano Serrano (2005) wrote, the IRYDA expanded the designated area of Sector I by annexing the neighbouring Sector III (996 hectares) and allocating more land plots to the descendants of the original settlers of Llanos del Caudillo.²³¹

every settler has to make the land produce". In the end, the INC admitted the appeal but imposed a fine of 2,000 pesetas. Registry INC Correspondence, Box 946, File 252214, Document 5, General Archive, Ministry of Agriculture.

²²⁸ Registry INC Correspondence, Box 1071, File 252214, Document 3, General Archive, Ministry of Agriculture.

²²⁹ As reflected in the 1959 Cultivation and Exploitation Plan for Sector I of La Mancha of December 1958. Registry INC Correspondence, Box 1212, File 252216, Document 94, General Archive, Ministry of Agriculture.

²³⁰ Registry INC Correspondence, Box 1212, File 252216, Document 94, General Archive, Ministry of Agriculture.

²³¹ The annexation of Sector III of La Mancha to the town of Llanos del Caudillo was achieved by expropriating the land from seven landowners. BOE, 21st of March 1972, No.69, page 4981.

5.4.2 The price of water in Llanos del Caudillo

The INC calculated groundwater and irrigation tariffs in Llanos del Caudillo as a ratio between the consumption of electricity and the general costs of maintenance and operations of wells (mechanic personnel plus additional hours) per irrigated hectare for each settler.²³² Following this formula, a different tariff was calculated for sprinkler irrigation and for gravity irrigation. The formula comprised a set tariff in terms of the price of water with a cap at 1000m³, after which point an additional fee would be charged. In the case of gravity irrigation, the INC set the exceeding cap at 3,000 m³ (Table 5.15).

Table 5.15 Evolution of the calculation of the water tariff in Llanos del Caudillo

		<i>Initial tariff 1956</i>	<i>Tariff 1957</i>	<i>Tariff 1958</i>
Gravity irrigation	<i>General costs</i>	726.78 ptas/ha	1,260.89 ptas/ha	798.66 ptas/ha
	<i>Volume</i>	3,000m ³ /ha	3,000m ³ /ha	3,000m ³ /ha
	<i>Excess of 1,000 m³</i>	0.16 ptas/m ³	0.25 ptas/m ³	0.17 ptas/m ³
Sprinkler irrigation	<i>General costs</i>	828.31 ptas/ha	1,217.33 ptas/ha	963.0 ptas/ha
	<i>Volume</i>	1,000m ³ /ha	1,000m ³ /ha	1,000m ³ /ha
	<i>Excess of 1,000 m³</i>	0.48 ptas/ha	0.43 ptas/m ³	0.421 ptas/m ³

Source: Report on the price of water in the Area La Mancha, Sector I, March 1958, Registry INC Correspondence, Box 1211, File 252211, Document 431, General Archive, Ministry of Agriculture.

Due to variations in water availability and yields, tariffs had to be constantly revised.²³³ For example, on May the 20th 1957, a request was submitted by 21 settlers

²³² Registry INC Correspondence, Box 1071, File 25221, Document 153, General Archive, Ministry of Agriculture.

²³³ The formula to calculate the revised water tariff was based on a minimum price per hectare and a fixed volume of water of 1000 m³ for sprinkler irrigation and 3000 m³ for gravity irrigation. The INC referred mentioned in 1959 that this formula benefitted the irrigators consuming more water. This

to the INC Delegation in Ciudad Real demanding a reduction of the water tariff.²³⁴ Further problems arose from the adjustment of the water tariff to different harvests and crops. A new credit had to be issued by the INC in February 1957 in order to pay for the maintenance and operation costs of the wells in Sector I of La Mancha due to non-fulfilment of the agricultural production targets in the previous year.²³⁵ In 1958, the INC Delegation of Ciudad Real revised and modified the tariffs, pointing out the need to establish a maximum irrigation surface and a water abstraction cap for each well according to the water irrigation necessities of each sub-sector. This move was partly motivated by the decrease in groundwater levels in the wells, which in some cases reached only 45 percent of water volume abstracted during the test drills carried out by the INC. This decrease in water level raised the price of water paid by irrigators due to the higher consumption of electricity needed for the wells. This also put pressure on engines and pumps (sometimes working up to 22 hours in August during the summer crop season) as well as personnel and mechanics who had to work additional hours. For these reasons, the INC resolved in November 1957 that the initial 1956 water tariff would be modified resulting in a 35 percent decrease in the water tariff (Table 5.15).²³⁶

generated conflicts arising from irrigators using less water, who refused to pay as long as the irrigators that consumed more water were still benefiting from this system. Due to the lack of effective coercive measures, the technicians of the INC suggested that water were to be charged per cubic metre. Registry INC Correspondence, Box 1345, File 252211, Document 33, General Archive, Ministry of Agriculture.

²³⁴ Registry INC Correspondence, Box 1071, File 25221, Document 82, General Archive, Ministry of Agriculture.

²³⁵ Registry INC Correspondence, Box 1071, File 25221, Document 16, General Archive, Ministry of Agriculture.

²³⁶ Registry INC Correspondence, Box 1211, File 252211, Document 431, General Archive, Ministry of Agriculture.

5.5 Discussion: the various dimensions of colonisation politics in La Mancha

This chapter complements Chapter 4 in exploring the history of irrigation and colonisation politics in twentieth century Spain. This chapter has analysed the town of Llanos del Caudillo as an example of the use of irrigation as a political technology of power and social control. This has highlighted the role of the state in constructing a new agrarian society whilst establishing a structure of hegemony and control over rural populations. By recognising the material and political dimensions of colonisation plans it is possible to reveal the socio-political aspects of colonisation politics in Spain and La Mancha.

Colonisation politics in the 1950s established the basis for agrarian reform in the countryside and triggered the development of new technology and agricultural crops. The capitalisation of small family-run farms with new production inputs such as modern technology for groundwater abstraction helped set in motion Spain's green revolution (Abad and Naredo 1997). Equally, a combination of discourse, ideologies and politics related to colonisation and irrigation sustained the emergence and development of the agrarian change in La Mancha. Thus, the economic and agrarian importance of colonisation politics tells only half the story. Considering Llanos del Caudillo as a newly created and organised agrarian community allows us to comprehend role of the colonial machinery of Franco's dictatorial state in sustaining a social, ideological, political and economic project (Table 5.16). The aim of this project was to transform rural society and at the same time maintain political and social hegemonic structures of state power in the countryside. Thus, hierarchy,

discipline and land ownership were structured in publicly colonised areas in order to preserve ideologically and politically the foundations of the fascist regime

Table 5.16 Aims of colonisation politics during Franco's regime

<i>Social</i>	<i>Political/ideological</i>	<i>Economic</i>
Mechanism of production of peasantry: to fix the peasant to the land and associate them to property.	Instrument of re-construction of an agrarian order, hierarchic, harmonic and stable, through the coexistence of the system minifundia-latifundia	Increasing the value of non-productive land through irrigation
To create a peasant class of small landowners, reducing the number of wage-earners and maintaining the subordination of small peasants to the state	Maintenance of the political and ideological foundations of the fascist regime by developing the ideal of peasantry and inculcating the values of work, family and religion	Increasing agrarian production through irrigation and higher productivity of small family-owned farms
Disciplining the countryside by suppressing rural conflict. Promoting social stability and against revolution by creating a conservative peasant landowning class	Initiating a process of social change by constructing rural communities as the epitomes of idealised communities	Maintaining the economic viability of small agrarian enterprise through the increase in productivity not surface
The forced association with vertical unions and the tutelage during the long period of access to property		Introduction of new crops for local consumption in national markets or export
		Promote the economic development and industrialisation of the country

Source: Based on Gomez Benito 1995: 282.

Against this backdrop, considering colonisation politics in its social, political and ideological facets provides additional insights into the role of the state in the development of modern irrigation in La Mancha. The construction of a new irrigated countryside took place at the same time as the development of colonial authority and

power over settlers. The state, through direct control, tutelage and training, created the settlers as new 'irrigation subjects' in Llanos del Caudillo. They experienced colonisation as a system of social, political and economic domination through government technologies (i.e. governmentality) employed by the dictatorial regime to rule over publicly designated irrigation areas. Government technologies such as the selection of settlers, the control of agriculture production, and the design of a new rural community, were rooted in an ideological and political context that maintained the Regime by means of agrarian control and transformation of the countryside.

The planning and construction of Llanos del Caudillo epitomise the ideology of the state's agrarian vision. This was characterised by the creation of a new agrarian polity and the development of new forms of social, political and economic relations in the countryside through a revisited ideology of agrarian fascism. Towns such as Llanos del Caudillo helped sustain rural populations whilst at the same time providing them with work, income, and land to cultivate. They also helped maintain the ideological apparatus of Franco's regime, centred on the transformation of the countryside in order to obtain larger revenues and productivity through irrigation. Equally, colonisation and irrigation helped appease social tensions and preserve the privileges of some large landowners. The attempt to create a new agrarian society was pursued by Franco's dictatorship as a means of rooting its own ideological and social values. Settlers were drawn to these areas with the promise of a better life but in reality had to face a strict system of state control and discipline. The fascist state would also try to inculcate the values of its vision of a modern society (family, property, religion, and work) through the layout and design of the town.

As shown in this chapter, state-sponsored irrigation in La Mancha played a dual role within the countryside. On the one hand, it was developed as a new

technology aimed at making the countryside more productive and rich. On the other hand, it performed a political role creating social and administrative structures and a new system of class relationships between landowners and small farmers. It also created communal entities such as Llanos del Caudillo, which helped sustain the ideological development of the Regime and produced new ‘agrarian geographies’ (Swyngedouw 2007) in the irrigated areas created by the INC.

This chapter has also shown that the INC played an important role in the development of modern groundwater abstraction for irrigation in La Mancha. Test drilling carried out by the INC in the 1950s tapped into newly studied aquifers. This process introduced new knowledge and infrastructure, which proved essential for the future intensive expansion of private irrigation in the 1960s and 1970s. The introduction of new techniques of groundwater abstraction technology in these areas set an example for the other farmers and showed the natural potential concealed below the surface. However, the publicly sponsored irrigation scheme in Llanos del Caudillo bore negative outcomes in terms of productivity and agrarian development. Settlers’ land plots were overrun by the private irrigation schemes of neighbouring farmers who were independent of state control. With the use of modern irrigation, neighbouring farmers began adopting similar groundwater abstraction technologies and the groundwater level in the wells drilled in Llanos del Caudillo decreased rapidly. Due to strict limitations imposed by the state in terms of production, cultivated surface and payments, settlers of Llanos del Caudillo quickly found themselves struggling to keep up with agrarian modernisation happening around them. As a result, they acquired land outside of the designated area of Sector I controlled by the INC in order to increase their productivity and income (Romano Serrano 2005).

Chapter 6 . From the noria to the borehole – old and new technology for groundwater abstraction in La Mancha

6.1 Introduction

This chapter examines the different types of technology used to abstract groundwater in La Mancha. From the traditional animal-drawn waterwheel (*noria* in Spanish) to the modern borehole, this chapter studies the characteristics and processes of the adoption of groundwater abstraction technology for irrigation in Manzanares. As described in Chapter 2, norias and boreholes are technological devices employed by farmers to abstract groundwater. However, as irrigation technologies they can also represent the material link between nature and society and thus the symbolic expression of hybridity of ‘mundane objects’ (Latour 1992; Mollinga 2003). For the most part, this chapter deals with the material aspects of the process of adoption of groundwater abstraction technology in Manzanares. The process of adoption of a particular type of groundwater abstraction technologies is characterised in this chapter as the product of specific technical characteristics, socio-economic necessities and characteristics of the adopting population (i.e. the farmers), and the availability of groundwater.

Based on qualitative interviews and quantitative data collected from the Community of Irrigators in Manzanares, this chapter analyses the main processes of technology change that occurred in the municipality of Manzanares over 45 years (1939-1985), which led to the development of intensive groundwater abstraction for

irrigation. First, this chapter examines the historical use of traditional water lifting technologies for irrigation in Spain and La Mancha at the beginning of the twentieth century. Then, the following section describes the advent of groundwater abstraction technology, focusing on the adoption stages and characteristics of traditional and modern groundwater abstraction technologies in Manzanares. This section also includes a quantitative statistical assessment of the hypotheses established in the previous sections allowing the formalisation and empirical substantiation of the preceding qualitative analysis. The final section recapitulates the findings and characterises the general process of adoption of groundwater abstraction technology.

6.2 Old technology: the use of traditional norias for irrigation in Spain and La Mancha

6.2.1 Historical use of traditional groundwater lifting technologies for irrigation in Spain and La Mancha

Different authors have scrutinised the process of mechanisation and use of water lifting technologies for irrigation in Spain. From the archaeological studies by Caro Baroja (1983), Peña Ortiz (2010) or Glick (1977, 1992) to those geographically localised in Valencia and Murcia (Cervantes 2007; Montoya Inglés 2007) or at the national level (Giner and Carrión 1999, 2005), these studies reflect the strong connection between technology change for irrigation and the socio-historical processes that transform local and national agrarian structures.

Investigations on traditional irrigation technologies in Spain have also looked into the traditional animal drawn noria of Arab origin, showing a long tradition of use

since Spain's medieval period (Glick 1977, 1979). The typical design of the animal drawn noria was introduced by the Arabs and later adopted by the Christians such that, by the sixteenth century it had become the dominant device for irrigation in these lands.²³⁷ As Glick (1992: 15) suggests, there seems to be a relationship, “between the relatively high density of Muslim settlement in New Castile (particularly La Mancha), the Levant, and the Balearic islands and the incidence of norias there.” In the case of La Mancha according to Glick (*ibid.*),

“the intensity of noria use [...] is no doubt owing more to its peculiar hydrological circumstances (shallow and high yielding water tables) than to the density of Muslim settlement per se. Nevertheless, from archaeological evidence we know that in this area the Muslims replaced a Roman canal-based irrigation system with another one based entirely on wells and norias.”

References to the use of norias by Gabriel Alonso de Herrera²³⁸ in an agricultural treatise of the sixteenth century, show the initial presence of this type of technology in La Mancha's landscapes where dry land farming was predominant (Peña Ortiz 2010: 212).²³⁹

²³⁷ In early medieval times, the establishment of settlements in the plains of Castilla along the frontier between Christian and Islamic kingdoms, was of a military and strategic purpose (Bishko 1963). Additionally, “[t]o a limited degree, the high water table offsets the surface shortage, permitting the sinking of wells and the raising of ground water through the noria, the vertical waterwheel with pots fastened to its rim which is turned by animal power; such wells determined in large part the distribution of frontier settlement, but they never became the basis for more than a very limited regadío or irrigated farming system” (Bishko 1963: 49).

²³⁸ Gabriel Alonso de Herrera, whose patron was cardinal and statesman Cisneros, wrote a treaty on agriculture in 1513 compiling Greek, Roman and Arabic agrarian experiences (López-Cuervo 1988).

²³⁹ Author's translation from original quote in Spanish.

“From the waters by which its nature arise from the earth we can say they are springs and rivers and flowing waters, yet there are none of these and it is necessary to make wells; vegetable *huertas* irrigated with norias for there are no springs; if it is a well for a noria, with the earth abstracted a path can be built for the animal, and the water will fall into the *alberca*,²⁴⁰ which has to be the tallest possible, trying to build it in the middle of the *huerta* for the quicker it will be irrigated.”

The use of norias varied according to the geographical location but its structural design remained mostly the same through time.²⁴¹ Norias found in Murcia at the end of the nineteenth century had depths of up to 32 metres and were drawn by two mules elevating water for 17 hours every day at a rate of 1.37 litres per second (Caro Baroja 1983). As Caro Baroja (*ibid.*) points out, similar norias were found in La Mancha at the same time, and were still used during the first half of the twentieth century to irrigate small *huertas*. Observations made by the politician and statistician Pascual Madoz in his geographical dictionary²⁴² of 1848, referred to the vast traditional irrigation systems in La Mancha where in the middle of 'sterile' dry land farming plains, thousands of wells were dug over the centuries to benefit from the abundant waters under the surface (Madoz 1848 in Peña Ortiz 2010: 211).

Quantitative historical data about the use of traditional water lifting technology in La Mancha is scarce. One of the most quoted data sources about the use and geographical distribution of the animal drawn noria in Spain during the first half

²⁴⁰ *Language note:* Small water reservoir used to irrigate farm plots.

²⁴¹ For a detailed study of cultural and literary references of water in La Mancha during the time of Don Quixote, see for instance Pillet Capdepón and Plaza Tabasco (2006) or Ortega Cantero (2007) for a more contemporary analysis of nineteenth century Regenerationist depictions of nature in La Mancha.

²⁴² *Language note:* ‘Diccionario Geográfico-Estadístico-Histórico de España y sus Posesiones de Ultramar’ in the original Spanish language.

of the twentieth century, is the survey carried out by the Ministry of Public Works in 1918 on different methods and technologies for irrigation. This work has been used by several authors to reflect on the ubiquity of the *noria* in the Spanish irrigated countryside (e.g. Caro Baroja 1983; Cuadra García 1991; Glick 1992, 1979; Giner and Carrión 1999). According to this survey, the area with the largest density of iron *norias*²⁴³ in Spain was the provinces of New Castile,²⁴⁴ with the province of Ciudad Real in first place with 21,006 *norias* irrigating approximately 25,500 hectares (Ministerio de Fomento 1918) (Table 6.1). Within the province of Ciudad Real the city with the largest number of *norias* (5,276) was also named Ciudad Real. This was followed by Almagro with 4,030; Manzanares with 2,584; and Daimiel with 2,558 (Figure 6.1). Despite its ubiquity in La Mancha, when comparing the numbers for 1918 with those put forward by Ladrón de Guevara Flores (1988) for 1909 in Manzanares (Table 6.2), it is possible to observe a rapidly increasing trend in the use of *norias* from 118 to 2,584 in ten years.

Table 6.1 *Norias* in Manzanares in 1909

<i>Irrigation</i>	<i>Hectares</i>	<i>Number</i>
Noria irrigating <i>huertas</i>	235	75
Noria irrigating cereal	2,212	33
<i>Total</i>	<i>2,547</i>	<i>118</i>

Source: Based on data from Ladrón de Guevara Flores 1988.

²⁴³ *Language note:* Iron *norias* refer to a more modern design, which evolved from the older, wood frame *noria*.

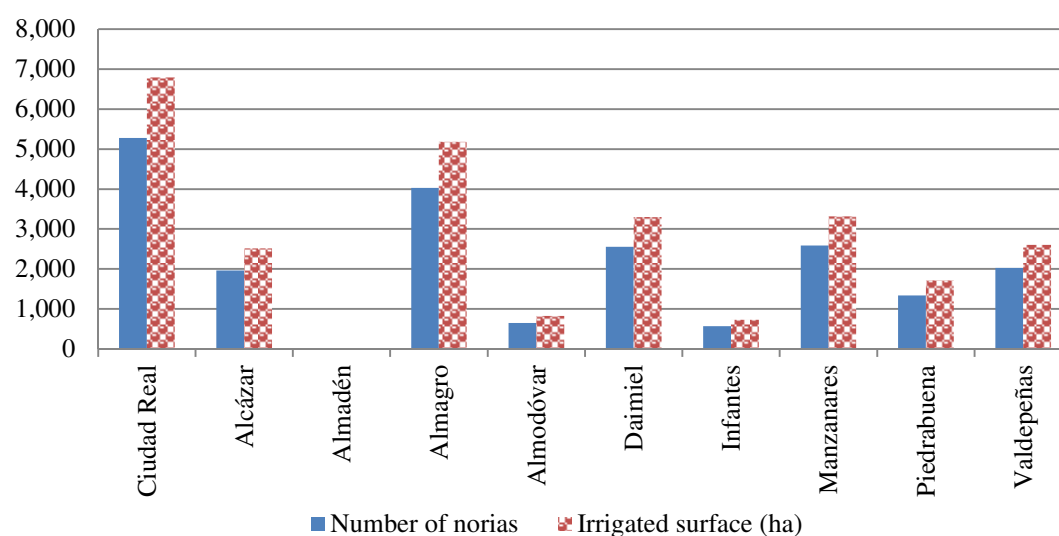
²⁴⁴ *Language note:* ‘New Castile’ was the historic province in central Spain including the area of the Moorish Kingdom of Toledo which was annexed to the former Kingdom of Castile in the 11th Century. In modern Spain, this area administratively and politically included the provinces of Ciudad Real, Guadalajara, Cuenca, Madrid and Toledo. In 1979 with the division of Spain into Autonomous Regions, all but Madrid were incorporated into the newly created Autonomous Community of Castilla-La Mancha (*Encyclopedia Britannica*).

Table 6.2 Distribution of norias in the provinces of New Castile in 1918

<i>Province</i>	<i>Number</i>
Ciudad Real	21,006
Toledo	2,750
Madrid	1,432
Cuenca	336
Guadalajara	29
<i>Total New Castile</i>	<i>22,553</i>
<i>Total Spain</i>	<i>39,401</i>

Source: Ministerio de Fomento 1918 in Glick 1992: 19.

Figure 6.1 Number of norias and total irrigated surface in Ciudad Real province in 1918



Source: Based on data from Ministerio de Fomento 1918.

Norias would typically irrigate a small land plot of one to two hectares with a well depth varying between 3 and 20 metres. The groundwater abstraction regime also varied according to the well depth, design of the noria and type of animal employed to draw the waterwheel. According to this survey, an average noria with a well depth of 10 to 12 metres and two mules working in alternative shifts of 16 hours a day could

fill a water tank of 25 m³ in four hours, abstracting 1.75 litres per second (Ministerio de Fomento 1918).

The Ministry of Public Works survey also mentions the use of steam engines to abstract groundwater, but here no specific data is provided.²⁴⁵ What the study does refer to is the potential gain in groundwater abstraction with the use of modern engines. Due to the abundant presence of groundwater in La Mancha, the use of an engine would provide secure and constant irrigation to the crops, “something that cannot be done, not because of a lack of water, but because of the deficiency of animal drawn engines” (Ministerio de Fomento 1918: 60-61).

However, the evolution of the number of traditional norias from 1916 to 1933 shows the persistence and spread of this type of groundwater abstraction technology in La Mancha. As Giner and Carrión (2005: 88) pinpoint,

“in 1916 norias were the most extended system: a minimum of 48,000 devices in the Spanish territory, the majority of them used to elevate groundwater [...]. In 1932 the number had increased to 72,725 devices and its localization was very similar to that fifteen years earlier”.²⁴⁶

As indicated by Giner and Carrión (2005: 93), irrigation engines were not very common in 1930s Castilla-La Mancha in contrast to its more intensive use in other regions in Spain (e.g. Valencia and Catalonia).²⁴⁷ In Ciudad Real only 666 irrigation

²⁴⁵ According to Giner (1990), the region of Valencia saw the first use of pumps where steam engines were used to move norias. Following Giner and Carrión (1999), in the 1930s 80 percent of the steam engines used to abstract groundwater were found in Valencia.

²⁴⁶ Author’s translation from original quote in Spanish.

²⁴⁷ Valencia, Catalonia and the Balearic islands made up 60 percent of the total number of pumps for intensive irrigation in the 1930s in Spain (Giner and Carrión 2005). This allowed the accumulation of capital by farmers, and investment in more expensive and modern groundwater abstraction technologies (*ibid.*). As these authors have also suggested, before the Civil War a process of intense

engines were in use in 1932, with 289 gasoline engines and 102 using electricity. In spite of the low presence of modern technology in La Mancha, the Civil War between 1936 and 1939 affected the technological innovation process as a whole. Technological change slowed down and traditional techniques resurfaced as shown by the number of norias in Spain increasing from 72,725 to 85,306 between 1932 and 1962 (*ibid.*).

The fascist agrarian ideology during Franco's dictatorship was also associated with the diffusion of traditional irrigation technology (Murviedro 1982). The development of rural areas was linked with a certain 'agrarian mythology' supported by the use of new technology for irrigation. The commercialization of the noria model ZEPOL in 1941 included the following instructions for farmers and gardeners:

“In order to fulfil the programme of the Falange, in order to transform the land into irrigation and make a Great Spain, there is nothing like irrigating the fields with the famous NORIAS AND PUMPS ZEPOL. Nationally manufactured.” (Magazine *Consigna* 1941 in Murviedro 1982: 245).

6.2.3 Traditional groundwater irrigation in La Mancha in the 1950s and 1960s

As Cuadra García (1991) points out, the noria in La Mancha centralised the small agrarian farm next to the family house; irrigating the lands with alfalfa, vegetables and fruits through flood irrigation techniques (or gravity-flow irrigation). Norias would traditionally be located in the middle of dry farming fields or inside

technological renovation in groundwater abstraction is observable in some areas in Spain (Catalonia, Valencia, Murcia), with techniques of different degrees of complexity coexisting in the agrarian landscape (*ibid.*).

towns, and their construction and maintenance directly influenced both the creation of agrarian wealth and the development of pottery artisans making and repairing the *arcaduces*²⁴⁸ (Peña Ortiz 2010). The maintenance and improvement of norias remained the sole responsibility of farmers (*ibid.*): accounts by some interviewees corroborate this data. Traditional water lifting technologies allowed for the cultivation through gravity flow irrigation of small-irrigated fields of no more than 2 hectares growing vegetables and fruit trees. The cultivation of vegetables from the *huerta* and commercialisation of the surplus in local markets was thus used to complement family subsistence economies and income. This sustained the cultivation and irrigation of vegetables in the summer as an economic complement to dry-farming revenues.

“My parents had a *huerta* ... we would sow and I was already irrigating ... it was for consumption and also to sell something” (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

“The *huertas* were used by the poor as a financial help and to get through the summer ... when the countryside was transformed, it was a complement for the cereals and vine” (Interviewee 16, 8th of June 2011, Manzanares).

Most of the farmers grew up cultivating and irrigating their small family plots with norias (Photograph 6.1).

²⁴⁸ *Language note:* Earthenware pot attached to the noria used to lift the water with a capacity of 6 to 8 litres.

“University was this [the countryside]” (Interviewee 6, 2nd of June 2011, Tomelloso).

“When I was 10 years old I was already irrigating” (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

Photograph 6.1 Traditional noria and family of farmers in La Mancha

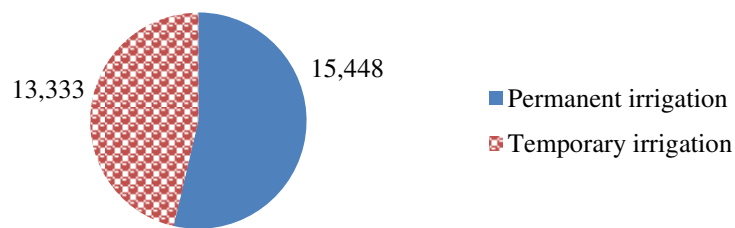


Source: Municipal Archive, Alcázar de San Juan.

Data from the 1962 agrarian census for Ciudad Real province provides a detailed break down of the use of traditional groundwater abstraction technology before the modernisation of irrigation in La Mancha. The data indicates that temporary irrigation was still very much in use in Ciudad Real province, and traditional techniques of groundwater abstraction (i.e. norias) were predominant. The allocation of land surface according to the type of irrigation system, suggests that agriculture based on irrigation was not the sole source of revenue in 1962. This

corroborates the fact that families used small-scale temporary irrigation as a complement to dry land farming, thus temporary irrigation was still important in terms of land surface (13,333 hectares) (Figure 6.2).

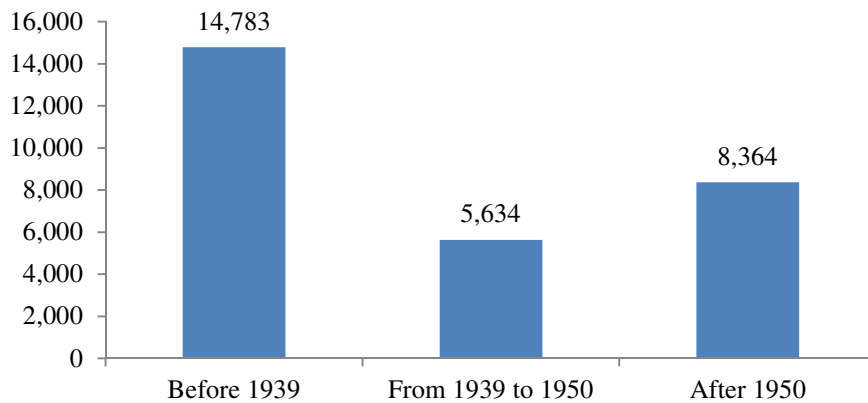
Figure 6.2 Total irrigated area in Ciudad Real province according to frequency of irrigation in 1962 (in hectares)



Source: Based on data from INE Agrarian Census 1962.

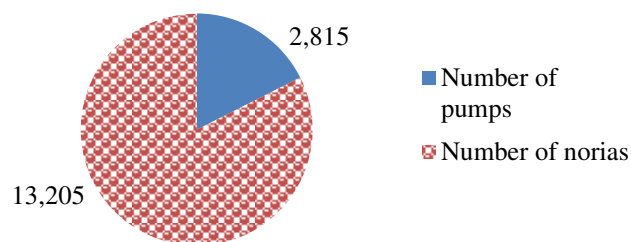
Data from the 1962 agrarian census also suggests that during the first half of the 1960s, irrigation using groundwater was still a predominantly traditional system of water abstraction, representing for many families an important secondary source of revenue. Moreover, most irrigation systems in the province of Ciudad Real date back to before the 1940s (Figure 6.3). This corroborates the predominance of traditional technologies for irrigation such as norias (13,205) over boreholes and pumps (2,815) (Figure 6.4).

Figure 6.3 Total irrigated area in 1962 in Ciudad Real province according to date of initialisation (in hectares)



Source: Based on data from INE Agrarian Census 1962.

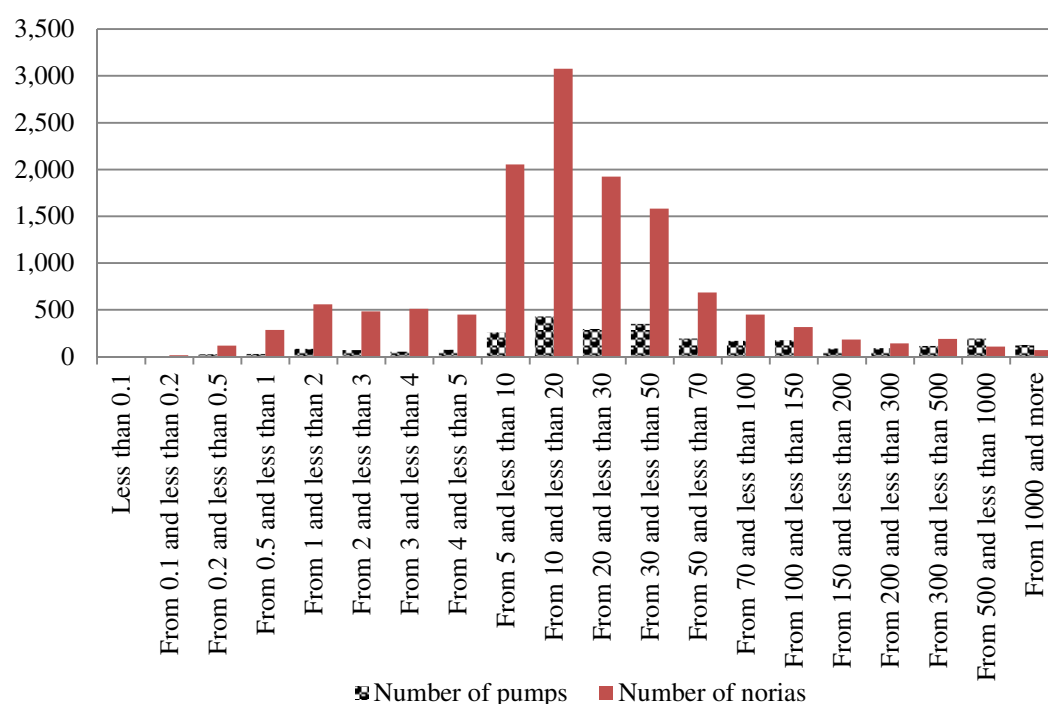
Figure 6.4 Number of pumps and norias in Ciudad Real province in 1962



Source: Based on data from INE Agrarian Census 1962.

The 1962 agrarian census also shows that norias were predominantly used in small to medium size farms (between 10 and 20 hectares) (Figure 6.5), and that the small number of pumps are more or less equally allocated across farm sizes (the highest number of pumps found in Ciudad Real is for farms from 10 and 20 hectares and from 30 and 50 hectares). The small number of modern pumps in the Ciudad Real province suggests a lack of ubiquitous relevance of modern groundwater abstraction techniques at that time.

Figure 6.5 Number of norias and pumps in Ciudad Real province in 1962 according to farm size (in hectares)



Source: Based on data from INE Agrarian Census 1962.

The need for a minimum size farm plot to compensate for the initial investment in irrigation was mentioned by some interviewees. The ownership of land and the need for economies of scale thus justified the purchase of more land to cultivate:

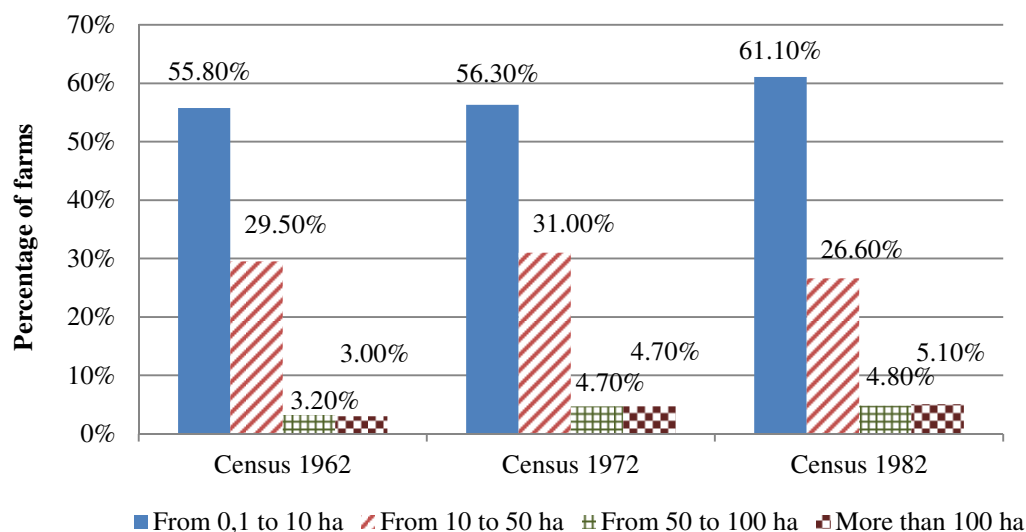
“After uniting land plots you would put a well” (Interviewee 9, 2nd of June 2011, Alameda de Cervera).

“In the 1950s, those who had economy would make some investments” (Interviewee 16, 8th of June 2011, Manzanares).

“I started gathering land and I made a well” (Interviewee 17, 13th of June 2011, Alcázar de San Juan).

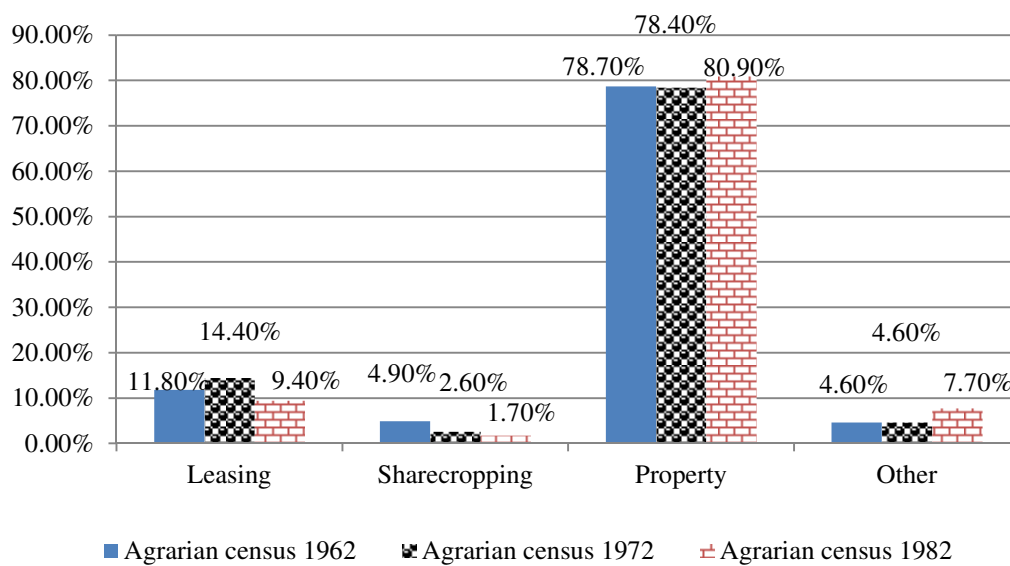
The predominance of small to medium size farms did not change from 1952 to 1982 (Figure 6.6), during which time the number of land property owners in Ciudad Real province increased from 78.7 percent in 1962 to 81.1 percent in 1982 (Figure 6.7).

Figure 6.6 Percentage of farms according to land surface in Castilla-La Mancha



Source: Based on data from INE in Sánchez Sánchez 2001.

Figure 6.7 Land ownership structure in Ciudad Real province



Source: Based on data from INE in Sánchez Sánchez 2001.

From this analysis it is possible to deduce that land ownership structures persisted through the process of technology adoption, suggesting that some form of access to land property in La Mancha was a necessary condition for farmers to alter the technology used to abstract groundwater.²⁴⁹ The predominance of small (0.1 hectares to 10 hectares) and medium size farms (from 10 hectares to 50 hectares) suggests that access to groundwater abstraction technology was not limited to large landowners with private capital and larger investment capacities. Most farmers benefited from state-sponsored schemes to modernise irrigation and rural areas and were thus able to access this new type of technology.

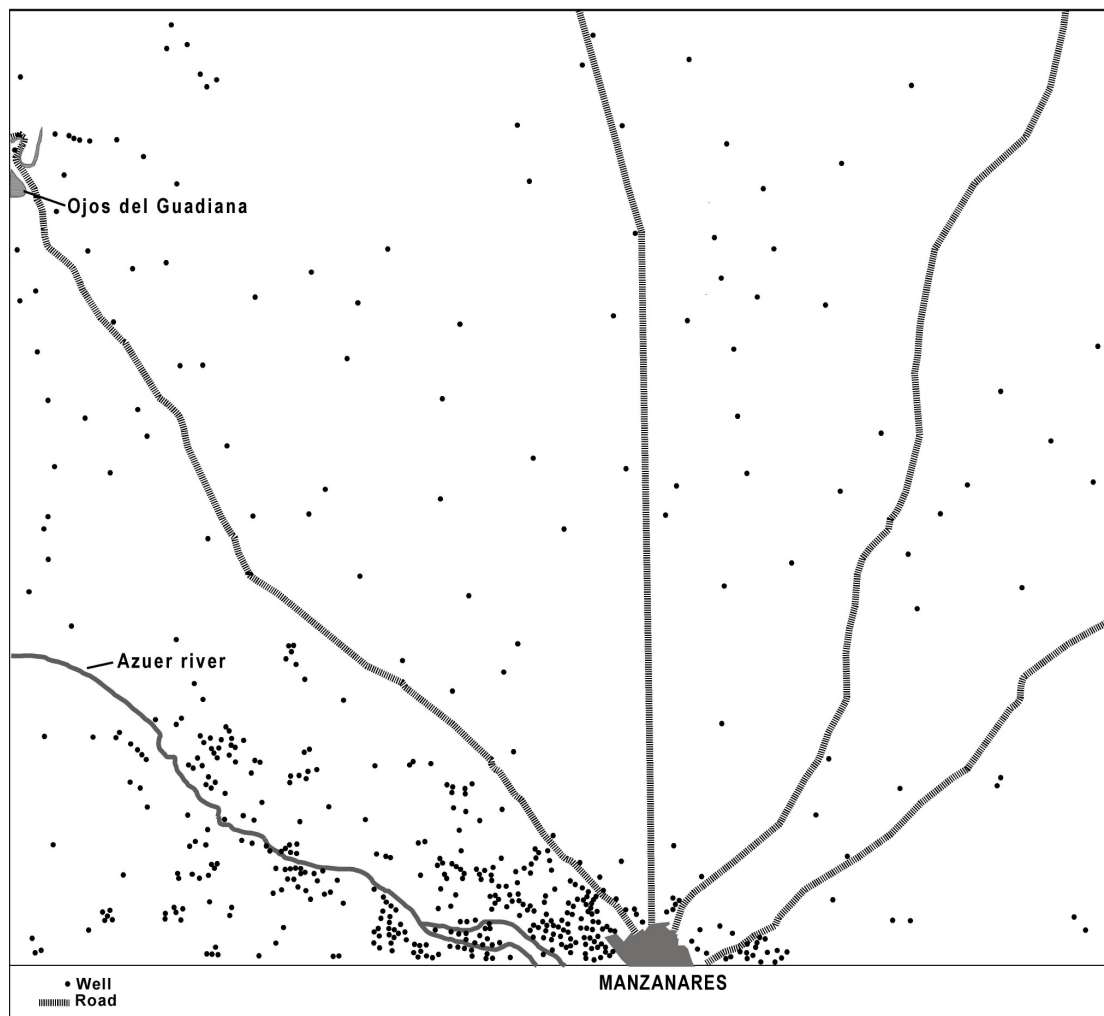
As Giner (1990) contends, the use of norias made perfect sense according to the logic and characteristics of agrarian farming needs. In La Mancha, large landownership and small properties coexisted with indirect cultivation through land

²⁴⁹ There is a similarity in India (Dubash 2002) or South Asia (Shah 2008), where access to land property and thus higher rents were a pre-requisite to investment in groundwater abstraction technologies.

tenure contracts such as *arrendamientos*²⁵⁰ as well as small farming plots directly owned by farmers. This permitted the coexistence of large dry farming areas with small irrigated plots served by norias (Cuadra García 1991). According to Giner (1990), the norias' technical specificities made them extremely adaptable to the necessities of small irrigation plots and shallow aquifer levels. As the data from the 1962 agrarian census shows, animal drawn norias were still predominant in the 1960s in La Mancha. Norias also formed an atypical agrarian landscape (Figure 6.8), in which “wells were very close to each other, and delimited a vast irrigated area by the juxtaposition of small land plots” (Giner and Carrión 2005: 87). The presence of a shallow water table, especially near rivers and riverbeds such as the Azuer or the Guadiana River in La Mancha, also determined the strong presence of this type of technical devices in the 1950s.

²⁵⁰ *Language note:* Land-leasing contracts in the original Spanish language.

Figure 6.8 Concentration of wells in La Mancha around Manzanares in 1953



Source: Author based on the original Los Romeros area map, No.741, 1953, National Geographical Institute.

6.3 New technology: the advent of modern boreholes in La Mancha

6.3.1 Technology innovation for traditional groundwater abstraction technologies

As described by Giner and Carrión (1999: 16), “the increase and intensification in the production of citrus fruits and vegetables in the mid nineteenth century would not have been possible without the development of more sophisticated

irrigation techniques”.²⁵¹ Along with improved traditional irrigation systems, the mechanisation and motorisation of groundwater abstraction devices associated with small irrigation plots and individual initiative, sustained the development of this new type of agriculture. Following Giner (1990), until the 1930s the majority of groundwater pumps were concentrated in the traditional *huerta* regions (Balearic Islands, Murcia and Valencia), representing 91.9 percent of total groundwater pumps in Spain in 1916.

The poor energy efficiency of animal-drawn norias whose *arcaduces* required constant repairing, made them sensitive to extended and continuous usage. The first change in the design of the original wood norias occurred during the nineteenth century when parts were replaced by metallic structures, such as the wheel, *cangilones*²⁵² and transmission gears (Giner 1990). Additionally, as Giner (1990: 208) pointed out, the specific technical characteristics of norias in Valencia meant they were uncomplicated to use and cheap to repair (mostly the breaking of the *rosario*²⁵³). This meant it was possible for farmers to individually repair them without relying on specialised professionals or external suppliers. For Garrabou (1990), this was also one of the main obstacles to agrarian modern mechanisation.

The second change in traditional water lifting technologies came when farmers started to install small engines attached to the noria (Photograph 6.2). As one of the interviewees described it:

²⁵¹ Author’s translation from original quote in Spanish.

²⁵² *Language note:* Metallic tin pots replacing the ceramic *arcaduces*.

²⁵³ *Language note:* The *rosario* is the term used in La Mancha to describe the potgarland moved by the rotating wheel (or portgarland wheel) and to which the pots used to lift the water would be attached.

“First it was the mule, then small engines started to replace the mule, then the waters started to go down, and they drilled” (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

In La Mancha, the simplest engines used for norias were the open flywheel, low-speed, single cylinder diesel engines as described by Fraenkel (1986). These were connected to the noria by a conveyor belt which transmitted motion through a series of transmission wheels.²⁵⁴ In La Mancha, the most common design was the Dieter engine developed and produced by a Spanish company in Badajoz, Extremadura, in 1940 (Photograph 6.2). Some more rudimentary engines also in use included petroleum-fuelled engines.

Photograph 6.2 Dieter engines for noria in Manzanares



Source: Author.

²⁵⁴ *Language note:* Referred as ‘*contramarcha*’ in the original Spanish language.

Thus, the process of modern technology for groundwater abstraction in La Mancha was initially based on the development and amelioration of traditional norias. The use of better components and parts extended the life of these devices and ensured their improved operation and use. As such, this initial stage followed a process of adaptation of traditional technologies to the different uses required. As Giner and Carrión (2005) point out, the process of technological adaptation of norias from the mid nineteenth century to the 1930s was based on the transformation of these devices, adopting new techniques and materials to improve the original waterwheel wood. A process of incremental adoption and adaptation of traditional technology devices occurred in La Mancha, following the development of scientific and technical improvements used by certain pioneers:

“But it's like when you saw the neighbour with the *contramarcha* and you were still with the mule ... ” (Transect Walk 4, Manzanares, 14th of June 2011).

New materials such as iron, and the amelioration of other parts contributed to the noria's increased capacity to abstract water. According to Giner and Carrión (2005), iron norias used from 1916 onwards were up to 30 percent more efficient in lifting water than older models made of wood (Photograph 6.3). As Glick (1977) witnessed during a reconnaissance journey to La Mancha in 1976:

“Virtually all of the sites are still observable, although considerably less than one-quarter appears to be in anything like working order. In most cases, the noria machinery has been removed (discarded iron wheels dot the countryside)

and electric or gas pumps installed. In a few cases, the pot-garland wheel remains, but has been mechanized by connecting it with a drive belt to a motor, with the pots discharging their contents as before into a trough or channel. Some norias (perhaps around 5 percent and certainly no more than 10) are still powered by mules; however, in all but a few cases these are now fitted with tin cans, rather than earthenware pots. Based on a one-day sample, I estimate that only one in fifty working Manchego norias, whether driven by animal or motor, now operate with clay pots” (Glick 1977: 647).

Photograph 6.3 Design of an improved iron noria in Manzanares



Source: Author.

6.3.2 From the noria to the borehole: the adoption of groundwater abstraction technology in La Mancha²⁵⁵

6.3.2.1 Introduction of modern groundwater abstraction technology in La Mancha by the INC

As described previously in this thesis, the intervention of the state and institutional and financial support of the INC through the different projects of irrigation and colonisation, were essential for the development of groundwater irrigation in La Mancha. The use of modern groundwater lifting technologies at the beginning of the 1950s was restricted to a small number of landowners irrigating 3,167 hectares in the province of Ciudad Real and 236 hectares (with 175 groundwater wells) in Llanos del Caudillo, Manzanares (INC 1950) (Table 6.3). Additionally, in 1950 there were 6 groundwater wells accounted for by the INC belonging either to Municipalities or to private owners in the area of Manzanares²⁵⁶ with modern groundwater abstraction technology (Table 6.4).

²⁵⁵ The authors Cruces de Abia et al. (1998) have used the expression ‘from the noria to the pump’ in the title of their compiled study of the environmental and social conflicts arising from the overabstraction of groundwater in the Upper Guadiana river basin.

²⁵⁶ In 1916 the mayor of Manzanares, José González-Elipe, ordered the test drilling of a well in the property of Los Romeros located 18 kilometres outside the town. After finding water, Dolores García-Noblejas Díaz-Pinés generously offered a land plot of two hectares next to the where the town hall drilled the first well. Although the project to carry water to the town and run the water supply infrastructure and sewage system was won by Casimiro Juanes Clemente and Tomás García-Noblejas Quevedo, it was not initially realised due to a lack of public funding. Their project included the supply of 1,000 m³ of water per day over ten hours, representing around 63 litres of water per capita. In spite of this, engineers were so committed to completing the project that they set up a private society to gather the capital needed to fund the project, and as a result the Society of Drinking Water and Sewage of Manzanares was founded on the 6th of December 1918. Amongst the original members of the Society were Tomás García-Noblejas Quevedo and José González-Elipe Rossique (as president). Because of this venture, after having inaugurated the well on the 20th of July 1923, the mayor Máximo González-Nicolás made the engineer Tomás García-Noblejas Quevedo Favourite Son of Manzanares (Bermúdez 2008).

Table 6.3 Wells accounted for by the INC in Ciudad Real province in 1950

<i>Municipalities</i>	<i>Wells functioning (number)</i>	<i>Irrigated surface (ha)</i>
Ciudad Real	251	310
Carrión	183	227
Torralba	485	491
Daimiel	3,000	1,500
Manzanares	175	236
Villarrubia	270	403
Total	4,764	3,167

Source: INC 1950: 6.

Table 6.4 Modern wells in Manzanares in 1950

<i>Wells</i>	<i>Depth of water table (m)</i>	<i>Abstraction flow (litres/second)</i>	<i>Uses</i>
Well Nuevo de los Romeros	22	70	Water supply for Manzanares
Well Antiguo “Los Romeros”	16	70	Out of service
Well 1 Colonia La Herrera	23	120	Irrigation for private exploitation
Well de la Perdiguera	18	140	Water supply for Alcázar de San Juan
Well 1 Cinco Casas	22	8	Irrigation land plot of 1ha
Well 2 Cinco Casas	22	16	Irrigation for Land plot, 3 ha

Source: INC 1950: 10.

As confirmed by the interviews conducted as part of this thesis, the impact of INC colonisation plans for La Mancha can be traced back to the original drilling of groundwater wells in Llanos del Caudillo; the first of their kind in La Mancha. The presence of this type of technology set in motion the development of intensive irrigation in the area. This crucial moment is represented by quotes from some of the interviewees:

“Maybe our beginning [as irrigators] has to do with Llanos [del Caudillo]”

(Interviewee 9, 2nd of June 2011, Alameda de Cervera).

“The first irrigation of larger quantity was here in this town [Llanos del Caudillo]” (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

“It started in this town [Llanos del Caudillo]” (*ibid.*).

“This was the first [town], to irrigate like that with engines and pumps” (*ibid.*).

Technical knowledge used for drilling and boring wells came from outside La Mancha (Photograph 6.4 and Photograph 6.5). Companies in charge of the first drilled boreholes in La Mancha came from areas with traditional irrigation knowledge and experience in drilling deep groundwater boreholes (e.g. Murcia, Valencia, Balearic Islands).²⁵⁷ These 'foreign' companies were key in the adoption and spread of new water lifting technologies and a 'technological market' was set up with companies bringing new techniques of borehole drilling from Murcia (José Ramón Aragón, personal communication, 29th of May 2011).

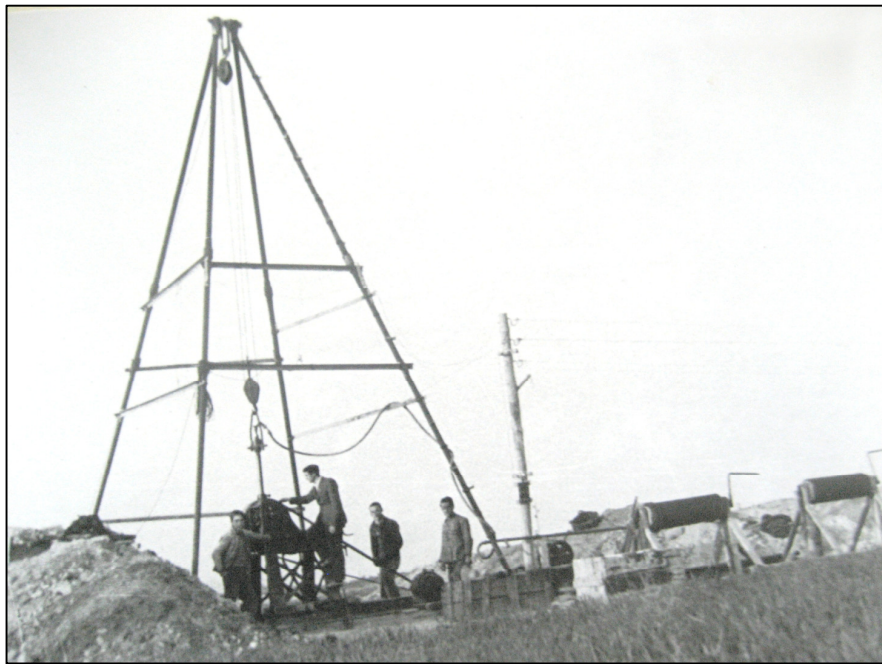
“Knowledge came from outside” (Interviewee 12, 3rd of June 2011, Manzanares).

²⁵⁷ The 17 interviews conducted during June 2011 in La Mancha confirmed that companies from outside the Ciudad Real province undertook 56.25 percent of the wells initially drilled (1 company from Seville, 1 company from Valencia, 3 companies from Mallorca and 4 from Murcia). This corroborates Giner and Carrion's (2005) research at the national level emphasizing a trend in the development of pumps in areas such as Valencia prior to La Mancha. José Ramón Aragón also mentioned that drilling machines came from Galicia and even Italy (personal communication, 29th of May 2011).

As Luis Martínez Cortina (2011) also points out, the adoption of modern groundwater abstraction technologies occurred in parallel with scientific advances in hydrogeology and drilling techniques, including:²⁵⁸

- The invention of the submersible turbine pump²⁵⁹
- The increasingly affordable costs of drilling associated with technological innovations²⁶⁰
- The development of hydrogeology as a science²⁶¹

Photograph 6.4 Percussion drilling for a well in La Mancha, 1950s



Source: Archive, Ministry of Agriculture.

²⁵⁸ Corroborated by Fornés and Senderos (2002), Martínez Cortina 2001 and Luis Martinez Cortina, personal communication, 13th of April 2011.

²⁵⁹ Fornés and Senderos (2002), corroborated by Manuel Ramon Llamas, personal communication, 12th of May 2012. See also Llamas and Martínez-Santos (2005a).

²⁶⁰ Corroborated by Martínez Cortina 2001 and Luis Martinez Cortina, personal communication, 13th of April 2011; and Manuel Ramon Llamas, personal communication, 12th of May 2012. See also Llamas and Martínez-Santos (2005a).

²⁶¹ Martínez Cortina (2001). This point is also corroborated by Fornés and Senderos (2002), Llamas and Martínez-Santos (2005a), and by Manuel Ramon Llamas, personal communication, 12th of May 2012.

Photograph 6.5 Drilling equipment in La Mancha, 1950s



Source: Archive, Ministry of Agriculture.

In Llanos del Caudillo, foremen were charged to train settlers in new irrigation techniques (Romano Serrano 2005). They not only supervised the settler's agricultural production but also the correct use of irrigation techniques for agriculture. These foremen were recruited from areas with a strong irrigation tradition (e.g. Murcia and Valencia) and with personal experience and knowledge of irrigation techniques (EUA 1985a: 117-118), and installed by the INC in every colonisation town.

In La Mancha, the development of colonisation towns also affected the adoption of new crops. Farmers were influenced by rumours and comments made by their neighbours about the large water abstraction potential of modern pumps in the area of Manzanares.

“We knew that in Llanos they were planting maize” (Interviewee 9, 2nd of June 2011, Alameda de Cervera).

“People would talk about, listen, they have built a town [Llanos del Caudillo] and they are abstracting a lot of water ... this was very weird ... a spurt of water like that ...” (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

“We thought this was ridiculous, the amount of water they were abstracting” (*ibid.*).

For Manuel Oteiza,²⁶² the areas irrigated by settlers, “stood out over the dry farming areas” (EUA 1985a: 112). Aided by the foremen who themselves came from areas with a strong irrigation tradition (e.g. Murcia), the settlers “always had water provided by the administration”.²⁶³ Thus landowning neighbours, on seeing what settlers were achieving in fields with groundwater, started drilling their own wells.²⁶⁴ Several quotes from the farmers interviewed confirm this process:

“The neighbours and adjacent owners, some of them also used the water from the INC-IRYDA, but the others, when they saw that there was water in the well, they started 'making' wells” (José Ramón Aragón, personal communication, 29th of May 2011).

²⁶² Deputy Director of the INC in 1970 (ABC 1970).

²⁶³ José Ramón Aragón, personal communication, 29th of May 2011.

²⁶⁴ Of the 17 semi-structured interviews in June 2012 in La Mancha, 12 interviewees (70.59 percent) stated that their neighbour was the main source of knowledge when they started irrigating with groundwater.

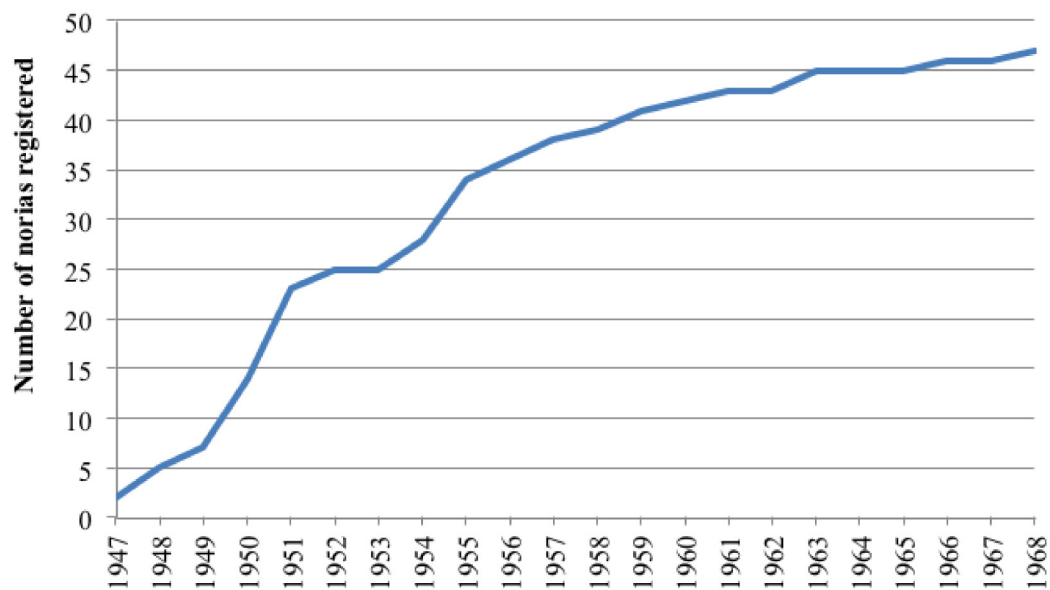
6.3.2.2 Evolution and adoption stages of groundwater abstraction technology in La Mancha

General studies of the use of groundwater abstraction technology in the province of Ciudad Real indicate that of the 25,470 registered wells at the Ministry of Mines before the 1985 Water Law, 55 percent were found in La Mancha with the largest proportion found in the municipality of Manzanares (14.6 percent) (Pillet Capdepón 1989). With the data gathered at the Community of Irrigators of Manzanares it is possible to complement these general studies and depict a detailed evolution of the use of traditional and modern groundwater abstraction technologies in Manzanares.

Figure 6.9 shows the accumulated number of norias registered in Manzanares. The general trend of the number of norias in Manzanares prior to the groundwater irrigation boom followed a slow increase from no devices registered in 1947 to 47 devices registered in 1968. The initial phase can be characterised as one of ‘early technology adoption’.²⁶⁵

²⁶⁵ Here I use the terminology established by Rogers (2003) to name the stages in the process of technology adoption. When considered generally by this author, the different phases of the technology adoption process form an S-Shaped curve. Classical studies on the development of technology innovation generally apply the S-shaped curve model as the conceptual representation of the dynamics of technology adoption. The origin of the S-curve can be traced back to models of cultural transmission developed by Chapin (1928 in Pemberton 1936) and later applied by Kuznets in finding trends in production represented by ogive curves (Pemberton 1936). The S-shaped curve appeared also in rural sociological studies on the adoption of hybrid corn in the United States as a function of time, also allowing more generally the representation of cumulative succession of the adoption of a certain technology through time following the representation given by the Gompertz curve (Pemberton 1936; Sunding and Zilberman 2001).

Figure 6.9 Accumulated number of norias in Manzanares (1947-1968)



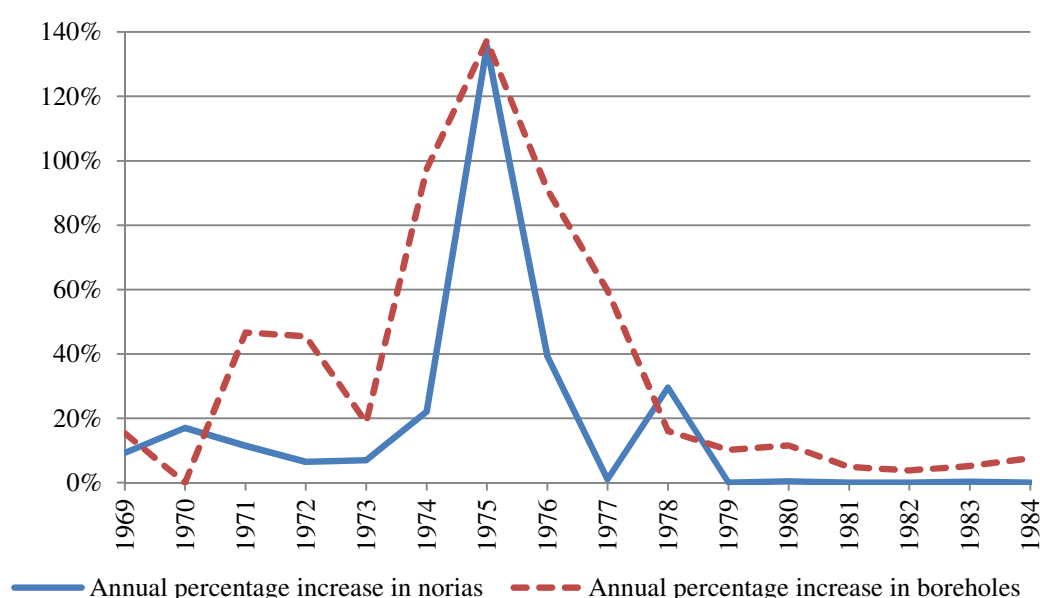
Source: Based on data from Archives of the Community of Irrigators of Manzanares.

After 1968 the number of norias continued to increase until 1975 when it reached 149. During that year, the annual rate of registration for norias increased from a 22.13 percent increase for 1974-1975 to its maximum of 135.57 percent for 1975-1976 (from 149 norias registered to 351 in one year). The annual increase in boreholes during the year 1976 also reached its maximum, with a 137.33 percent increase in relation to 1975. In Figure 6.10, plotting the evolution of the registration rate for norias and boreholes in La Mancha, it is possible to establish the years of 1975-1976 as the point of inflexion when the majority of norias and boreholes were registered. This moment marks the initial date of the ‘take off’ stage of technology adoption for groundwater abstraction in La Mancha. This rate of adoption confirms the opinion of some of the interviewees about the short and intense boom of groundwater abstraction technology in La Mancha:

“Water technology developed very quickly” (José Ramón Aragón, personal communication, 29th of May 2011).

“There was a water fever which lasted less than a decade” (Agustín Apio, personal communication, 1st of August 2012).

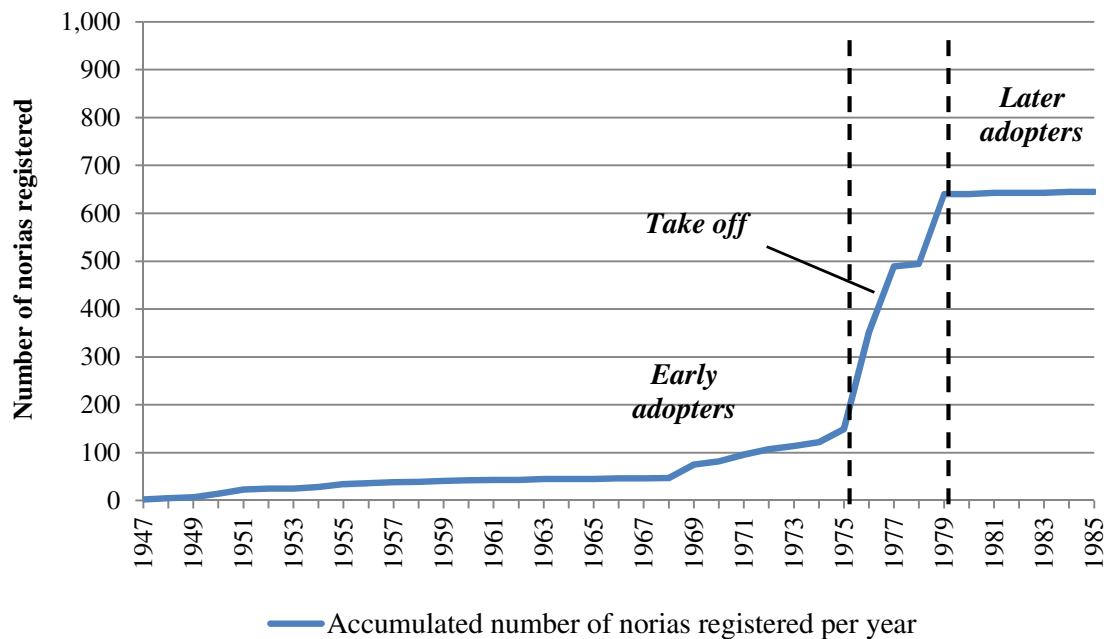
Figure 6.10 Annual registration rate of norias and boreholes in Manzanares (1969-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

The peak of the ‘take off’ period occurred in 1979 when the total accumulated number of norias registered in Manzanares reached 640 (Figure 6.11). Then the number of norias reached a plateau with very small variations (less than 1 percent annual increase) until 1985. This final phase would be the phase where ‘later technology’ adopters joined in, or also the ‘mature’ stage of technology adoption, when innovation has lost its attributes or better techniques have replaced older ones.

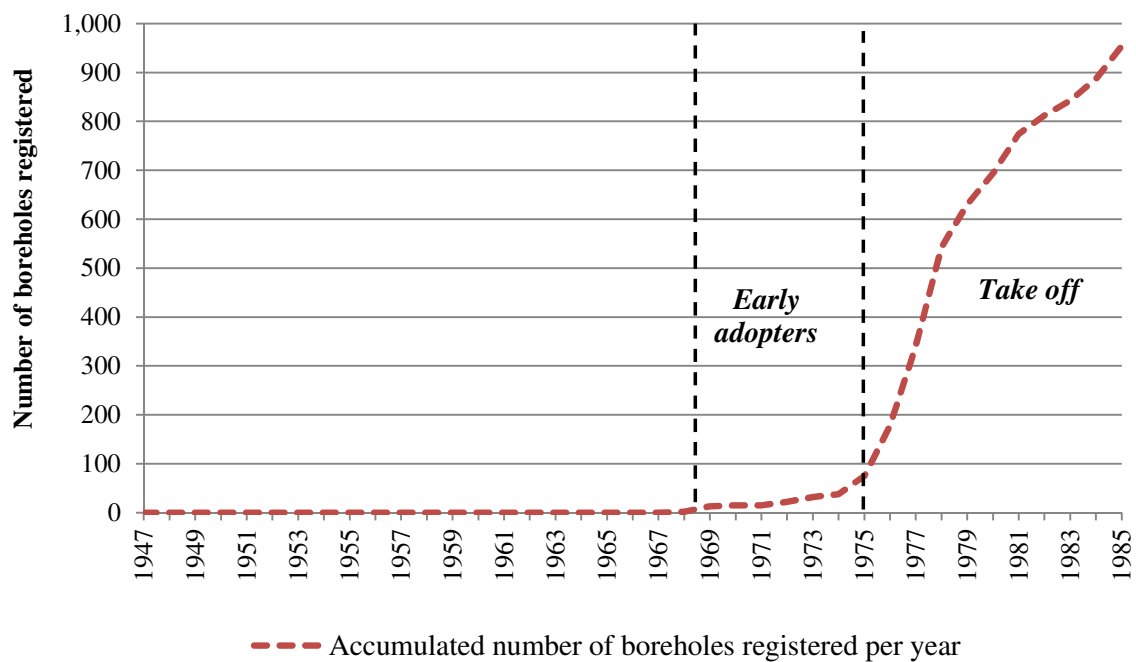
Figure 6.11 Accumulated number of norias and stages in the adoption process of traditional groundwater abstraction technology in La Mancha (1947-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

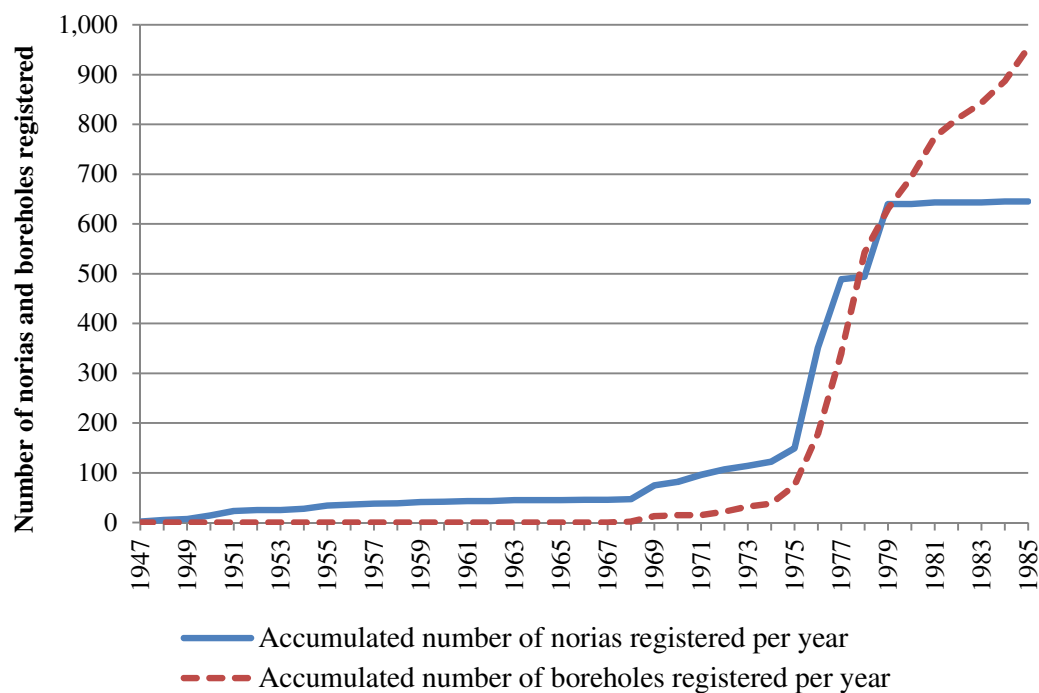
The evolution of the number of boreholes in Manzanares followed a different pattern however (Figure 6.12). Before 1968 there were no boreholes registered in Manzanares and the ‘early adopters’ stage started after 1968 and lasted until 1975. After 1975, a ‘take off’ stage appeared with a very sudden change in the number of registered boreholes in Manzanares, coinciding with a sudden increase in the number of norias registered. The ‘take off’ stage for boreholes is however much more elapsed in time and does not reach a plateau at the end of the period studied. The increase in borehole numbers follows a similar steep increase after 1974 but unlike the number of norias it does not stagnate after 1979 (Figure 6.13).

Figure 6.12 Accumulated number of boreholes in Manzanares and stages in the adoption process of modern groundwater abstraction technology in La Mancha (1947-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

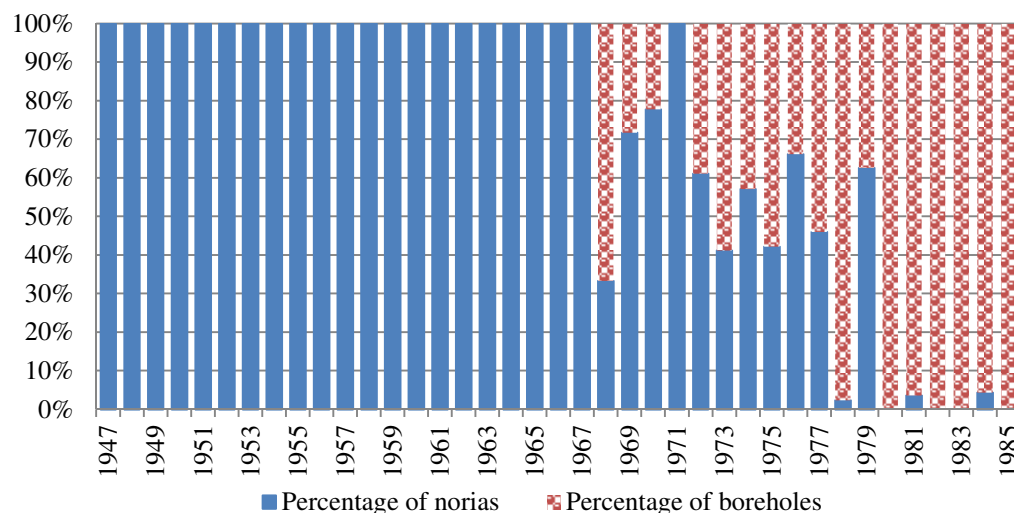
Figure 6.13 Total accumulated number of norias and boreholes in Manzanares (1947-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

Figure 6.14 shows the transition from traditional to modern groundwater abstraction technology, which occurred between 1968 and 1977. The use of traditional technologies for groundwater abstraction in Manzanares is prevalent until 1968 when the first private boreholes appeared, quickly becoming the predominant type of groundwater abstraction technology. The years between 1968 and 1973 show an alternation period in the type of technology used, however after 1977 the data indicates a predominance of boreholes being registered in Manzanares.

Figure 6.14 Percentage of norias and boreholes registered in Manzanares (1947-1985)



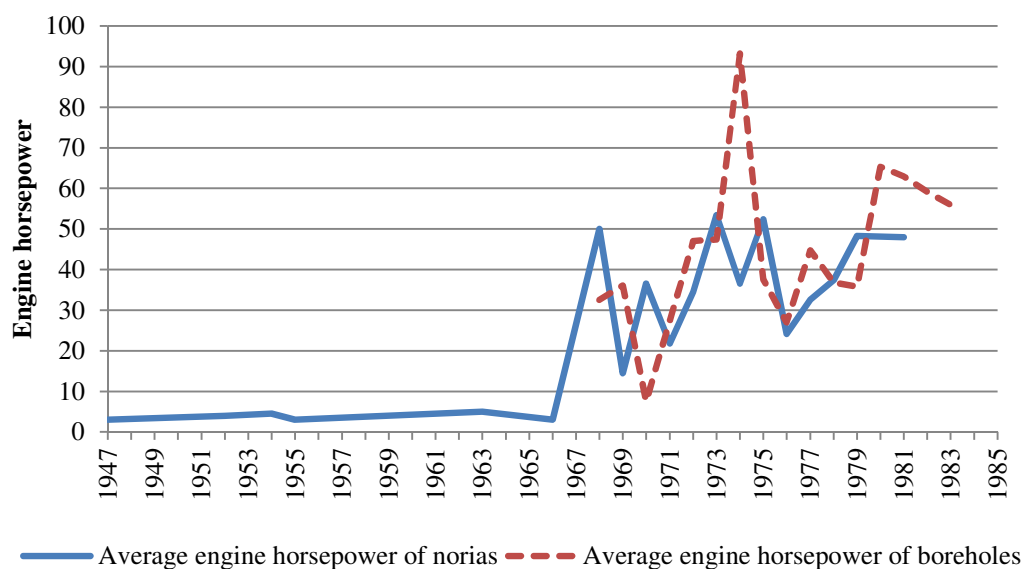
Source: Based on data from Archives of the Community of Irrigators of Manzanares.

6.3.2.3 Characteristics of traditional and modern groundwater abstraction technology in La Mancha

Analysis of the data set also allows a more detailed study of the characteristics of traditional and modern groundwater abstraction technologies in Manzanares, considering the use of different types of engines, pumps and the depth of both norias

and boreholes. In Figure 6.15 it is possible to observe a gradual increase in the average engine horsepower for norias and boreholes in Manzanares, particularly after 1967. For many years prior to that, it is noticeable that the average engine horsepower remained very low. Most likely, this indicates a predominance of traditional technologies for groundwater abstraction and a low mechanisation intensity of irrigation in Manzanares, corroborating the data from the 1962 agrarian census.

Figure 6.15 Average engine horsepower of norias and boreholes in Manzanares (1947-1985)

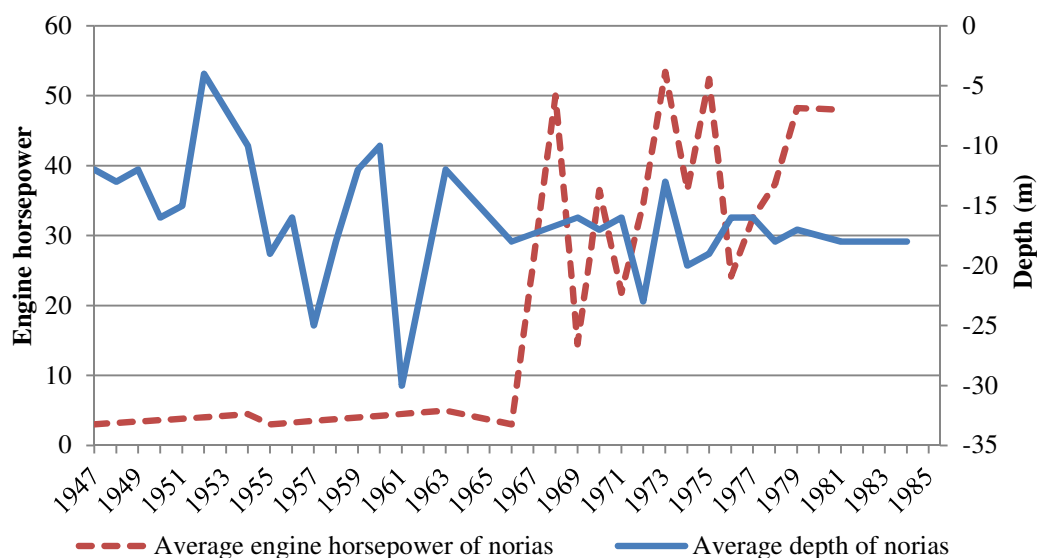


Source: Based on data from Archives of the Community of Irrigators of Manzanares.

The type of technology used to abstract groundwater also influenced the characteristics of the engine and the depth of wells. Due to technical limitations, the use of engines in norias suffered from high variability and unreliability. As shown in Figure 6.16, the average engine horsepower for norias shows a very sensitive relationship with small variations in well depth after 1967. This suggests a high degree of variability in operation costs at the time when mechanisation and modernisation of groundwater abstraction technologies started to appear in

Manzanares. Before 1967, large variations in the depth of wells seemed not to affect the average engine capacity of norias, which all remained very low. This again corroborates the notion of the low degree of mechanisation of traditional groundwater abstraction technologies. After 1967, however, it is possible to discern a more positive relationship between the average engine horsepower installed in Manzanares and the depth of wells for norias. Variations of five metres in well depth represented in some cases an important change in engine capacity of more than 30 horsepower. This also suggests that the mechanisation of traditional groundwater abstraction technologies was closely linked to the depth of the wells and thus the depth of the water table.

Figure 6.16 Average engine horsepower and depth of norias in Manzanares (1947-1985)

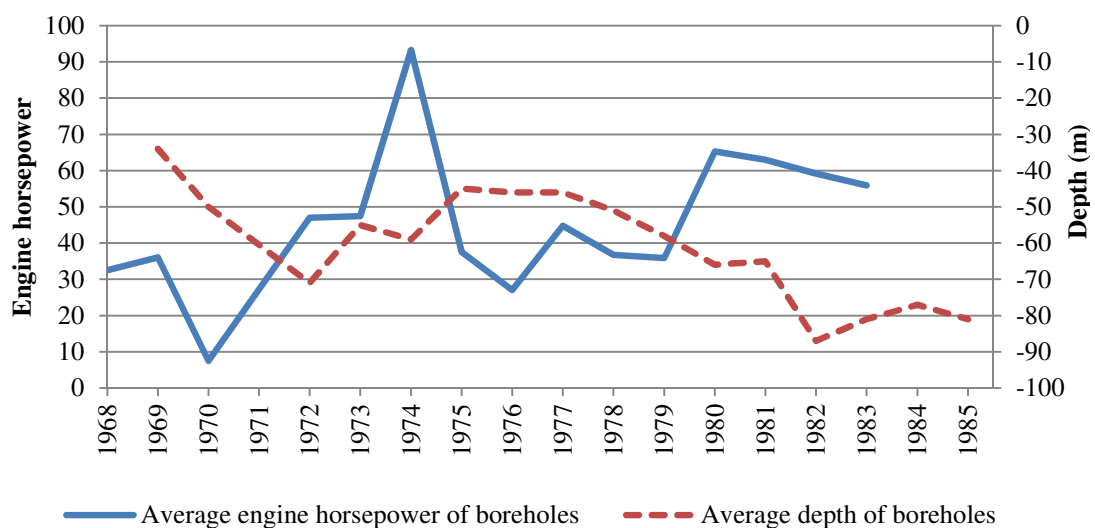


Source: Based on data from Archives of the Community of Irrigators of Manzanares.

Figure 6.17 plots both the evolution of the average engine horsepower for boreholes and the depth of boreholes. As the average engine horsepower increases in time it is possible to observe a general increase in borehole depth. In this case and similarly to norias, the variation in engine horsepower is affected by the depth of

boreholes. Therefore, it is possible to assume that there is a positive relationship between horsepower and well depth: as water levels fall, the size and pump capacity to raise water to the surface increases. The variation in average engine horsepower shows, however, a delayed response after an increase in well depth. As previously pointed out, boreholes were more reliable and less affected by water table variations than norias. This would thus explain why the average horsepower for boreholes presents fewer variations.

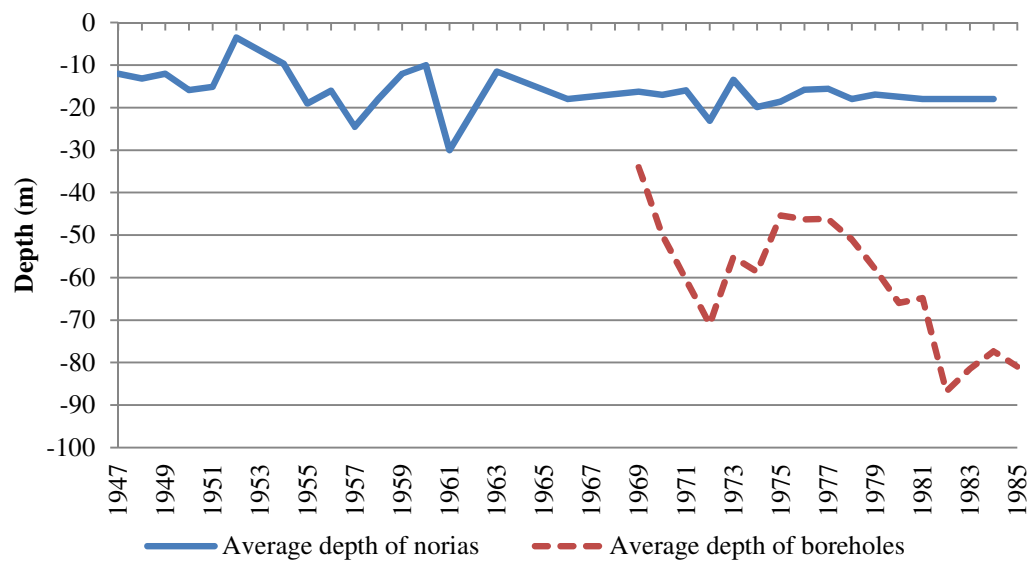
Figure 6.17 Average engine horsepower and depth of boreholes in Manzanares (1968-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

The technical limitations concerning norias versus boreholes can also be illustrated by examining the average depth of wells in Manzanares. Figure 6.18 charts the average depth of norias and boreholes in Manzanares and it is possible to observe that the maximum depth attained by norias was 30 metres whereas when boreholes appear in Manzanares (circa 1968) they start at 30 metres and go down to a maximum depth of 82 metres in 1982.

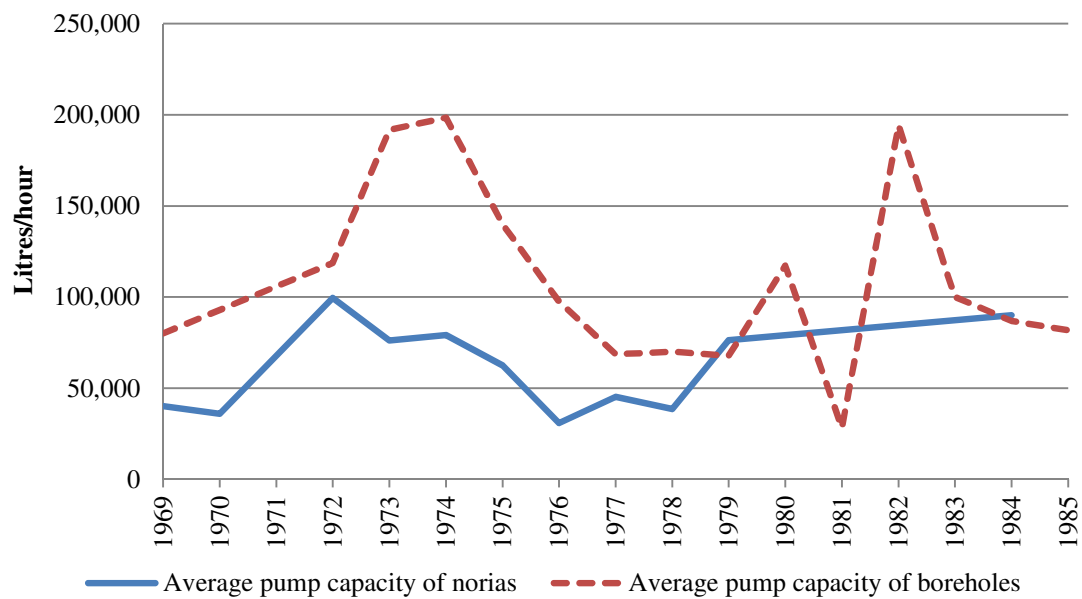
Figure 6.18 Average depth of norias and boreholes in Manzanares (1947-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

The abstraction capacity of pumps for norias and boreholes in Manzanares also presents some differences. The need for more powerful engines is related to the fact that more powerful pumps were required to abstract groundwater, partially reflected by the fact that boreholes were deeper than norias (Figure 6.18). In Figure 6.19 this trend is observable, with a graph curve indicating an installed pump capacity for boreholes higher than that of norias.

Figure 6.19 Average pump abstraction capacity for norias and boreholes in Manzanares (1969-1985)

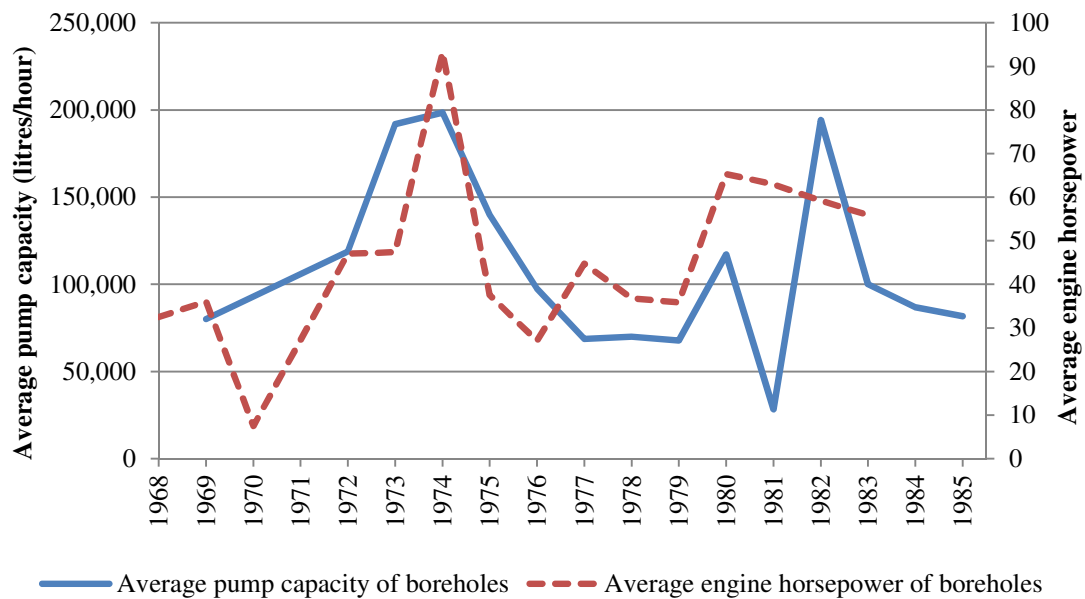


Source: Based on data from Archives of the Community of Irrigators of Manzanares.

Only after 1969 is it possible to find pumps used in norias. This would indicate a change in the use of traditional technologies to abstract groundwater and the initiation of the mechanisation process of traditional technologies. The capacity to use pumps in norias is again affected by the technical and design limitations of norias as well as limitations in the wells depth of these traditional devices. The use of boreholes with more powerful abstraction pumps (able to extract up to 200,000 litres per hour) also indicates a much greater need for water abstraction (Figure 6.19).

The evolution of the average engine horsepower installed in Manzanares coincides with increasing levels of pumps abstraction capacity. This relationship between engine horsepower and pump capacity is shown in Figure 6.20. The need to operate more powerful pumps with bigger engines seems to indicate an increase in groundwater abstraction potential in Manzanares. This potential would then be translated into a larger irrigated area with modern groundwater abstraction technologies.

Figure 6.20 Average engine horsepower and pump capacity of boreholes in Manzanares (1968-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

6.3.2.4 Cheap diesel: the groundwater-energy nexus in La Mancha

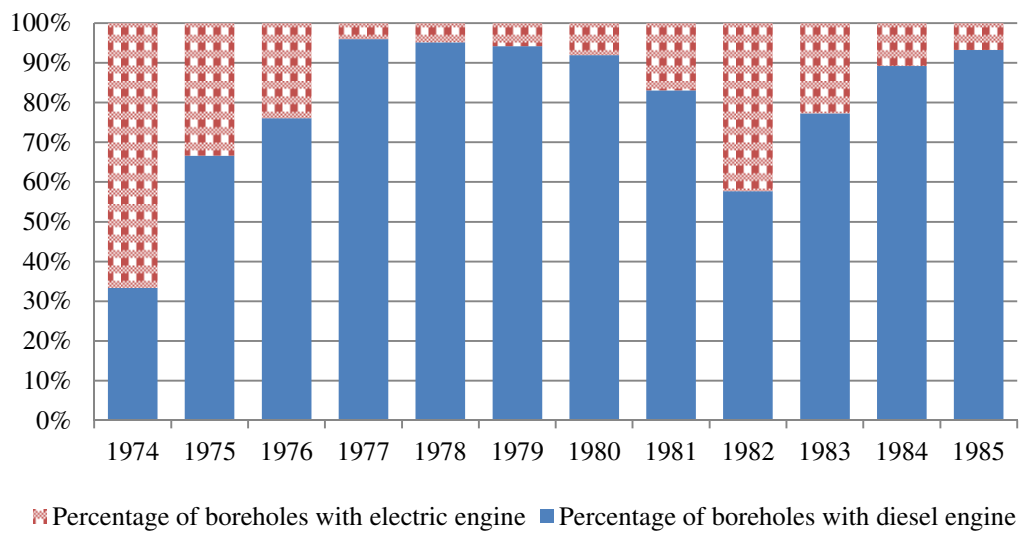
The study of the adoption of technology for groundwater abstraction is also intrinsically linked to the origin of its different energy sources. The process and pace of rural development and modernisation through electrification had a major impact on the development of potential groundwater abstraction. According to Giner and Carrión (1999), the electrification of Spain's countryside determined the diffusion of electric and diesel engines for groundwater abstraction. In La Mancha, electric and diesel engines coincided in time, although the availability of energy supply played a role in shaping the type of technology used to abstract groundwater.

Although electric engines were easy to use, reliable and had lower maintenance and reparation costs, the spread of centrifugal pumps powered by diesel

engines was influenced by the geography of the development of electricity supply in some areas in Spain. For Giner and Carrión (1999: 32), “although in the 1950s the technicians were in favour of electric pump sets, the availability of electric energy still conditioned its diffusion in remote areas and made it dependent on the expansion of the national electric grid”. This process would explain the 'spectacular' levels of diesel pumps used in the countryside to the detriment of electric engines. Also, as Ortega Cantero (1983: 138) points out, “analysis of the energy fluxes acting on the agrarian systems is crucial to understand its relations with the ecological systems in which they are immersed”.

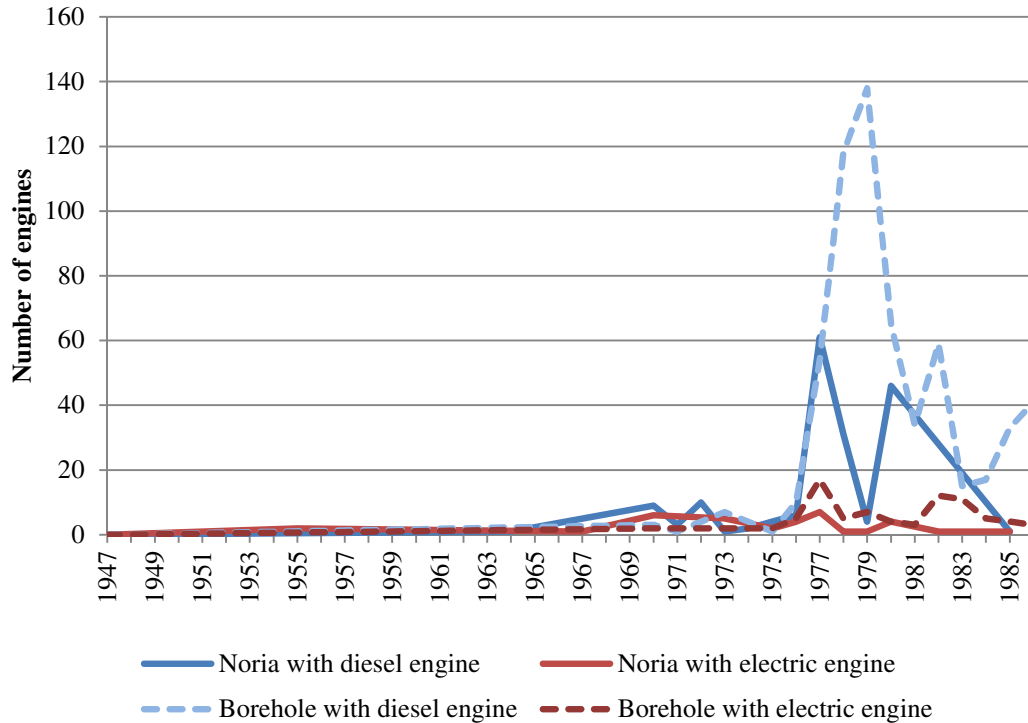
The data indicate that the diesel pump contributed most to La Mancha's irrigation boom. Access to electric engines as opposed to diesel was largely determined by income and capital given the higher costs of this type of technology. Due to the slow process of electrification of the countryside, often linked to large investment required in cables and posts, the number of diesel engines installed in Manzanares is generally higher than that of electric engines, especially during the second half of the 1970s. During that period, more than 90 percent of the engines installed in Manzanares were diesel engines (Figure 6.21 and Figure 6.22).

Figure 6.21 Percentage of boreholes with electric and diesel engine in Manzanares (1974-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

Figure 6.22 Number of norias and boreholes with diesel or electric engine in Manzanares (1947-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares.

In rural areas, electric engines depended on power plants and infrastructure to transport electricity. This affected farmers' individual and collective choices when they came to choose one type of energy over another. In Sector I – La Mancha, the INC's irrigation plans relied on the location of a coal-powered thermo-electric station in Puertollano around 100 kilometres southwest of Manzanares. This location represented, according to the INC, "an important opportunity for the electrification of large parts of the countryside and the transformation of large surfaces, now with cereals and pasture, into irrigated lands" (INC 1950: 13).²⁶⁶

As the interviews suggest, the installation of electric engines represented an important investment that most farmers could not afford. Most interviewees had no choice but to rely on diesel for their engines due to its low cost subsidised by the state. As three of the interviewees confirmed, diesel engines were the type of technology farmers were resigned to use:

"[Diesel engines] there was nothing else, the easiest, what people did"
(Interviewee 6, 2nd of June 2011, Tomelloso).

"Diesel with Franco was very cheap" (Interviewee 9, 2nd of June 2011, Alameda de Cervera).

"Electricity was very expensive" (Interviewee 13, 6th of June 2011, Llanos del Caudillo).

²⁶⁶ Following the development plans of the National Institute of Energy, the Puertollano power Station was due to have a capacity of 40,000 KW at the end of 1950 so that the supply of energy to the town and wells of Llanos del Caudillo would be ensured by a new electric line (INC 1950). For a more detailed explanation of energy subsidies for agriculture see Chapter 7.

Special subsidies for diesel prices were beneficial for farmers and allowed them to access more affordable technology to abstract groundwater.²⁶⁷ Additionally, state-sponsored decrees regulating and developing small loans for private investment in irrigation techniques also proved very beneficial for farmers.²⁶⁸ The sudden increase in modern boreholes to abstract groundwater followed the availability of agrarian loans and credits to invest in modernisation techniques.

Access to electric energy for groundwater abstraction reflected a dualistic situation between state-sponsored and private irrigation in La Mancha. The previously mentioned report by the IBRD and FAO (1966)²⁶⁹ suggested an imbalance between tariffs for state-sponsored and private irrigation projects, which clearly benefitted the settlers in state-sponsored irrigation plans. Private irrigators paid a tariff for kilowatt per hour between six and eight times higher than the tariff paid by irrigators sponsored by the state (i.e. the settlers of state-sponsored irrigation and colonisation plans). According to the IBRD and FAO report (1966), the state's concession contracts with electricity companies provided a certain quantity of electricity at a lower price to be used for public projects such as railroads, and water pumping for urban consumption and irrigation purposes. As the report observed, "naturally, the users of water of the irrigation projects developed by the state would benefit considerably from this subsidy" (IBRD and FAO 1966: 172).²⁷⁰

²⁶⁷ See Chapter 7 for a detailed description of energy subsidies for agriculture.

²⁶⁸ See for example Decree 2499/1976 and Decree 1616/1978 explained in detail in Chapter 7.

²⁶⁹ See Chapter 4.

²⁷⁰ Author's translation from original quote in Spanish.

6.3.3 Quantitative assessment of the study on the adoption of modern groundwater abstraction technology in Manzanares

The preceding sections have provided qualitative insights into the Manzanares data set and the characteristics of the adoption of groundwater abstraction technology in La Mancha. This section further examines the relationship of pump technology, energy source and depth well against an identified inflection point in groundwater technology change. Given the unique nature and size of the Manzanares data set a regression model is specified that estimates the probability of occurrence of technology types, energy sources and groundwater depth variables occurring after the previously illustrated inflexion point in registrations of norias and boreholes in November 1975 (Figure 6.10). The results offer a useful approach to substantiate commonalities and differences with the qualitative findings. The sudden and sustained shift in groundwater registrations from late November 1975 drives this empirical analysis within the boundaries of the available empirical data. Understanding why November 1975²⁷¹ was such a pivotal date in the rapid transformation of groundwater abstraction in Manzanares is central to inform the wider research question on the role of the state in groundwater governance in Spain.

The choice of the date of 26th November 1975 reflects a visible point of inflection based on the Manzanares data set of over 1,000 observations between 1947 and 1985. This provides a useful watershed in the historical data to code the dependent variable in the model as ‘1’ after 26th of November 1975’ and ‘0’ otherwise. The model tests the likelihood of having a noria registered after 26th

²⁷¹ Francisco Franco died in Spain on the 19th of November 1975.

November 1975 against a range of independent variables available from a data set of 999 valid observations (Table 6.5).

Table 6.5 Regression model variables of groundwater abstraction technology in Manzanares

	<i>Variable name</i>	<i>Variable type</i>	<i>Variable description</i>	<i>Expected relationship to DV</i>
Dependent variable (DV)	Date	Dichotomous	Registration date of technology (0=before 26/11/75; 1= after 26/11/75)	
Independent variables (IV)	Noria	Dichotomous	Type of technology (0= Borehole; 1= Noria)	+ve
	Diesel	Dichotomous	Type of engine used (0= Electric; 1= Diesel)	+ve
	HP	Interval	Engine horsepower installed	+ve
	Less 20m	Dichotomous	Depth of well being less than 20 metres	-ve
	Greater 20m	Dichotomous	Depth of well being greater than 40 metres	+ve

Source: Author.

The dependent variables reflect the available data, which did not include socio-economic status, land holdings or other potentially significant predictors of adoption. Specification of the model follows the availability of data by groundwater abstraction technology (noria, borehole), energy used (diesel, electric), engine horsepower and depth. The depth of groundwater abstraction has a critical role related to technology and energy type. In preliminary models, depth had no significant relationship with the dependent variable which may be anticipated based on the wide range of depths. To better understand the transformation from shallow to deep wells two dichotomous variables that reflected the general trend of norias being fairly shallow due to

technical and design limitations (less than 20 metres) to later wells being substantially deeper (greater than 40 metres). This somewhat arbitrary distinction reflects the descriptive data and the evidence provided by the farmer informants.

The regression model results are presented in Table 6.6 with positive significant indicators of model fit. As such, the model has a reasonable explanatory power. Findings indicate that diesel engines, horsepower and deep wells are significant in predicting the likelihood of registration of modern boreholes from 26th November 1975. Inversely, the model predicts that there will be a smaller likelihood for wells being shallower than 20 metres after the 26th of November 1975.

Table 6.6 Logistic regression model of characteristics influencing the adoption of groundwater abstraction technology from 26th November 1975 in Manzanares (n=999)

<i>Variables</i>	<i>Coeff.</i>	<i>Std. error</i>	<i>Sig.</i>	<i>Exp(B)</i>
Noria	-0.655	0.409	0.109	0.520
Diesel	1.244	0.218	0.000***	3.470
Horsepower	-0.011	0.004	0.005***	0.989
Less than 20 metres	-0.569	0.308	0.065*	0.566
Greater than 20 metres	1.352	0.407	0.001***	3.866
Constant	1.365	0.388	0.000***	3.917

*Note: Hosmer and Lemeshow Test of significance (chi-square = 3.24, df=8, p.0.05, R sqd = 0.981); Nagelkerke model fit, pseudo R sqd = 0.22); Significant at less than 1 per cent***, 5 per cent ** and 10 per cent * levels.*

An unexpected result is that the variable ‘horsepower’ has a negative coefficient. Possible explanations for this result include the lack of geographical data about the location of the well in relation to the depth of the water table in the aquifer. The result suggests that the behaviour of the variable ‘horsepower’ may depend on factors other than well depth not included in the data available. Overall, the analysis largely consolidates the qualitative findings. As anticipated by the qualitative study, 1975 represents the inflexion point in traditional groundwater abstraction technology

and from that moment in time onwards it is less likely to find norias registered for Manzanares. This model contributes to the prediction of change in technology use for irrigation and the pace of change from November 1975 onwards.

6.4 Discussion: a new groundwater abstraction era in La Mancha

Following the study of the adoption of groundwater abstraction technology in La Mancha, it is possible to establish the general characteristics of traditional and modern groundwater lifting technologies based on a series of parameters referred to in previous sections of this chapter (Table 6.7).

Despite the preservation of land tenure disparities in La Mancha,²⁷² access to technology and groundwater abstraction was available to all, with a predominance of small and medium size landowners (more than 50 percent of landowners had farms between 5 to 30 hectares). In La Mancha, access to pumps helped raise yields and revenues for small and medium size farmers who decided to switch from dry-land farming to irrigation.²⁷³

²⁷² Castilla-La Mancha remained though a land of large estates, with a small number of landowners controlling most of the land. According to data from the National Office of Statistics, Sánchez Sánchez (2001) shows how in 1962, 59 percent of the land in Castilla-La Mancha was found in estates larger than 100 hectares. In 1972 it was 64 percent and in 1982 it was 65 percent.

²⁷³ This is also the case in South Asia, where “the pump revolution enabled farmers to stretch their tiny land holdings to provide subsistence for their families” (Shah 2009: 47).

Table 6.7 General characteristics of traditional and modern groundwater lifting technologies in La Mancha

	<i>Traditional water lifting technology</i>	<i>Modern water lifting technology</i>
Type of technology	Traditional animal-drawn noria	Vertical turbine pump and groundwater borehole
Type of irrigation system	Gravity-flow irrigation	Gravity-flow irrigation, sprinklers
Water abstraction	Low water abstraction	Intensive water abstraction
Profitability	Low revenues	Large revenues and high profitability
Technology ownership	Individual or family ownership	Individual or family ownership
Land plot size	Small family land plot	Small family land plot or large farm
Financial investment (*)	Private investment	Private investment, supported with bank loans and state subsidies
Crop type (*)	Vegetables, cereals, fruits	Cereals, vegetables, fruits, forage, industrial crops, vines
Commercialisation	Family consumption, economy of subsistence, local markets	Large commercialisation and potential export

Note: (*) See Chapter 7 for a more detailed analysis.

Source: Author.

As shown in this chapter, one of the drivers of the adoption of groundwater fed-irrigation was the lack of surface water and need to find secure and abundant water reserves for agriculture. As reflected by both interviews and data analysis, technology change for irrigation in Manzanares occurred initially with the adaptation of traditional water lifting technologies to new techniques (e.g. engines connected to the norias, or pumps added inside the *noria* shaft to lift water from the shallow aquifer). Following the description of the use of water lifting technologies in La Mancha, four stages in the evolution of technology for irrigation can be defined:

Stage 1: Traditional animal-drawn technologies to abstract groundwater (nineteenth century and early twentieth century).

Stage 2: Traditional groundwater abstraction technologies with technological ameliorations (early twentieth century to 1940s, use of iron norias and small engines attached to them).

Stage 3: Early use of modern technology for groundwater abstraction and coexistence with traditional water lifting technologies (starting with boreholes drilled by the INC in Llanos del Caudillo in the 1950s until 1975).

Stage 4: Extensive use of modern technology for groundwater abstraction and residual use of traditional technologies in some cases (1976 onwards).

Through these different stages it is possible to establish a process of technology adaptation and substitution involving: the improvement of norias (Stage 2); a transitional period of coexistence of traditional and modern groundwater technologies (Stage 3); and a process of technology substitution (Stage 4) with a certain set of variables in place (e.g. the need for deeper wells, profitability and high yield capacity of deep boreholes) making use of traditional technology obsolete. The crossover between traditional and modern water lifting technologies indicates a coexistence pattern between these two types of technology. Traditional norias were still in use until groundwater levels reached a certain depth, after which modern water

lifting technologies took over due to the benefits they would provide for farmers, the proliferation of state subsidies and high crop productivity and profits.²⁷⁴

Analysis of the data also corroborates the intensity and shortness of the modern groundwater abstraction technology boom – the so-called ‘silent revolution’. Modern groundwater lifting technology showed a much higher relative advantage than traditional norias and farmers moved slowly from awareness and knowledge of the innovation to full adoption of technology.

Groundwater abstraction technology was partially subject to endowed economic and financial capital due farmer’s lack of access to electric engines. Despite this, subsidies and large revenues from crop productivity allowed most farmers to pay back investments in groundwater lifting technologies. The historical availability of water lifting technology in small-scale irrigation schemes as well as state-sponsored colonisation plans in La Mancha also affected the development of groundwater abstraction technology. Moreover, state-sponsored financial credit, subsidies and incentives for private irrigation established positive initial conditions that sustained the development of modern groundwater abstraction technology. It is this aspect that will be the focus of the following chapter.

²⁷⁴ See Chapter 7 for further explanations on state subsidies for irrigation.

Chapter 7 . Irrigation socio-ecologies, the state and the production of groundwater scarcity in La Mancha

7.1 Introduction

As seen in the preceding chapters, the development of irrigation technology at the local level and by the state has been studied separately. The state's use of irrigation and colonisation policies took the form of direct control over irrigation and society in La Mancha, and state intervention through hierarchical and direct rule over new 'irrigation subjects' in colonised areas (Chapter 4 and 5). Conversely, at the community level, the adoption of groundwater abstraction technology (Chapter 6) reflected an individual process of technology development based on a number of factors (both technical and environmental). This final chapter unifies these disparate aspects by exploring how a set of indirect state rules and policies aimed to develop and promote the private initiative of farmers in the development of modern irrigation and agriculture.

This chapter shows how through indirect state rule (public subsidies from the Ministry of Agriculture, as well as a legal framework allowing the preservation of private abstraction rights), intensive groundwater-fed irrigation prospered in La Mancha for over 30 years. This production of modern irrigated groundwater socio-ecologies also had a clear impact on the environment, leading to the production of water scarcity through a lack of regulation and control of groundwater abstractions.

This last chapter also assesses the impact of state-sponsored policies and subsidies for the development of irrigation and modern agriculture on the aquifer.

The second section of this chapter examines the role of the state in the creation of agrarian associations of farmers, the sponsorship of private investment in agriculture, and irrigation modernisation through agrarian credits, loans and direct and indirect subsidies for agriculture. The following section looks at the development of public water legislation, particularly the reform of the historical 1879 Water Law in 1985, other means of regulating groundwater abstraction rights. The last section investigates the production of irrigation socio-ecologies in La Mancha and the impact of intense use of groundwater abstraction technology on the environment, focusing particularly on the decreasing levels of the water table in the Mancha Occidental aquifer and disappearing flooded surface of the Las Tablas de Daimiel wetland.

7.2 The state and agriculture in Spain: subsidies and publicly sponsored private irrigation

7.2.1 State-sponsored agrarian credits and loans

As Douglass North (1992) suggests, the role of the state is essential for the development of financial markets in rural areas with low economic and financial means. In Spain, the state's capacity to finance irrigation and colonisation projects represented a key element in the development of the agrarian reform after the Civil War (Abad and Naredo 1997). The modernisation of irrigation technology through subsidies and credit had important implications for the development of private

irrigation. Money was funnelled from the central government to local communities through private saving banks and agrarian credit cooperatives.

Before the Civil War, the National Service of Agrarian Credit²⁷⁵ (SNCA) managed the availability of agrarian loans for farmers. The reform of the republican SNCA by the dictatorship in 1946²⁷⁶ allowed the transformation of this organisation into an entity that would help different agrarian sectors with emergency credits and loans (Martínez Soto et al. 2008). At the same time, the 1942 Law of Cooperation²⁷⁷ allowed the creation of credit cooperatives and rural saving banks (*Cajas Rurales*).²⁷⁸

After the Civil War, Franco's regime abolished all syndicates, social and professional representational structures and replaced them with the vertical syndicate. The aim of the vertical syndicate was to bring together workers and entrepreneurs under a single and unitarian structure controlled by the state. The organisation worked to repress social conflict at work and beyond, establish salaries, repress workers' rights, and create an artificial and completely rigid work market (Castelló Muñoz 1972). These structures were divided into 28 different economic activities, each with a national and provincial structure. In the case of agriculture, the vertical syndicate was complemented by the Official Syndical Chambers of Agriculture where the

²⁷⁵ Language note: 'Servicio Nacional de Crédito Agrícola' in the original Spanish language.

²⁷⁶ Law of 17th of July 1946. BOE, 18th of July 1946, No.199, pages 5639-5641.

²⁷⁷ BOE, 2th of January 1942, No.12, pages 219-227.

²⁷⁸ The '*Cajas Rurales*' are financial cooperatives established in order to manage the savings of its members and grant credits in order to finance agrarian operations. The origin of agrarian associations in Spain follows the Law of Agrarian Unions in 1906 (Martínez Soto and Martínez Rodríguez 2006; Planas Maresma 2003). Before this date the development of agrarian associations had been very weak: the right of social association was only established in 1869 and the first legal text regulating the creation of agrarian associations (i.e. agrarian chambers) appeared in 1890 (Planas Maresma 2003). These were created by royal decree in 1890 as associative entities aiming at supporting the development of agriculture through the initiative of its members. The chambers would perform a consultative role with regards to its members (i.e. ensuring that the interests of its members were heard and respected) but also a cooperative role, establishing credits and money lending schemes through for its members (*ibid.*). After the First World War, agrarian cooperatives benefitted from the support and activity of large landowners aiming to gain support, protection and benefits for growing cereal as well as to fund activities and subsidize agrarian inputs (e.g. fertiliser or machinery) (Martínez Soto and Martínez Rodríguez 2006; Pan-Montojo 2002).

Brotherhoods of Farmers and Livestock Owners²⁷⁹ were also integrated. Such organisations represented the only institutional structures at the municipal level apart from the town halls (*ibid.*). The Syndical Brotherhood of Agriculture and Livestock owners, the Official Agrarian Syndical Chambers and the National Syndical Brotherhood of Farmers and Livestock Owners integrated both the local syndicates and brotherhoods at the national level (*ibid.*).

As Martínez Soto et al. (2008: 2) point out, the 1940 Law of Syndical Organisation gave vertical syndicates “the control, patronage and development of cooperatives.” Thus, it was conceived that cooperativism had no place in the new state, seen by the Falangists as vertical and corporativist. The Law of Cooperation of the 2nd of January 1942 hierarchically organised the cooperatives around the Syndical Organisation of the Movement, thus transforming these organisations into another instrument in the hands of the state to regulate and control society politically and economically (*ibid.*). Local cooperatives thus became a local appendage of the Brotherhoods of Farmers and Livestock Owners, which were turned into “true local powers with certain levels of autonomy given their control by the Falangist movement” (Martínez Soto et al. 2008: 4).²⁸⁰ Public organisations (the brotherhoods) and private organisations (the cooperatives) shared interests, funds and even regulation structures and therefore the divide between them became 'fictional' (Martínez Soto et al. 2008).

²⁷⁹ These were representative organisations for the protection of interests of farmers and livestock owners. These were structured locally, regionally and nationally and acted as syndical trade unions, providing technical guidance and administrative support to farmers and livestock owners. Although the National committee of Brotherhoods was created in 1947, the complete organizational and pyramidal structure of the franquist Brotherhood of Farmers and Livestock owners was completed in 1967 with the National Brotherhood Syndicate of Farmers and Livestock Owners. This body coordinated the local and provincial brotherhoods as well as the agrarian syndical chambers (Gil García 2005).

²⁸⁰ Author's translation from original quote in Spanish.

This period also saw the expansion of the number of cooperatives, with an annual growth rate in the number of cooperatives of 9.65 percent (*ibid.*). On the contrary, the previous period of 1923-1942, coinciding with the dictatorship of Primo de Rivera,²⁸¹ the Second Republic and the Civil War, had a negative annual growth rate of minus 3.93 percent. A new law in 1951²⁸² gave greater credit responsibility to the SNCA, and a subsequent law in 1954²⁸³ extended the initial amount of 1,000 million pesetas²⁸⁴ entrusted to the SNCA by another 1,500 millions. The initial stages of this period of state-sponsored agrarian initiative reached 300,000 farmers and contributed, “to the initial stages of mechanisation and funding of new irrigation schemes” (Martínez Soto et al. 2008: 18).²⁸⁵ The law of 1954 also modified the credit limit for farmers and individual loans to up to 500,000 pesetas²⁸⁶ in case when, “its purpose would be the realisation of improvement works in agrarian exploitations and the establishment of loans for the acquisition of agrarian machinery that would stimulate the mechanisation of the countryside” (*ibid.*).²⁸⁷ Between 1947 and 1961, 1,106,000 farmers benefited from 8,272 credits granted to collective agrarian entities and 300,290 individual loans representing a total investment of 16,084 million pesetas²⁸⁸ (Martínez Soto et al. 2008) (Figure 7.1).

²⁸¹ With the dictatorship of Primo de Rivera, the agrarian chambers were given more power within the financial and political state structure of agrarian credit. In 1929, a royal decree re-organising the national credit services (*Servicio Nacional de Crédito Agrícola*) granted a seat in its governing body to the agrarian chambers and other representatives from local agrarian unions. It also gave the agrarian chambers priority over the agrarian credits of larger amount (Pan-Montojo 2002).

²⁸² Law of 17th of July 1951 modified some articles of the Law of 17th of July 1946 related to Agrarian Credit. BOE, 18th of July 1951, No.199, pages 3377-3378.

²⁸³ Law of 30th of March about modifications of the Law of Agrarian Credit. BOE, 31st of March 1954, No. 90, pages 1950-1951.

²⁸⁴ Equivalent to approximately 91.3 million USD in 1954 (with the currency exchange rate peseta/USD in 1954 = 10.95. Carreras de Odriozola and Tafunell Sambola 2006).

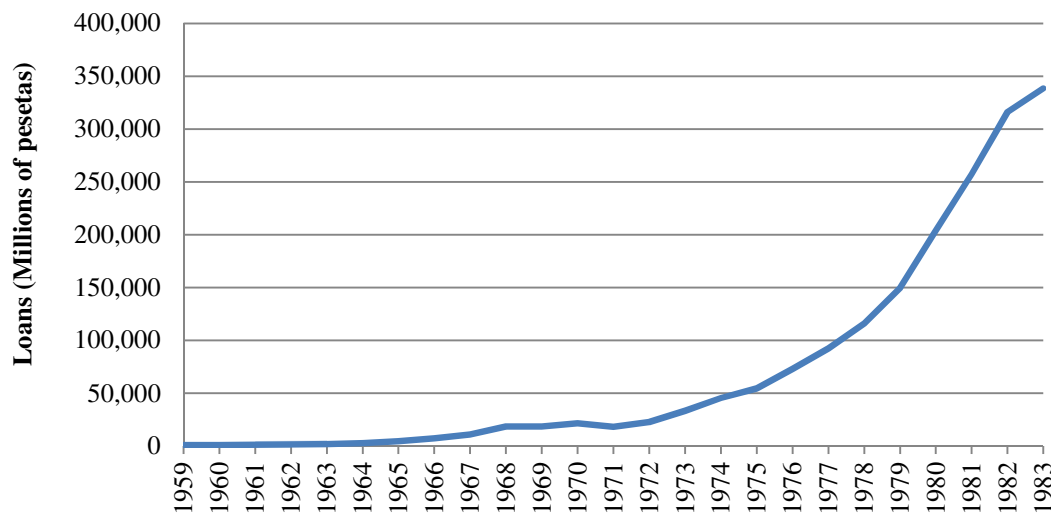
²⁸⁵ Author’s translation from original quote in Spanish.

²⁸⁶ Equivalent to approximately 45,600 USD in 1954 (with the currency exchange rate peseta/USD in 1954 = 10.95. Carreras de Odriozola and Tafunell Sambola 2006).

²⁸⁷ Author’s translation from original quote in Spanish.

²⁸⁸ Equivalent to approximately 267 million USD in 1961 (with the currency exchange rate peseta/USD in 1961 = 60.25. Carreras de Odriozola and Tafunell Sambola 2006).

Figure 7.1 Evolution of loans from rural savings banks to farmers in Spain (1959-1983)



Source: Based on data from Martínez Soto et al 2008.

A new reform in 1962, the Law 2/1962 for the foundation of organisation of credit and banks,²⁸⁹ represented an important change for the financial and agrarian economic system in Spain. As Martínez Soto et al. (2008) make clear, the Bank of Agrarian Credit²⁹⁰ replaced the SNCA, giving a renewed impulse to agrarian credit and helped create the provincial rural saving banks.²⁹¹ Thus, at the end of the 1960s, the provincial rural saving banks controlled 72.4 percent of agrarian financial resources (*ibid.*).²⁹²

The Bank of Agrarian Credit also had specific credit lines for agrarian cooperatives, syndicalist organisations and its members (González del Barrio 1976). The Bank of Agrarian Credit was the most important agrarian credit organisation, lending money to rural saving banks and the INC (Table 7.1). As shown in Figure

²⁸⁹ Language note: 'Ley de Bases de Organización del Crédito y de la Banca' in the original Spanish language. Law 2/1962 of 14th of April. BOE, 16th of April 1962, No.91, pages 5091-5095.

²⁹⁰ Language note: 'Banco de Crédito Agrícola' in the original Spanish language.

²⁹¹ Language note: 'Cajas Rurales Provinciales' in the original Spanish language.

²⁹² Due to its small size, the Provincial Rural Saving Banks were united in 1974 with the creation of the *Consortio Nacional de las Cajas Rurales Provinciales* (National Consortium of Provincial and Rural Saving Banks) helping harmonise and coordinate the operations of the Cajas (Martínez Soto et al. 2008).

7.2, private savings banks received the majority of agrarian credits granted by the Bank of Agrarian Credit (from over 70 percent in the mid 1960s down to 45 percent in the late 1970s).

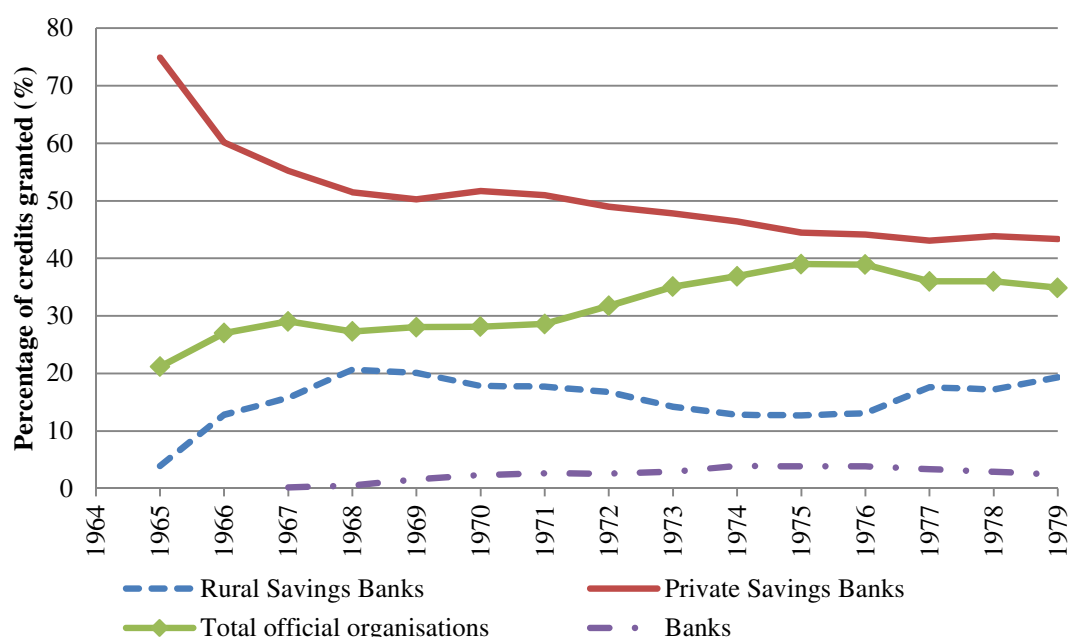
Table 7.1 Amount of credit granted by banks and other agrarian financial institutions in Spain for agricultural activities

	<i>1967</i>		<i>1968</i>		<i>1969</i>		<i>1970</i>	
	Millions of pesetas	%	Millions of pesetas	%	Millions of pesetas	%	Millions of pesetas	%
Bank of Agrarian Credit	10,064	66.54	12,885	66.99	13,226	67.41	14,536	69.35
Mortgage Bank	75	0.50	414	2.15	371	1.89	390	1.86
INC	1,766	11.68	1,416	7.36	1,533	7.82	1,427	6.81
National Service of Land Concentration and Rural Planning	374	2.47	486	2.53	819	4.18	869	4.14
National Service of Cereals	2,815	18.61	4,034	20.97	3,670	18.70	3,740	17.84
National Service of Cultivation and Fermentation of Tobacco	30	0.20	0.2		1.2			
Total	15,124	100	19,235.2	100	19,620.2	100	20,962	100

Note: In this table the original names of the financial organisations and banks have been translated into English. The original names are the following: Bank of Agrarian Credit is '*Banco de Crédito Agrario*'; Mortgage Bank is '*Banco Hipotecario*'; National Service of Land Concentration and Rural Planning is '*Servicio Nacional de Concentración Parcelaria y Ordenación Rural*'; National Service of Cereals is '*Servicio Nacional de Cereales*'; National Service of Cultivation and Fermentation of Tobacco is '*Servicio Nacional de Cultivo y Fermentación del Tabaco*'.

Source: Castelló Muñoz 1972.

Figure 7.2 Percentage of credit granted by the Bank of Agrarian Credit to other financial organisations in Spain (1966-1979)



Source: Based on data from Martínez Soto et al. 2008.

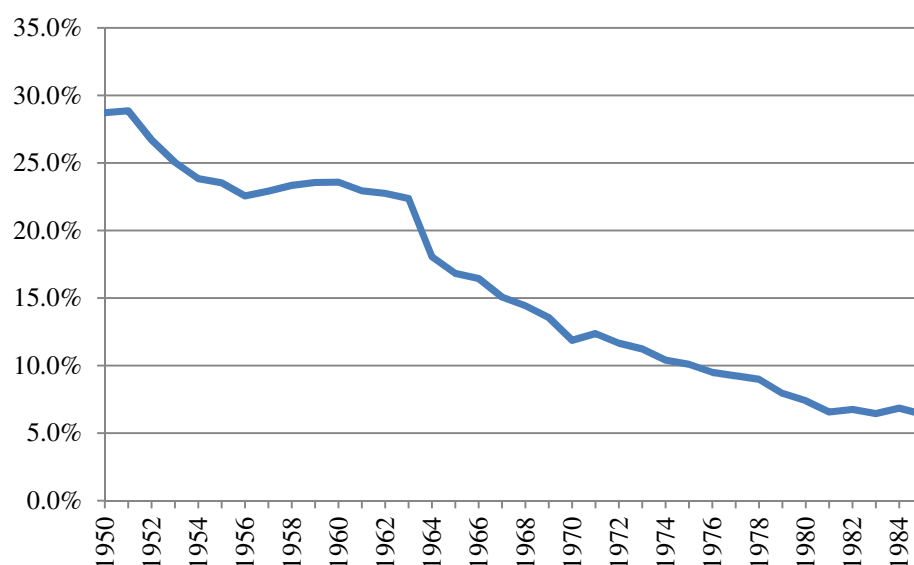
The *Servicio Nacional de Concentración Parcelaria* (National Service of land plot concentration) granted credits for the purchase of livestock, machinery, new equipment and installations, and acquisition of land. From 1967 to 1970, of the total credit granted by the Bank of Spain to different financial organisations (agrarian and non agrarian), 68 percent was for agrarian organisations and 32 percent for non-agrarian organisations (Castelló Muñoz 1972) (Table 7.1). Furthermore, private funding for agrarian activities came from private banks, private savings and rural banks, and the level of credit granted by these organisations represented a small part of their credit activities (*ibid.*). According to national data from 1967 to 1970, the amount of credit for agrarian activities coming from private banks fell from 5.49 percent to 4.12 percent in 1970. In terms of business and credit percentage, credits to the agrarian sector represented 18.31 percent of the total credits of private saving banks in 1970 (Castelló Muñoz 1972). Although these numbers might seem low, they

have to be contextualised within the wider process of economic recovery and development at the national level (Martínez Soto et al. 2008). The *Cajas de Ahorros* (private saving banks) had a strong local and provincial presence in the Spanish countryside and were linked to the social and economic structure of rural areas (*ibid.*).

7.2.2 State subsidies for agriculture in Spain

For the first two decades after the Civil War, a regime of international autarchy and rigid interventionism in agriculture caused a decrease in production, productivity and wealth in the country (Fernandez García 2008). In the 1960s, the beginning of industrialisation and economic growth brought a decrease in the number of agrarian workers (from almost 50 percent of the total population in 1949 to 17 percent in 1980) (Cruz-Villalón 1987). Moreover, there was a reduction in the size of the primary sector from almost 30 percent of Spain's GDP in 1950 to around 6 percent in 1985 (Figure 7.3). Due to these macroeconomic changes, state intervention in agriculture and subsidies were increased in order to protect the sector and maintain levels of income (Fernández García 2008). To increase the productivity and competitiveness of the Spanish agrarian sector, direct subsidies to incentivise farmers began in 1957. These were increased by 50 percent in 7 years, such that subsidies represented 2 percent of agrarian production in 1965 and 11 percent of the total public expenditure (Table 7.2).

Figure 7.3 Evolution of the percentage of the primary sector size in Spain's GDP (1950-1985)



Source: Author based on data from Barciela López 2005: 1347-1348.

Table 7.2 Subsidies and public investment for agriculture in Spain (1957-1985)

Year	Subsidies (millions of pesetas)	Public investment (millions of pesetas)	Percentage of production value		Subsidies for farmers (per capita)	Total transfers as percentage of total public expenditure
			Subsidies	Public investment		
1957	1,338		0.1			0.1
1960	28,491	112,579	1.3	5.3	6,066	8.9
1965	51,729	197,461	2	7.7	11,915	10.7
1970	68,678	168,347	2.6	6.3	18,002	5.3
1975	93,866	207,326	4.3	9.5	30,851	4.9
1980	110,038	188,453	5.1	8.7	51,929	3.1
1985	135,048	153,173	7	7.9		

Source: Fernández García 2008: 19.

During the 1960s and 1970s, protection of agriculture and production and commercialisation of agrarian products were controlled by the state. This was achieved through high import taxes for external products (e.g. 45 percent for wheat), compensatory payments for agricultural production, establishment of retail prices, the

guarantee of purchase and control of stocks and storage by the Ministry of Agriculture (Fernández García 2008).

The Second Development Plan (1968-1972) specifically emphasised the goal of increasing farmers' income through the control of prices and the supply and demand of agrarian products (*ibid.*). As a consequence of this Second Plan the government doubled the level of subsidies to farmers for production inputs such as fuel (Table 7.3). Subsidies reached 95,000 million pesetas²⁹³ in 1975, representing 4.3 percent of the value of agrarian production. This represented a subsidy per capita for farmers of around 30,000 pesetas which increased to over 50,000 pesetas per farmer in 1985 (Table 7.2). In 1985, the value of subsidies as percentage of agrarian production value had risen to 7 percent.

Table 7.3 Subsidies directly transferred by the Ministry of Agriculture to farmers (1967-1975) (in millions of pesetas)

	<i>1967-1969</i>	<i>1970-1972</i>	<i>1973-1975</i>
Payments for production	21	33	22
Maintenance of prices	25	65	75
Private or public storage	75	18	12
Payments for inputs	70	58	62
Fuel	75	73	81
Seeds and fertilisers	12	15	10
Treatments against plagues	8	8	3
Plan for amelioration of livestock	6	4	5
Others	9	8	15

Source: Ministry of Agriculture 1977 in Fernández García 2008: 22.

²⁹³ Equivalent to approximately 1,593 million USD in 1975 (with the currency exchange rate peseta/USD in 1975 = 59.64. Carreras de Odriozola and Tafunell Sambola 2006).

7.2.3 State-sponsored fuel production and diesel subsidies for agriculture: back to the groundwater-energy nexus

After the Civil War, the political, economic and social groups that had supported Franco's uprising believed that Spain had to be self-sufficient, "in as many areas of production as possible" (San Román and Sudria 2003: 76). Production of synthetic fuels (e.g. diesel) was the responsibility of ENCASO, a body created in 1942 as part of the state-owned industrial holding National Institute of Industry (INI), with the objective to control industrial production in strategically important sectors (*ibid.*). After its creation in 1942, ENCASO put forward a proposal to build four different sites dedicated to the manufacture of synthetic fuels between 1944 and 1947 (*ibid.*).²⁹⁴

Synthetic fuel produced by ENCASO was commercialised by a state monopoly. The retail price was controlled by the government and managed by CAMPSA, a privately owned company closely supervised by the Ministry of Finance (Garcia de Coca 1992). CAMPSA was created in 1927 to nationalise the oil industry during the dictatorship of Primo de Rivera (*ibid.*). CAMPSA would receive a compensation for managing the monopoly, a proportion of the margin generated between the standard retail price and the tax revenue (Garcia de Coca 1992; San Román and Sudria 2003). However, due to its high costs (80 percent higher than imported fuels) and a timid move from state protectionism to the liberalisation of domestic markets in the early 1960s,²⁹⁵ the national production of synthetic fuels gradually disappeared in favour of the more cost-effective imported oil-based

²⁹⁴ Of those four sites, the Puertollano plant in Castilla-La Mancha using shale as raw material was the most detailed and ambitious project, with an investment cost of 600 million pesetas (45 million USD) (San Román and Sudria 2003).

²⁹⁵ Due to the Stabilisation Plan of 1959 and the IBRD Report from 1962, see Chapter 5.

products. In 1966, the plant at Puertollano closed all its facilities previously used for the treatment of shale (*ibid.*).

In Spain, the loss of energy auto-sufficiency negatively affected the agrarian sector by increasing dependency on foreign markets (Ortega Cantero 1983). Energy costs for agrarian machinery increased in percentage of total costs from 15 percent in 1964 to 23 percent in 1981 (*ibid.*). As a result, subsidies for fuels and diesel continued and different decrees were issued by the state and the Ministry of Finance to subsidise the price of diesel for agriculture (i.e. for tractors and irrigation pumps). The Decree of 21st of December 1956 gave authorisation to the Ministry of Finance to establish over two years a monthly subsidy, to be allocated to the Ministry of Agriculture, as compensation for the price of diesel for tractors.²⁹⁶ Moreover, the Order of the 11th of January 1957 put into effect the Decree of 21st of December 1956²⁹⁷. Article 12 of this order established a tax exemption of 1.0 peseta²⁹⁸ per litre over the total price of 4.0 pesetas²⁹⁹ per litre for diesel consumers for agriculture. The consumers would benefit from such exemption by using coupons issued by the Ministry of Agriculture. At the end of the two-year period granted by the Decree of the 21st of December, the government issued a new order on the 27th of May 1958 extending the subsidy and regulation of prices for diesel for tractors and irrigation pumps.³⁰⁰ These decrees and orders, along with Decree 1303 in 1959 created and regulated subsidies and tax exemptions for diesel supplied by the Monopolistic Company of Petroleum for

²⁹⁶ Article 5. Decree of 21st of December 1956. BOE, 31st of December 1956, No.366, pages 8231-8232.

²⁹⁷ Order of 11th of January 1957. BOE, 15th of January 1957, No.15, pages 285-286.

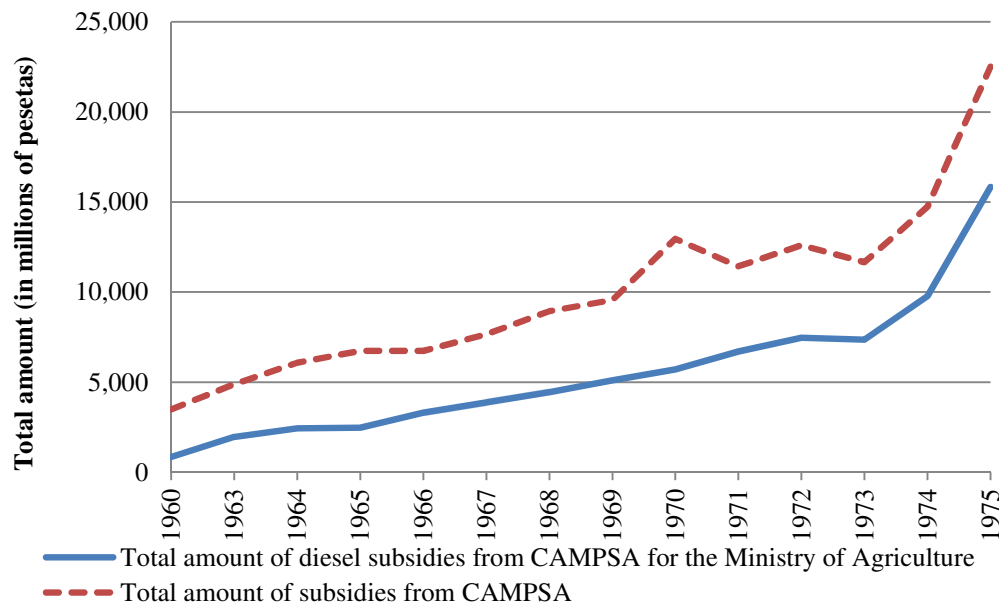
²⁹⁸ Equivalent to approximately 0.09 USD in 1956 (with the currency exchange rate peseta/USD in 1956 = 10.95. Carreras de Odriozola and Tafunell Sambola 2006).

²⁹⁹ Equivalent to approximately 0.3 USD in 1956 (with the currency exchange rate peseta/USD in 1956 = 10.95. *ibid.*).

³⁰⁰ Order of 27th of May 1958. BOE, 3rd of June 1958, No.132, page 1000.

agricultural activities.³⁰¹ Figure 7.4 depicts the total amount in millions of pesetas per year of the subsidy for diesel in agriculture (including the amount in cash or vouchers and tax exemption) granted by CAMPSA to the Ministry of Agriculture.

Figure 7.4 Diesel subsidies from CAMPSA to the Ministry of Agriculture (1960-1975)



Note: Total amount of diesel subsidies from CAMPSA for the Ministry of Agriculture includes diesel price subsidy in pesetas and also fuel tax exemption in pesetas.

Source: Author based on data from *Memorias Anuales de la Delegacion del Gobierno en CAMPSA* (CAMPSA various years).

In 1973, the Ministry of Finance issued another regulation given the considerable increase in fuel and diesel consumption in agriculture as a consequence of the mechanisation of the countryside.³⁰² This new legislation stated that all compensation and subsidies would be effectuated in cash after the 1st of August 1973 either at the commercial offices or branches of the company, or at specific credit entities designated by CAMPSA. Additionally, the Ministry of Agriculture would suggest to the Ministry of Finance the amount of diesel to be subsidised. The structure

³⁰¹ Order of 3rd of June 1973. BOE, 20th of July 1973, No.173, page 14789.

³⁰² *ibid.*

and system of diesel subsidies for agriculture was put to an end, however, in October 1975 when the Ministry of Finance cancelled the regime of subsidies and cash vouchers replacing it with a system of free market consumption.³⁰³

7.2.4 Irrigating by decree: the IRYDA and the promotion of private irrigation by the state

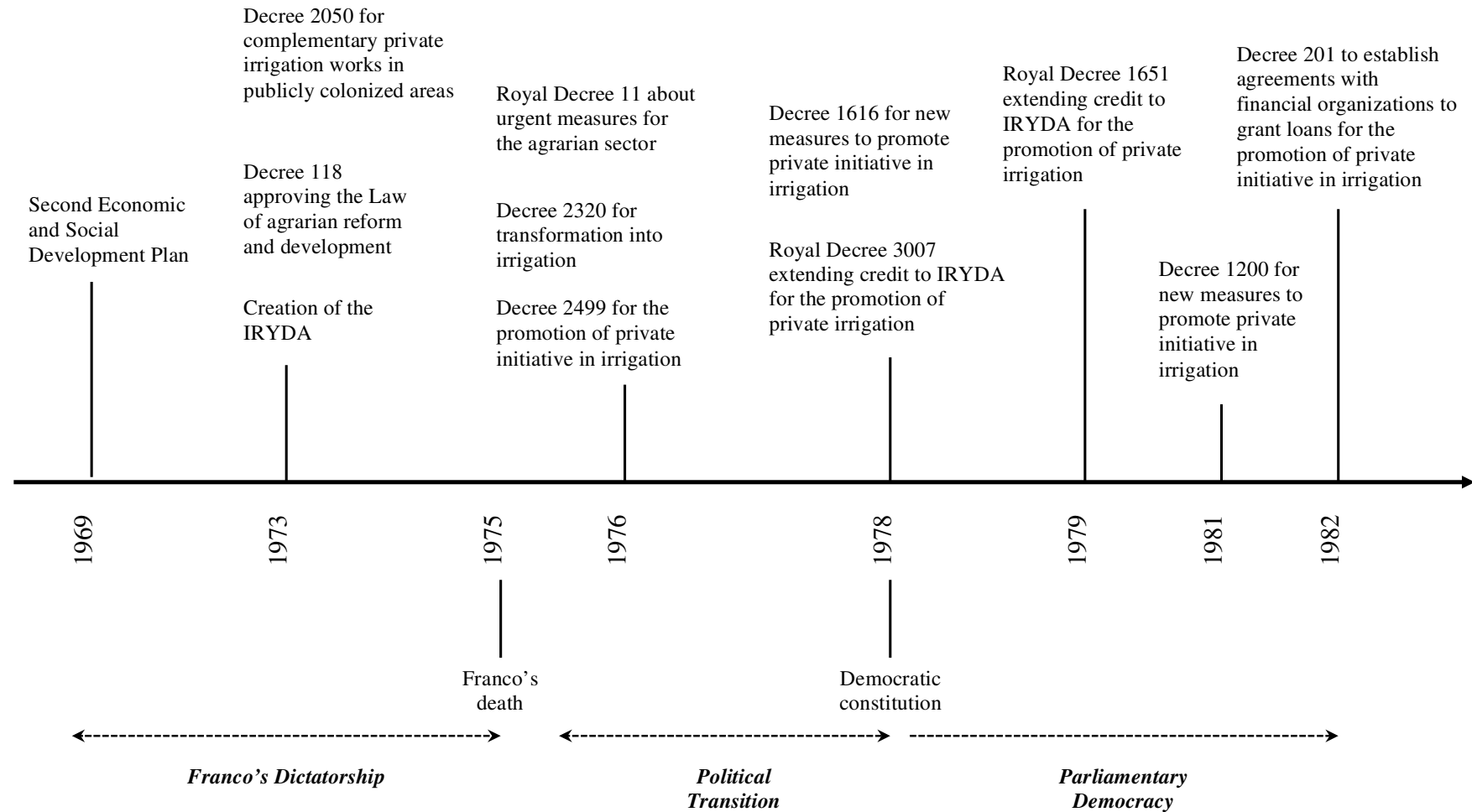
In 1969, the technocratic government of Franco approved the Second Economic and Social Development Plan.³⁰⁴ Its main objectives for agriculture were to develop and improve the productivity and efficiency of the agricultural sector, and to increase the livelihoods of people depending on agriculture. This would be translated into a series of specific public interventions and projects in order to revitalise the agrarian sector. One of the activities included in this plan was to ameliorate and modernise 90,000 irrigated hectares and irrigate 290,000 new hectares (Gómez Manzanares 1971). Subsequent state decrees following the Second Economic and Social Development Plan aimed at ensuring the capitalisation of farm units and improving farmers' access to investment capital by restructuring and consolidating agrarian credits and loans granted by the state through the IRYDA (Figure 7.5 and Figure 7.6). The IRYDA was created in 1973 by Decree 118³⁰⁵ approving the Law of Agrarian Reform and Development issued on the 12th of January 1972. Part of its mandate was to promote the constitution of cooperatives and syndicalist groups in order to stimulate agrarian enterprise as well as private works for the modernisation of irrigation systems.

³⁰³ Order of 6th of October 1975. BOE, 30th of October 1975, No.260, page 22735.

³⁰⁴ Law 1/1969 of 11th of February. BOE, 12th of February 1969, No.37, pages 2137-2142.

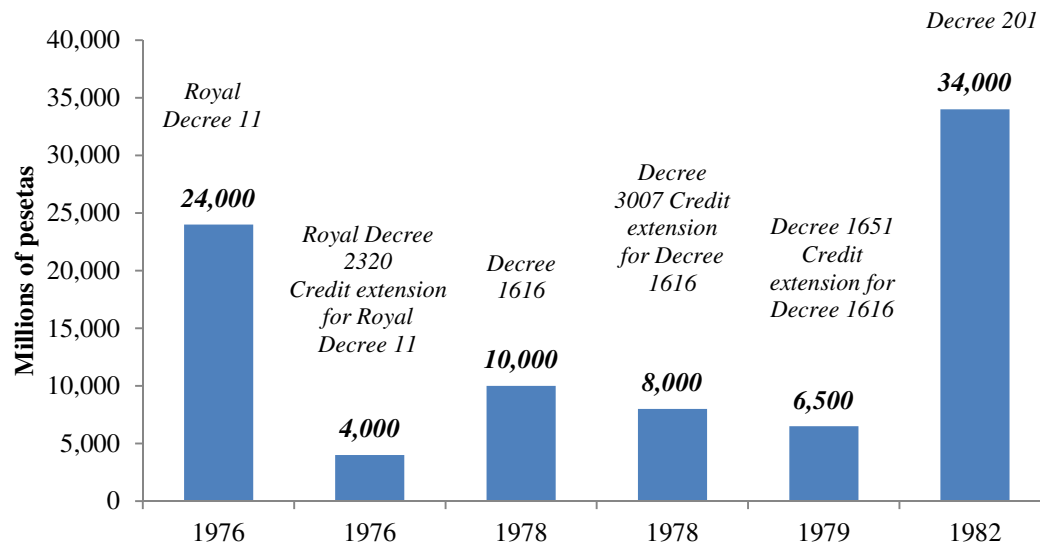
³⁰⁵ Decree 118/1973 of 12th of January. BOE, 3rd of February 1973, No.30, pages 1990-2026.

Figure 7.5 Chronology of state decrees sponsoring private initiative in irrigation



Source: Author.

Figure 7.6 Amounts granted by state decrees to IRYDA to promote private irrigation in Spain



Source: Author based on Royal Decrees 11/1976; 2320/1976; 1616/1978; and Decrees 3007/1978; 1651/1979; 201/1982.

Following article 68 of the newly enacted 1973 Law of Agrarian Reform and Development, Decree 2050 in 1973³⁰⁶ aimed at sponsoring private irrigation works in publicly colonised areas (e.g. La Mancha and Sector I) by allowing, supervising and funding new irrigation works requested by settlers. Additionally, with Decree 2499 in 1973³⁰⁷ special funds were made available to individual farmers wishing to transform more land into irrigation or improve existing infrastructure and technologies. Loans granted by private rural savings banks with interest rates above 4.5 percent would be subsidised by the IRYDA (Figure 7.7).^{308, 309}

³⁰⁶ Decree 2050/1973 of 5th of July. BOE, 5th of September 1973, No.213, page 17543.

³⁰⁷ Royal Decree 2499/1976 of 15th of October. BOE, 5th of November 1976, No. 266, page 21820-21821.

³⁰⁸ Of the 17 semi-structured interviews conducted in La Mancha in June 2011, 10 interviewees (58.8 percent) asked for a credit to drill their first well.

³⁰⁹ The initial investment for a farmer to drill a borehole would vary depending on the depth of the water table, access to capital and technology by local drilling companies. However it is possible to find an estimate of the drilling costs in La Mancha in Serna and Gaviria's (1995) study of groundwater abstraction technologies in Daimiel: diesel engine 6 cylinders – 1,000,000 pesetas (equivalent to approximately 8,000 USD with the currency exchange rate peseta/USD in 1995 = 124.73. Carreras de Odriozola and Tafunell Sambola 2006); Pump 5 inches – 800,000 pesetas (equivalent to approximately 6,400 USD with the currency exchange rate peseta/USD in 1995 =

According to Decree 2499 for the promotion of private initiative in irrigation,

“loans could reach 70 percent of the total investment, not exceeding 20 million pesetas in the case of individual farmers, or 40 million pesetas in the case of Cooperatives, Syndicalist Groups of Colonisation, Communities of Irrigators or other agrarian associations”.³¹⁰

Individual farmers would apply directly to the IRYDA, either through its provincial offices or through the provincial or municipal offices of the Agrarian Chambers.³¹¹ The IRYDA would then present the farmer's application to a private savings bank, which would then establish the type and terms of the loan. Based on the loan, the IRYDA would then establish the amount of the subvention granted to the farmer.

124.73. *ibid.*); Drilling 100 metres – 1,000,000 pesetas (equivalent to approximately 8,000 USD with the currency exchange rate peseta/USD in 1995 = 124.73. *ibid.*); Irrigation pipes and sprinklers for an 8-hectare land plot – 1,200,000 pesetas (equivalent to approximately 9,600 USD with the currency exchange rate peseta/USD in 1995 = 124.73. *ibid.*).

³¹⁰ Author's translation from original quote in Spanish. Equivalent to approximately 292,000 USD and 585,000 USD (with the currency exchange rate peseta/USD in 1976 = 68.31. *ibid.*).

³¹¹ José Ramón Aragón, personal communication, 9th of August 2012.

Figure 7.7 Information leaflet for Decree 2499 in 1976



Note: The title of the leaflet reads “Private initiative. Farmer!!”

Source: Archive, Ministry of Agriculture.

Royal Decree 2320 in 1976³¹² granted IRYDA a public loan of 4,000 million pesetas³¹³ in order to increase privately irrigated areas in Spain and continue with the modernisation of irrigation systems and techniques. This decree gave the IRYDA special funds to sponsor and subsidise private initiatives for the transformation of dry land into irrigation.³¹⁴ In 1976, the state issued Royal Decree 11³¹⁵ with urgent measures for the agrarian sector to be prioritised by the Ministry of Agriculture. This included the promotion and subsidy of national agriculture in areas affected by poverty and unemployment, as well as the development of modern irrigation techniques.

³¹² Royal Decree 2320/1976 of 24th of August 1976. BOE, 7th of October 1976, No.241, page 19559-1960.

³¹³ Equivalent to approximately 58.5 million USD (with the currency exchange rate peseta/USD in 1976 = 68.31. Carreras de Odriozola and Tafunell Sambola 2006).

³¹⁴ Following Article 2 of Royal Decree 2320/1976.

³¹⁵ Royal Decree 11/1976 of 30th of July. BOE, 4th of August 1976, No.186, page 15098.

With Decree 2499 from 1976 expiring on the 1st of December 1977, Decree 1616 in 1978³¹⁶ extended the financial conditions for the promotion of private irrigation by granting a supplementary credit of 10,000 million pesetas³¹⁷ to IRYDA for the transformation of land into irrigation. This credit was to be granted to farmers through financial and credit organisations. That same year, Royal Decree 3007³¹⁸ enacted a further credit extension by the state, giving an additional 8,000 million pesetas to the IRYDA.³¹⁹ However, the demand for loans following Decree 1616 was larger than the original amount granted.³²⁰ In view of such success, the state through the Ministry of the Presidency, issued Decree 1651³²¹ in 1979 with a further credit extension of 6,500 million pesetas.³²²

In 1981, Decree 1200³²³ extended state Decrees 2499 and 1616 to promote private initiative in irrigation. This decree formalised and codified the relationship between the IRYDA and other private financial organisations, granting credits and loans for the transformation of land into irrigation. Decree 1200 also regulated different payment methods, interest rates and payment instalments of loans given by the rural savings banks. The Royal Decree 201 of 1982³²⁴ complemented Decree 1200 and granted an amount of 34,000 million pesetas³²⁵ to the IRYDA in order to establish

³¹⁶ Royal Decree 1616/1978 of 2nd of June. BOE, 7th of July 1978, No.161, pages 16151-16152.

³¹⁷ Equivalent to approximately 130 million USD (with the currency exchange rate peseta/USD in 1978 = 76.67. Carreras de Odriozola and Tafunell Sambola 2006).

³¹⁸ Royal Decree 3007/1978 of 1st of December. BOE, 23rd of December 1978, No.306, pages 29032-29033.

³¹⁹ Equivalent to approximately 104 million USD (with the currency exchange rate peseta/USD in 1978 = 76.67. Carreras de Odriozola and Tafunell Sambola 2006).

³²⁰ As stated in the preamble of Royal Decree 1651/1979 of 1st of June. BOE, 5th of July 1979, No.160, page 15325.

³²¹ *ibid.*

³²² Equivalent to approximately 97 million USD (with the currency exchange rate peseta/USD in 1979 = 67.12. Carreras de Odriozola and Tafunell Sambola 2006).

³²³ Royal Decree 1200/1981 of 22nd of May. BOE, 23rd of June 1981, No.149, page 14356-14357.

³²⁴ Royal Decree 201/1982 of 15th of January. BOE, 4th of February 1982, No.30, page 2807.

³²⁵ Equivalent to approximately 309 million USD in 1982 (with the currency exchange rate peseta/USD in 1982 = 109.92. Carreras de Odriozola and Tafunell Sambola 2006).

agreements with financial and credit organisations to grant loans for the promotion of private initiation in irrigation.

7.3 The state and groundwater legislation

7.3.1 Historical regulation of groundwater abstraction rights: the Water Law of 1879

As a result of liberal revolutions in the second half of the nineteenth century in Spain,³²⁶ groundwater abstraction rights were codified in the law as linked to ownership and property of the land according to the original 1879 Water law.³²⁷ According to this law, groundwater was excluded from the declaration of public water resources³²⁸ and was ruled to be private property owned by the person who would tap into the resource.³²⁹ Following Fornés Azcoiti et al. (2005), the reason for leaving groundwater out of the regulation of public water resources was due to the fact that at the time groundwater abstraction and exploitation was relatively small compared to surface water. Additionally, hydrogeology was still to be fully established as a science and the abstraction of groundwater was still a matter of mystery and ignorance (*ibid.*).

³²⁶ In Spain the main liberal revolutions during this period were the revolution of 1848, the liberal revolution of 1854 and the revolution of 1868 also called 'The glorious' leading to the First Spanish Republic in 1873-1874 (Carr 1966).

³²⁷ The legal doctrine informing the 1879 Water Law can be found in its predecessor legislation, the 1866 Water law (Fornés Azcoiti et al. 2005; Moreu Ballonga 1996, 2002). The 1879 Water Law was in use for 106 years until 1985.

³²⁸ *Language note: 'Dominio público hidráulico' in the original Spanish language.*

³²⁹ Articles 18 and 22 of the 1879 Water Law (Moreu Ballonga 1996).

This regulation, which gave absolute control of groundwater to the private owner or driller,³³⁰ was aimed at ensuring the access to private property and to promote consumptive uses and productivity of groundwater exploitation (Maluquer de Motes 1983; Moreu Ballonga 2002). The legislator at the time did not establish any limitations or administrative control for groundwater abstractions, leaving it to the sole responsibility of the land or well owner. The state backed down in that respect and only retained the responsibility of keeping a basic record of wells and controlling the use of private rights in case they affected the public salubrity or the security of people and goods (Pérez Pérez 1992).³³¹ As Moreu Ballonga (1996) wrote, these functions were aimed at intensifying the use of groundwater for agriculture and reinforcing the structure of private and inalienable ownership in the countryside as well as the access to private property by the rising bourgeoisie.

7.3.2 Ministerial authority and conflict over groundwater regulation under the 1879 Water law

According to the 1879 Water Law in Spain, the Ministry of Industry and Mines had the administrative mandate to regulate and legislate groundwater abstractions. In the following years however, conflict arose with the Ministry of Public Works over the allocation of regulatory responsibilities related to groundwater. A previous law to the 1879 Water Law, the 1849 Law of Mines, had given the

³³⁰ The implementation of this law established also a juridical distinction between ‘ordinary wells’ for domestic use in small farms and ‘artesian wells’. The property of groundwater in the case of ‘ordinary wells’ went to the owner of the land where the drilling had been done and in the case of ‘artesian wells’ the property of groundwater was for the person who had drilled the well (Fornés Azcoiti et al. 2005).

³³¹ Article 227 of the 1879 Water Law (Pérez Pérez 1992).

authority to carry out specific geological studies to the Geological Institute (which is part of the Ministry of Mines) (Fernández Rodríguez 1973). The Decree of 21st of January 1905 approved the Regulation of the Corps of Mine Engineers³³², giving them the capacity to carry out hydrogeological maps and supervise the exploration and abstraction of groundwater (*ibid.*). However, following a further decree on the 23rd of July 1910, a new department in charge of the applications for groundwater abstractions from individual farmers was added to the General Directorate of Agriculture within the Ministry of Public Works (*ibid.*). As Fernández Rodríguez (*ibid.*) explains, this decree allowed the Ministry of Public Works to supervise the study and regulation of public and private abstractions sponsored by the state. On the other hand, the Geological Institute would maintain administrative responsibilities over groundwater as long as they formed part of research studies or the general interest of the state (*ibid.*). The resolution of conflicts such as these, as described by Fernández Rodríguez (*ibid.*), was regulated by a legal instruction dating from 1883. This instruction sentenced that in the case of groundwater abstractions and exploration works for irrigation purposes, the agronomic engineer of the province would intervene; thus implicating the Ministry of Agriculture. (*ibid.*). As a result of this regulation, the Ministry of Agriculture also claimed part of the administrative control of groundwater in Spain (*ibid.*).

To establish the limits of its regulatory powers, the Ministry of Industry and Mines issued the Regulation of Mining and Metallurgical Police in 1934³³³ in order to regulate the use and abstraction of groundwater. In its second article this Regulation established the corps of engineers, within the Ministry of Mines, as the inspectors of

³³² Gaceta de Madrid, 24th of January 1905, No.24, pages 283-285.

³³³ Gaceta de Madrid, 16th of September 1934, No. 259, pages 2346-2374.

boreholes.³³⁴ Subsequently, article 208 established that the works and mechanisms involved in drilling and abstracting groundwater, whatever its nature or purpose, will have to be supervised, recognised and approved by the representative office of the Ministry of Mines.³³⁵ The regulation by the Decree on the 23rd of August 1934 approving rules for the control and surveillance of metallurgic and mining activities, confirming the unique authority of the Ministry of Industry over the surveillance and control groundwater and also establishing the mandate over the control and regulation of groundwater.³³⁶ Article 2 of this Decree created the Registry of Groundwater abstractions at the provincial level and made it compulsory for any farmer wishing to abstract groundwater for irrigation to register any new groundwater abstraction device.

In spite of these regulations, the conflicts between the Ministry of Mines and the Ministry of Public Works continued. In 1958, the Order of 31st of July 1959³³⁷ – Regulation for the Water and River Bed Police of the Segura River – gave the Ministry of Public Works the power to control and supervise any work affecting the natural regime of public or private waters as established by the 1879 Water Law (*ibid.*). Despite the fact that this decree favoured for the first time the Ministry of Public Works in relation to the attribution of competencies over the management of groundwater, it is possible to observe over the years a duplication of responsibilities between the two ministries (*ibid.*).

Notwithstanding the conflicts between the Ministry of Public Works and the Ministry of Mines over the regulation of groundwater abstractions, the most important interference in the regulatory tasks of the Ministry of Mines came from the Ministry

³³⁴ Article 2. *ibid.*

³³⁵ Article 208. *ibid.*

³³⁶ That is until the Reform of the 1879 Water Law in 1985.

³³⁷ BOE, 4th of August 1959, No.185, page 10574.

of Agriculture and the INC. With the Decree of the 5th of February 1954 declaring of national interest the irrigation works carried out by the INC, the Ministry of Agriculture took over groundwater management authority from the Ministry of Public Works and the Ministry of Industry and Mines in specially declared irrigable areas. In the areas declared irrigable by the INC, such as La Mancha, the technicians and engineers from the Institute would carry out necessary studies to locate and abstract groundwater.³³⁸

With this account of the regulatory and management authority between ministries it is possible to see how the basic groundwater governance structure functioned in Spain under the 1879 Water Law and where the imbalance of power resided. At the user level, groundwater abstraction rights were loosely defined and lacked regulation and control. The definition and attribution of ministerial responsibilities over groundwater has always been surrounded by a lack of administrative definition with regulations from many Ministries overlapping one another. This lack of coordination also proved that the loci of administrative disputes related to groundwater shifted constantly between the three ministries of Mines, Public Works and Agriculture, resulting in a de facto paralysis of the government's regulatory capacity.

³³⁸ See Chapter 5. The testimony of Ángel Martínez Borque, director of the INC in 1965 quoted in chapter 5 also complements this aspect: “[t]he Institute also carried out a very important task with respect to groundwater [...] early in the 1950s [...] they brought lots of litres of water ... La Mancha [...]. There were also frictions with the Geological [Institute] then, big, of course with Mines [the Ministry]. [...] But Mines had not done any water drilling ... they had not drilled a single metre ... it was the Institute [sic]” (EUA 1985a: 52). Author’s translation from original quote in Spanish.

7.3.3 The 1985 Water Law: a new legal framework?

7.3.3.1 Legal dispositions of the 1985 Water Law

The reform of the 1879 Water Law in Spain came in 1985.³³⁹ One of its aims was to alter the private regime of groundwater private abstraction rights by declaring groundwater part of the public water domain. The new law also gave river basin agencies autonomous powers for the management of aquifers under the responsibility of the Ministry of Public Works.³⁴⁰ However, special clauses for the regulation of already existing groundwater abstractions, found in annexes to the 1985 Water Law, limited the regulatory effects of this law over groundwater abstraction (Moreu Ballonga 2002; Fornés Azcoiti et al. 2005).

The aim of the 1985 Water Law was to establish all groundwater abstractions as public concessions. The law would retroactively grant the same status to historically acquired groundwater rights by transforming them into concessions after a transitional period (Moreu Ballonga 1996). Additionally, it would quantify the number of users and volume of groundwater abstraction, as well as organising and regulating future groundwater abstraction concessions (Fornés Azcoiti et al. 2005). In order to do so, according to Article 72 of the Water Law, the river basin agencies would be in charge of an official Registry of Waters³⁴¹ containing all public groundwater concessions as well as any authorised changes in either abstraction regimes or ownership.

Furthermore, the 1985 Water law established in its annexes a grace period of 3 years after its promulgation (ending on the 31st of December 1988) in order to

³³⁹ Law 29/1985 of 2nd of August, BOE, 8th of August 1985, No.189, pages 25123-25135.

³⁴⁰ Article 20, Law 29/1985 of 2nd of August, BOE, 8th of August 1985, No.189, pages 25123-25135.

³⁴¹ *Language note: 'Registro de Aguas' in the original Spanish language.*

accommodate to the new legal framework all groundwater abstraction rights previously considered private by the historical 1879 Water Law (Fornés Azcoiti et al. 2005; Molinero et al. 2011). The law gave two options to owners of existing groundwater abstraction rights under the 1879 Water Law:

- a) To register their private rights in a Registry of Waters and remain in a transient state of private ownership of their historical rights (i.e. obtained according to the 1879 Water Law) for 50 years until 2038, after which their rights would be transferred to a public groundwater abstraction concession;³⁴²
- (b) To retain permanently their private abstraction right by registering the wells in a Catalogue of Private Waters.

Remaining groundwater abstraction rights, granted to farmers after the new water law came into force on the 1st of January 1986, would be part of the public water domain. The legislator intended no legal difference between these two options in the 1985 Water Law (Fornés Azcoiti et al. 2005). However, after the three-year grace period those groundwater users not having registered their private right in the Registry of Waters or the Catalogue would still retain ownership of a private abstraction right (Llamas et al. 2001). This was due to the fact that registration in the Registry or Catalogue was only declarative and did not constitute or grant any additional private rights per se (García Carretero 1997). Hence, registration did not supersede the previous historical right, and lack of registration did not make groundwater abstraction rights illegal, only temporarily depriving administrative protection (*ibid.*).

³⁴² Those farmers registering their groundwater abstraction rights in the Registry of Waters would have a quantitative groundwater abstraction limitation based on the current abstraction regime and volume of water used when the law came into force. Any modification to the pre-existing abstraction regime or modification of the well would have to be approved by the river basin authority and granted as a new groundwater concession (Llamas et al. 2001).

This de facto statutory right was not considered to be appealing by the legislator (Llamas et al. 2001). However, due to a lack of information and trust by groundwater users, many saw in this formulation a way to maintain ownership of their private abstraction rights and a safe exit door to the legal imbroglio caused by the new law (*ibid.*). With this legal loophole, it has been estimated that only around 10 to 20 percent of well owners have registered their rights in the Registry of Waters, and retaining their private rights for another 50 years (Moreu Ballonga 2002). Consequently, more than 80 percent of well owners have not registered their abstraction rights and thus maintain their private water rights in perpetuity (Moreu Ballonga 2002; Fornés Azcoiti et al. 2005).

Based on these legal inaccuracies, for Moreu Ballonga (1996) the 1985 Water Law established a dual regime of public and private rights. It also restricted the capacities of the law to deal with groundwater abstraction rights not included in the legal framework (*ibid.*). Additionally, the feeble retroactivity of the 1985 Water Law in dealing with private historical groundwater rights and allowing owners to maintain such private abstraction rights has brought juridical, administrative and legal complexity to the management and control of groundwater abstractions (*ibid.*). In the Guadiana River Basin Authority, the lack of human and financial resources to deal with the large amount of administrative and bureaucratic paperwork has paralysed its capacities to dealing with these files (Llamas et al. 2001). The result of this process is that due to the poor definition of private versus public concessions and a lack of financial and human resources to implement the law, many groundwater exploitations remain un-registered (Molinero et al. 2011).

However, a new aspect of the 1985 Water Law is that it foresaw the possibility of declaring aquifers overexploited, both by quality and quantity (*ibid.*). The 1985

Water Law gave river basin authorities legal powers to manage aquifers declared overexploited, drawing up management plans and determining caps on annual pumping regimes. By law, restrictions would have to be applied and users would have to create groundwater user associations in order to assist with the design and implementation of the aquifer management plans.³⁴³

7.3.3.2 The implementation of the 1985 Water Law in La Mancha

The implementation of the 1985 Water Law caused confusion and suspicion amongst farmers in La Mancha (García Carretero 1997; Moreu Ballonga 1996). The lack of clarity and understanding of the law meant that farmers mistrusted its implementation and feared that they would lose their private abstraction rights (Hernández-Mora 1998). The existence of the third transitory provision in the 1985 Water Law resulted in a de facto permanence of the historical groundwater private property rights (Moreu Ballonga 1996) and a lack of clear regulation of groundwater abstractions.³⁴⁴ Additionally, the traditional individualism of groundwater users in La Mancha resulted in a lack of formal institutions aimed at representing the rights and interests of farmers during the preparatory phases of the new water law (Hernández-Mora 1998). Thus, instead of informing and educating the groundwater users about the contents of the new law, the legislator promulgated the law unilaterally (*ibid.*). Once the law was enacted, groundwater users found support and information about

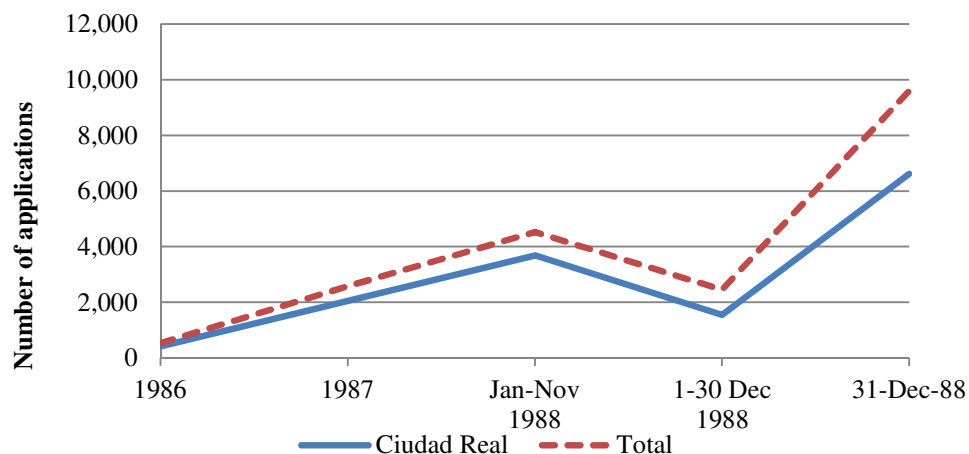
³⁴³ Of the 16 aquifers officially declared overexploited in Spain, only 5 have created groundwater user organisations and only 3 have drawn management plans (Molinero et al. 2011).

³⁴⁴ There is a lack of agreement amongst researchers as to how many wells exist in La Mancha and several authors have attempted to quantify the total number of groundwater wells (e.g. Llamas et al. 2001; Martínez Santos et al. 2008; PEAG 2008; Pulpón 2008). For Martínez-Santos et al. (2008) nearly 40,000 wells exist in the Mancha Occidental aquifer, of which only 17,000 have been registered at the Guadiana River Basin Authority.

the law through representatives of the Agrarian Chambers, agrarian union groups and town halls.³⁴⁵

In the Guadiana river basin, the majority of registrations for groundwater abstraction rights are found in the province of Ciudad Real (Figure 7.8). However, for well owners and farmers in La Mancha, the 1985 Water Law came almost un-noticed (García Carretero 1997). Due to a lack of information and awareness, the majority of registrations either in the Registry of Water or the Catalogue of the River Basin Authority occurred at the end of the 3-year grace period, on the 31st of December 1988 (García Carretero 1997; Pulpón 2008). Thus, the majority of well owners in La Mancha followed the third and fourth transitory disposition of the 1985 Water Law and requested the recognition of their historical groundwater abstraction rights following the historical 1879 Water Law (García Carretero 1997).

Figure 7.8 Number of applications for the recognition of groundwater abstraction rights at the Guadiana River Basin Authority



Source: Based on data from Aragón Cavaller 2002.

³⁴⁵ José Ramón Aragón, personal communication, 9th of August 2012.

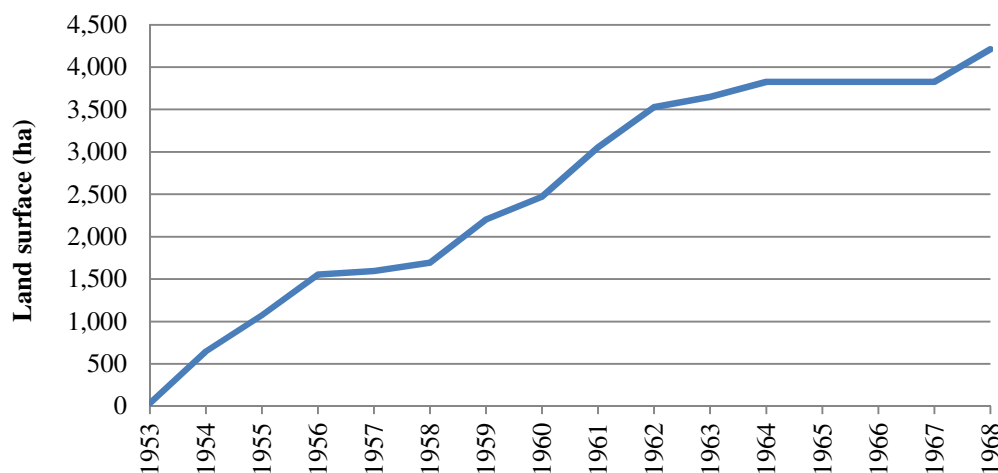
7.4 The production of groundwater socio-ecologies and scarcity in La Mancha

7.4.1 Irrigated landscapes and groundwater for agriculture in La Mancha

7.4.1.1 Expanding irrigation and groundwater consumption for agriculture

The development of irrigation in La Mancha, initiated by the state and coordinated by the INC, introduced intensive agriculture to lands that were previously dedicated to dry farming, or in some cases barren. Since the beginning of the colonisation process in La Mancha (1953-1968), the state transformed more than 4,000 hectares of land into irrigation (Figure 7.9).

Figure 7.9 Accumulated irrigated surface by the INC in La Mancha (1953-1968)

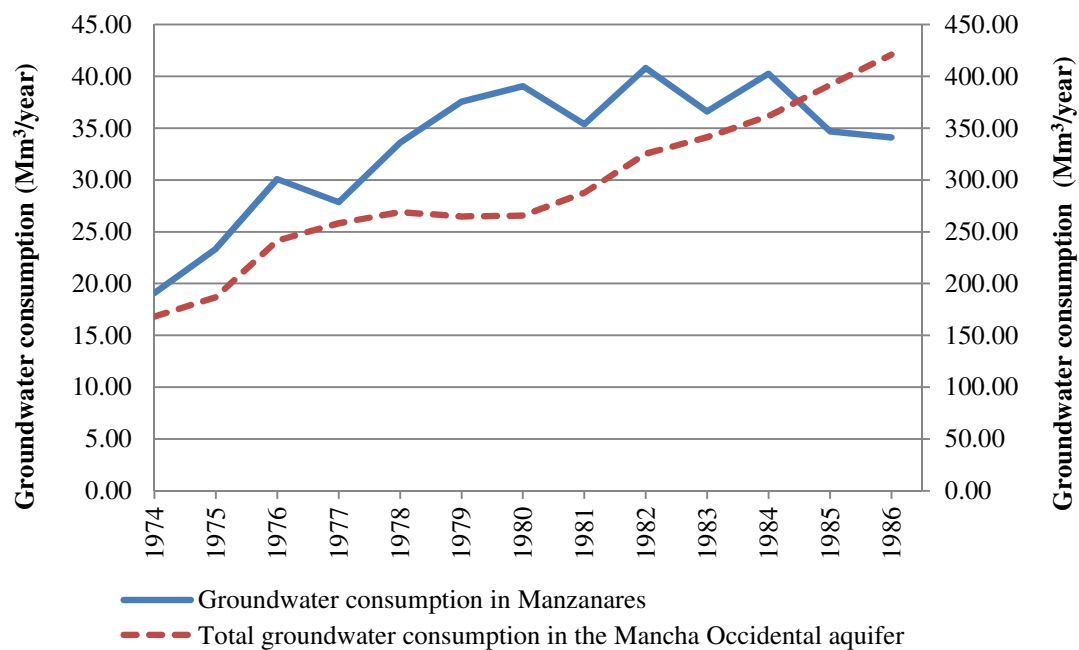


Source: Based on data from Archives of the INC, Box 2571, File 25220, Document 2.

From 1974 to 1986, the area of La Mancha irrigated with groundwater increased from around 40,000 hectares to over 87,000 hectares (Figure 7.10), representing 6.6 percent of the total increase in irrigated surface at the national level

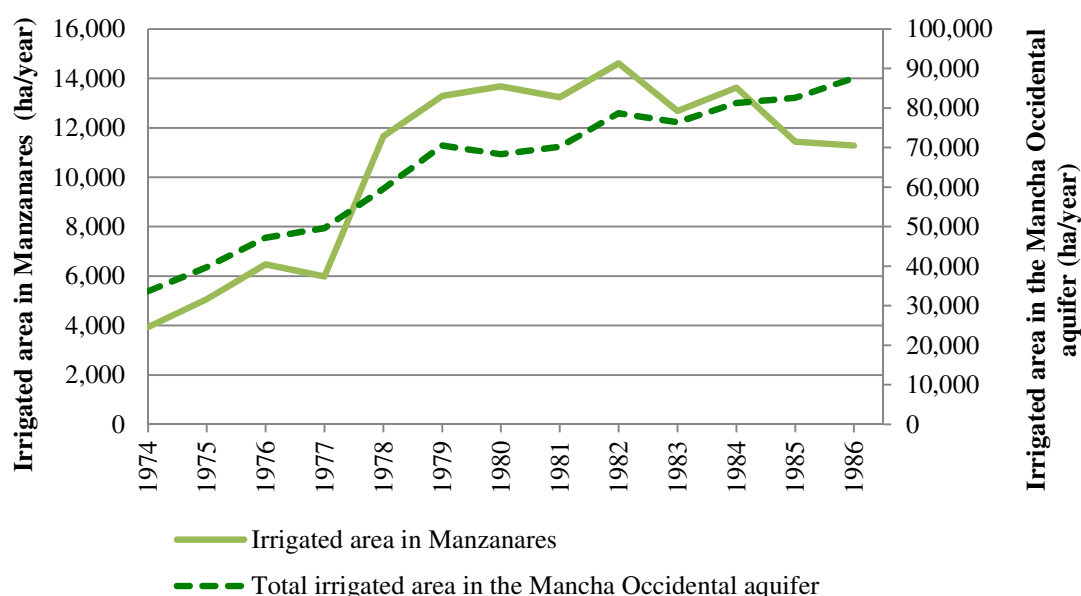
(Pillet Capdepón 1989). This general trend occurring across La Mancha also existed in Manzanares, where irrigation accelerated in 1977 from around 6,000 hectares to more than 14,600 hectares in 1982. Subsequent groundwater consumption also increased from 27 Mm³ to more than 40 Mm³ during the same period (Figure 7.11).

Figure 7.10 Groundwater consumption for irrigation in Manzanares and in the Mancha Occidental aquifer (1974-1986)



Source: Based on data from ITGE 1989 and Martinez Cortina 2001, 2011.

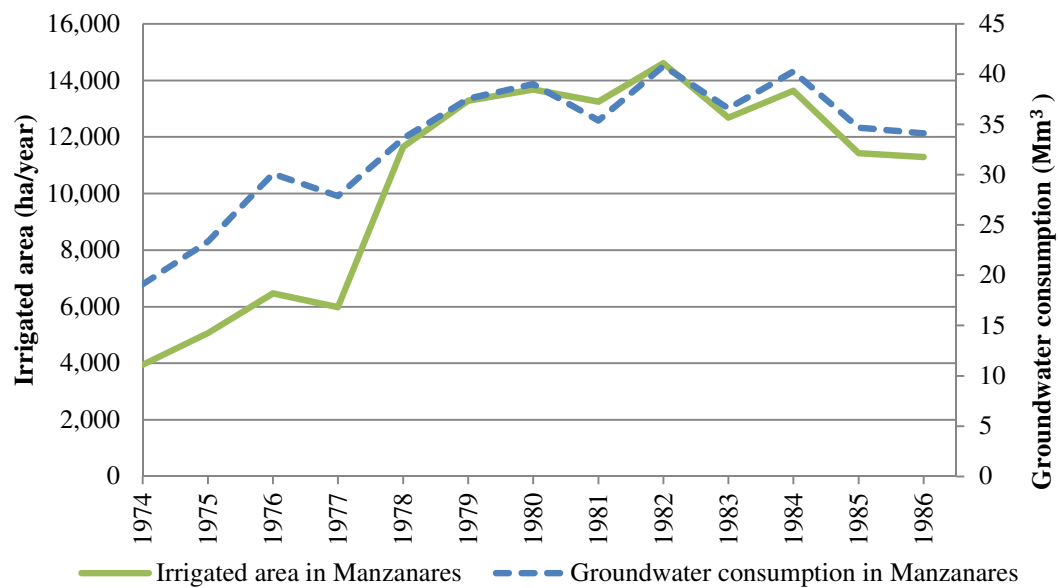
Figure 7.11 Irrigated area in Manzanares and in the Mancha Occidental aquifer (1974-1986)



Source: Based on data from ITGE 1989 and Martínez Cortina 2001, 2011.

In the 1980s, groundwater represented 63 percent of irrigation water use in Castilla-La Mancha, compared to 28 percent in the whole of Spain (Pillet Capdepón 1989). In the Upper Guadiana river basin, irrigation with groundwater currently accounts for 90 to 95 percent of the area's total water use (Castaño-Castaño et al. 2008), with the Mancha Occidental aquifer providing nearly 90 percent of water in 1989 (Cruces de Abia and Martínez Cortina 2000). In Manzanares, data indicates groundwater abstraction and irrigated surface in the municipality increased concomitantly, suggesting that most of the newly irrigated land was groundwater-fed (Figure 7.12).

Figure 7.12 Irrigated area and groundwater consumption in Manzanares (1974-1986)



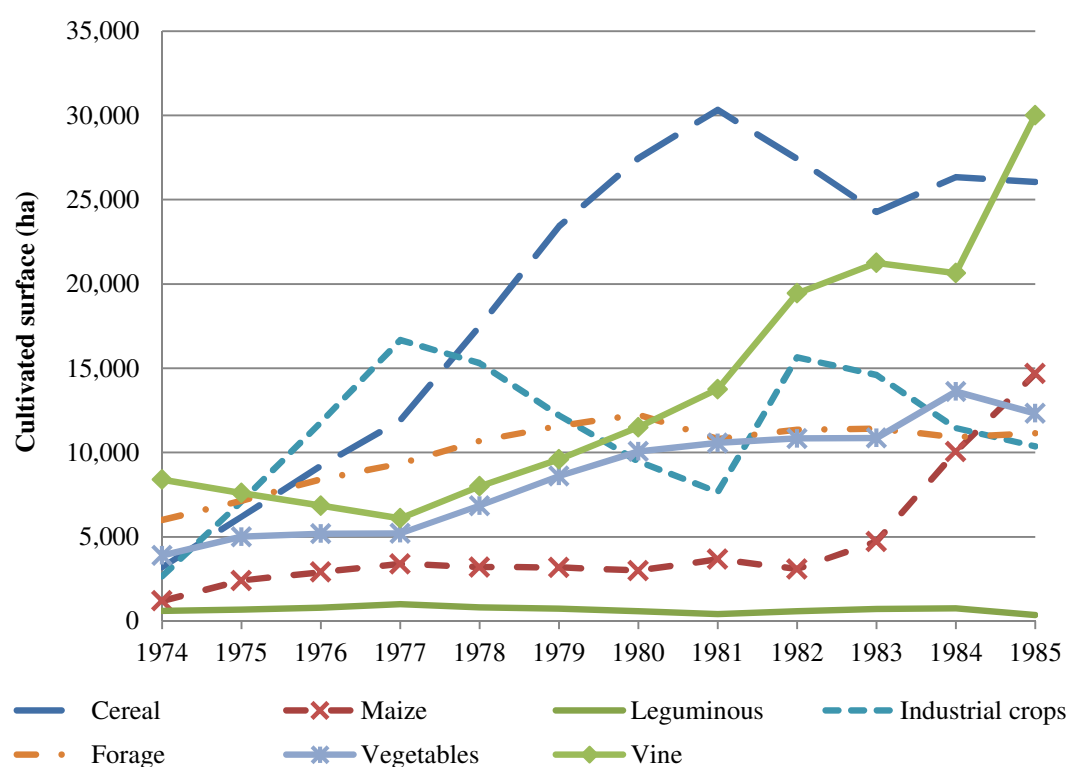
Source: Based on data from ITGE 1989.

7.4.1.2 Changes in cropping patterns: the need for more water

Subsidies, financial incentives and the control of markets, prices and production sustained the development of irrigation in the area. The use of groundwater fed the development of water intensive crops which benefitted from state subsidies and market regulation. In the 1970s, irrigation also facilitated the introduction of more productive crops such as maize, alfalfa and industrial crops (e.g. beetroot) over traditional dry farming crops such as cereal, vines and olive trees (Rosell and Viladomiu 1977). These cash crops requiring intensive irrigation (Fabeiro et al. 2003) appeared in La Mancha in the mid 1970s (Figure 7.13 and allowed farmers to obtain quick profits to repay the initial loan or investment in irrigation. Irrigated cereal with groundwater from the Mancha Occidental aquifer shows the highest increase, with a peak in cultivated surface of more than 30,000 irrigated hectares in in 1981. Maize appeared later in the 1980s, with an increase from around

4,000 cultivated hectares in 1983 to more than 14,000 hectares in 1985, becoming the third most cultivated crop in La Mancha.

Figure 7.13 Crop cultivated surface area in the Mancha Occidental aquifer (1974-1985)



Source: Data provided by Martinez Cortina 2011.

High crop profitability linked to market regulation made the cultivation of cash crops extremely appealing, thus reducing the investment risk of drilling a well. As some of the interviewed farmers in La Mancha put it:

“A lot of people in dry farming, agriculture was not profitable, we made an economic sacrifice for progress” (Interviewee 12, 3rd of June 2011, Manzanares).

“To produce much more” (Interviewee 17, 13th of June 2011, Alcázar de San Juan).

“The person who didn't irrigate was stupid!” (Agustín Apio, personal communication, 23rd of March 2011).

As some of the interviewees put it, the reason for switching to irrigated crops followed a very simple rationale:

“Because we would get a bigger harvest” (Interviewee 10, 2nd of June 2011, Alameda de Cervera).

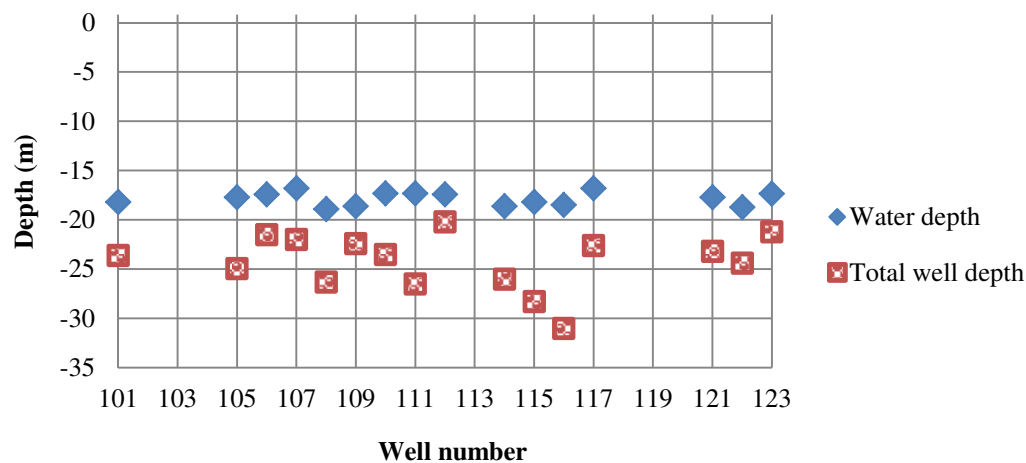
“People started drilling the first wells and they saw the yields from the crops, the ‘green gold fever’ of alfalfa” (Agustín Apio, personal communication, 1st of August 2012).

7.4.2 Producing groundwater scarcity in La Mancha

7.4.2.1 Decreasing groundwater levels in Llanos del Caudillo

Despite the use of new technology in Llanos del Caudillo, the depth of the wells remained on average below 17 metres, indicating a high groundwater table due to the predominant use of traditional technologies in the area at the time (Figure 7.14). However, signs of groundwater table lowering were recorded in Llanos del Caudillo soon after the development of irrigation.

Figure 7.14 Depth of water and wells in Llanos del Caudillo (1953)



Source: Based on data from Registry INC Correspondence, Box 643, File 25221, Document 508, Official letter of transmittal, Delegation Chief of Ciudad Real to the Director of the INC, General Archive, Ministry of Agriculture.

Due to a sudden decrease in groundwater levels in Llanos del Caudillo, on the 2nd of March 1955 the horizontal axis pump in well 104 was replaced by a vertical axis pump of the same capacity (60 litres per second).³⁴⁶ Later that year, due to the continuous decrease in groundwater levels, the INC decided to replace all horizontal axis pumps with vertical axis pumps.³⁴⁷ In 1958, the INC engineers in Ciudad Real formally informed the INC that decreasing groundwater levels were limiting the expansion of irrigation in La Mancha. According to a letter from the INC chief engineer of the Ciudad Real delegation to the Director of the INC (dated on the 28th of July 1958),³⁴⁸ decrease in the first groundwater layer caused an increase in depth of wells to reach the second layer of the aquifer (to 80 metres) and maintain groundwater abstraction levels for irrigation. Thus, the chief engineer recommended limiting the

³⁴⁶ Registry INC Correspondence, Box 3472, File 252211, Document 60, General Archive, Ministry of Agriculture.

³⁴⁷ This was done with credit extensions issued by the INC for the works and purchase of pumps Credit extensions in April and July 1955, February 1956, November 1958 and December 1959. Registry INC Correspondence, Box 3472, File 252211, Document 60, General Archive, Ministry of Agriculture.

³⁴⁸ Registry INC Correspondence, Box 1211, File 252210, Document 59, General Archive, Ministry of Agriculture.

activities of the INC to those three sectors in La Mancha. In 1972, the decrease in groundwater levels in Llanos del Caudillo was experienced at a general level when wells drilled five years before by the INC in the newly annexed Sector III in Herrera de la Mancha dried up (Romano Serrano 2005).³⁴⁹

7.4.2.2 The 'water fever':³⁵⁰ groundwater over-abstraction in La Mancha

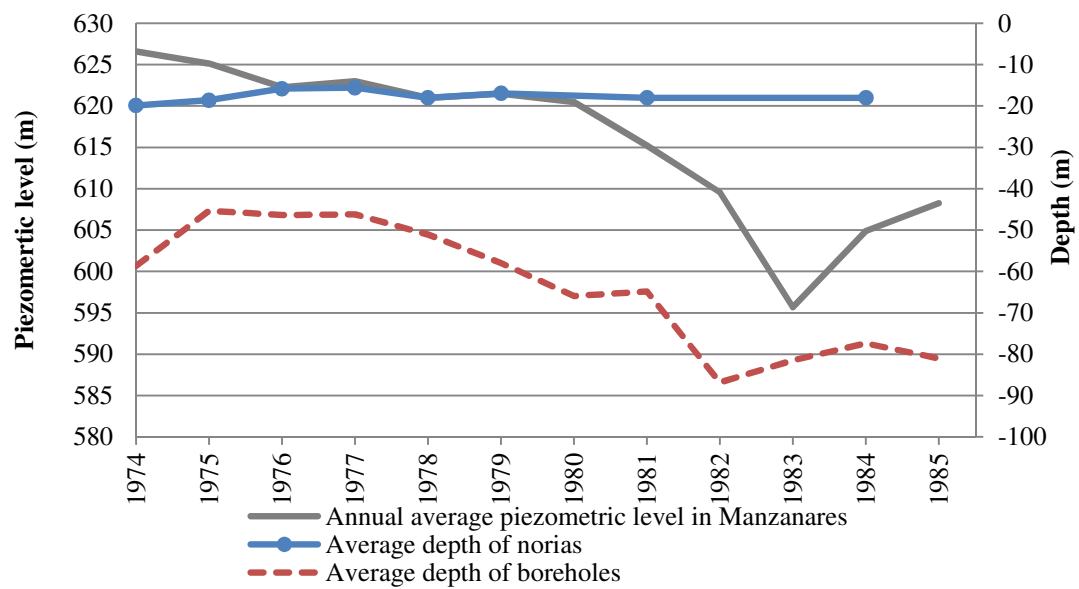
New drilling technology along with state colonisation politics and irrigation subsidies were the cause of this irrigation boom, which allowed farmers to drill deeper and access lower layers of aquifer, resulting in the increasing abstraction and depletion of the aquifer. In Manzanares, traditional water lifting technologies show average annual depths of between 10 and 30 metres for dug wells. Conversely, modern water lifting technologies show depths between 34 metres and 87 metres, with a fluctuation in time and a deepening of wells (Figure 7.15). These figures also show that the deepening of boreholes precedes the decrease in average piezometric levels in the Mancha Occidental aquifer in Manzanares. Additionally, a decrease in precipitation below the annual average at the end of the 1970s and early 1980s could also have influenced the use and abstraction of more groundwater (Figure 7.16). As confirmed by Bromley et al. (2001), due to a series of dry years between 1974 and 1994 the water balance of the aquifer suffered a reduction of its natural recharge input of over 25 percent from 592 Mm³ to 445 Mm³ per year. However, groundwater

³⁴⁹ Sector III had been annexed to the town of Llanos del Caudillo in 1972. In 1986 the farmers in Sector III could not irrigate melons during that summer and lost the harvest because the wells drilled by the IRYDA dried out (Romano Serrano 2005).

³⁵⁰ Expression used by Agustin Apio, personal communication, 1st of August 2012.

abstractions for irrigation increased from 60 Mm³ during the natural baseline period (pre-1959) to 536 Mm³ during the period 1984-1996 (*ibid.*).

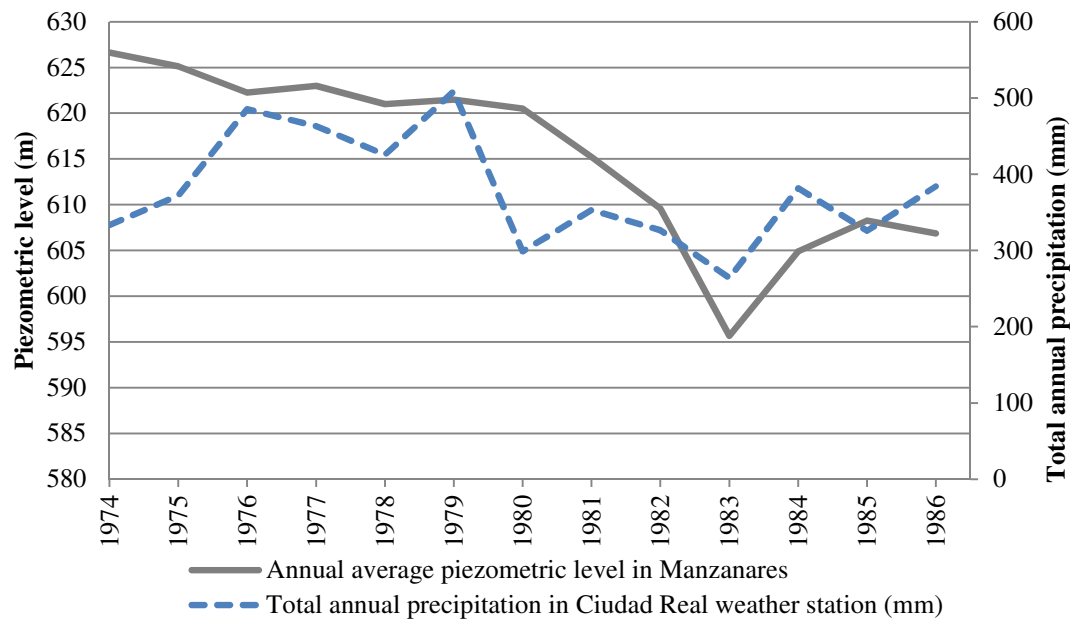
Figure 7.15 Average piezometric level of the Mancha Occidental aquifer in Manzanares and depth of norias and boreholes in Manzanares (1974-1985)



Note: Piezometric level measured for Manzanares, Piezometric Code 2030-30001, Elevation 648, depth 153 metres.

Source: Based on data from Archives of the Community of Irrigators of Manzanares; ITGE 1989.

Figure 7.16 Average piezometric level of the Mancha Occidental aquifer in Manzanares and annual precipitation (1974-1986)



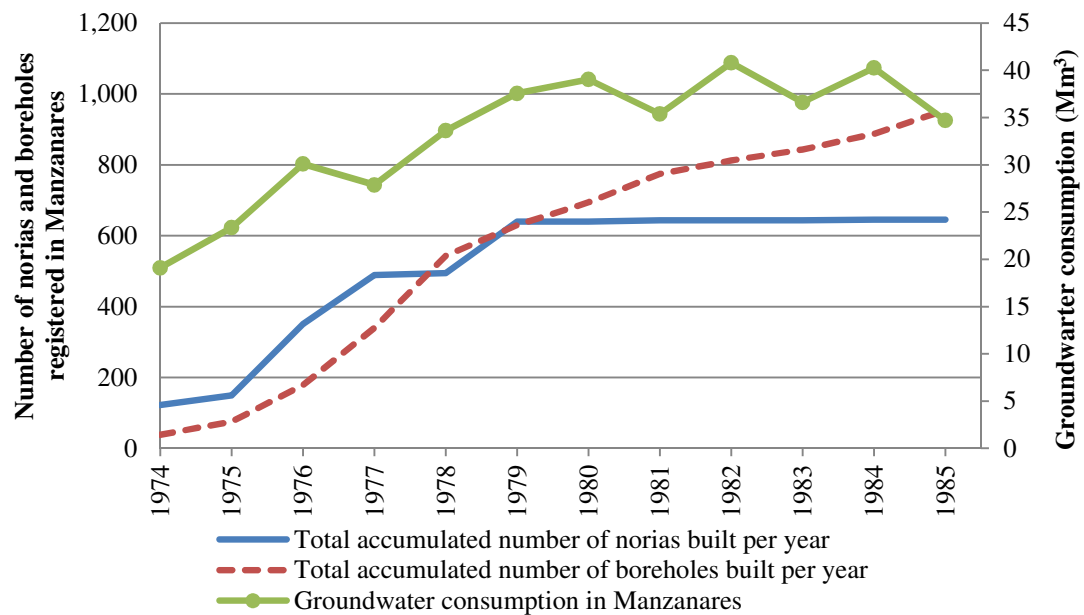
Note: Piezometric level measured for Manzanares, Piezometric Code 2030-30001, Elevation 648, depth 153 metres.

Source: Based on data from AEMET and ITGE 1989.

Collected data shows an increase in groundwater consumption in Manzanares following the increase in registered norias and boreholes (Figure 7.17). However, according to previous studies, groundwater depletion rates were the main problem affecting the Las Tablas de Daimiel wetland, with a falling water table rate of approximately 3 metres between 1974 and 1981, 6 metres between 1981 and 1984, and 5 metres between 1984 and 1987 (Naredo and Gascó 1990). This resulted in an average increase in well depth of 30 metres reaching 40 to 50 metres in some areas (Cruces de Abia and Martínez Cortina 2000). According to Martínez Cortina (2001). The average decrease in piezometric levels in the central area of the Mancha Occidental aquifer³⁵¹ between 1974 and 1986 was of 12 metres.

³⁵¹ Measured by IGME at the Manzanares piezometric control borehole, Piezometric Code 2030-30001, Elevation 648, depth 153 metres. The network of boreholes for the control of piezometric levels in La Mancha was installed in 1973-1974 by the IGME (Luis Martínez Cortina, personal communication, 13th of April 2011).

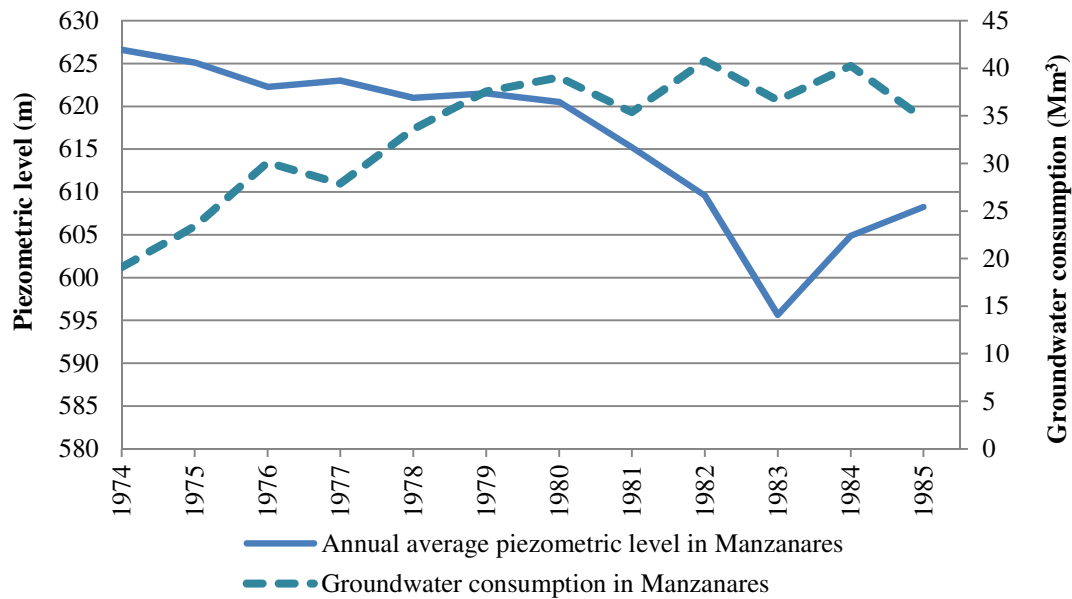
Figure 7.17 Number of norias and boreholes and groundwater consumption in Manzanares (1974-1985)



Source: Based on data from Archives of the Community of Irrigators of Manzanares; ITGE 1989.

Analysis of the Manzanares data set indicates that a drop in piezometric levels followed an increase in borehole depth in Manzanares. This is also reflected by the evolution of piezometric levels and groundwater consumption in Manzanares (Figure 7.18). Average piezometric levels in Manzanares dropped subsequently to a minimum level of around 595 Mm³ after groundwater consumption had reached its maximum of 40.8 Mm³ in 1982.

Figure 7.18 Average piezometric levels of the Mancha Occidental aquifer in Manzanares and groundwater consumption (1974-1985)



Note: Piezometric level measured for Manzanares, Piezometric Code 2030-30001, Elevation 648, depth 153 metres.

Source: Based on data from ITGE 1989.

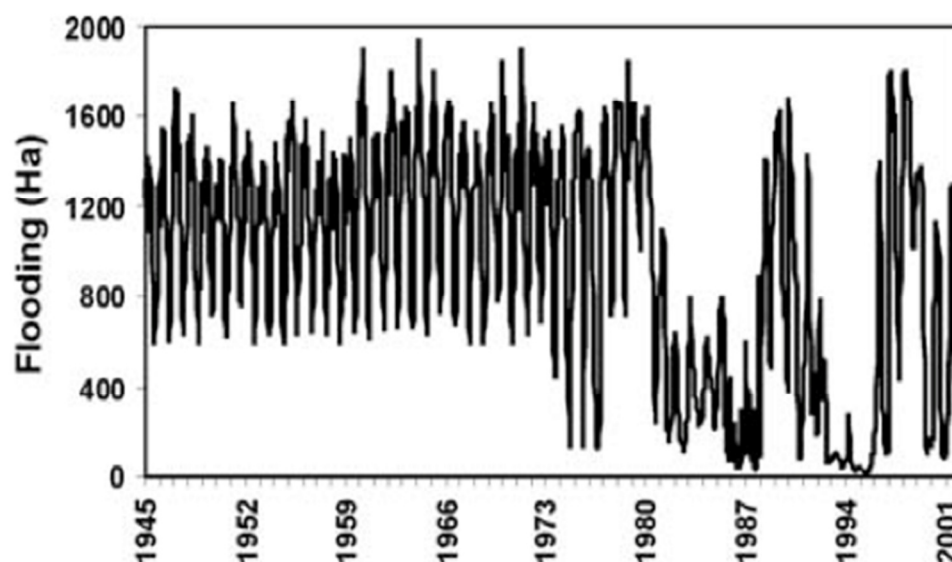
7.4.2.3 Producing dryland in the Las Tablas de Daimiel wetland

Although agricultural activities have fostered economic development in this region over the past four decades (Martínez-Santos et al. 2008), these activities have also resulted in a decrease in the surface area of La Mancha's wetlands fed by the Mancha Occidental aquifer from 250 to 70 km² (Conan et al. 2003; Fornés et al. 2000).³⁵² Between 1965 and 1973 the Las Tablas de Daimiel wetland suffered from large-scale drainage operations, draining a total area of 130 km² for irrigation purposes and malaria prevention (Alvarez-Cobelas et al. 2001; Castaño-Castaño et al.

³⁵² There are 53 protected wetlands and water bodies in Castilla-La Mancha with a total surface of 18,554.82 hectares, 24 of which are in the province of Ciudad Real covering a surface of more than 9,200 hectares (<http://pagina.jccm.es>, last accessed 10th of January 2013).

2008). By 1980, these programmes had the effect of reducing the total area to one seventh of its original size (Alvarez-Cobelas et al. 2008) (Figure 7.19).³⁵³

Figure 7.19 Long-term flooding patterns in the Las Tablas de Daimiel wetland (1945-2001)



Source: Alvarez-Cobelas et al. 2008: 263.

Many of the major impacts on superficial river flows reaching the wetland originate from drainage works and river channel modifications carried out in the 1960s and 1970s in order to transform naturally flooded land into irrigation (Cruces de Abia and Martínez Cortina 2000).³⁵⁴ These drainage operations began with the ‘Law on the colonisation of wetlands and swamps next to the Guadiana River in the

³⁵³ The 1956 Drainage plan for the Las Tablas de Daimiel wetland by the Ministry of Public Works aiming to drain 23,000 hectares along the rivers Guadiana, Zancara and Cigüela quoted a 1918 law to eradicate malaria in swamps and wetlands (known as the ‘Cambó Law’) (ABC 1980).

³⁵⁴ Previous attempts to desiccate the Guadiana River date as far back as the nineteenth century when in 1897 the engineer Mariano Diaz (1897) wrote a book on the importance of the channelisation of the Guadiana for the economic development of La Mancha. In that book, Diaz established the need to incorporate the Guadiana to a large network of canals for internal navigation and also to desiccate the unhealthy marshes due to the presence of foci of malaria in the area. Notes from 1805 by chief engineer Jose Agustín Larramendi quoted by Diaz (1897) already comment on the possibility to build a canal at the confluence of the rivers Záncara and Cigüela and further down in the Guadiana river. According to Diaz (1897), a concession in 1864 for a canal irrigating 30,000 hectares of land between the Lagunas de Ruidera to Manzanares failed after having just initiated minor works.

provinces of Ciudad Real, Toledo and Cuenca' on the 17th of July 1956.³⁵⁵ Work conducted by the INC started in 1965 in order to drain 8,000 hectares of flooded areas and privatize them for agricultural uses. Work was suspended in 1971 when the wetland became internationally protected by the RAMSAR Convention (Ramos Gorostiza 2006). Therefore, an emergency operation had to be devised in that year in order to pump water directly from the Guadiana River into the wetland in order to artificially maintain the flooded surface (López Sanz 1998). However, the transformation of land for irrigation around the wetland continued through the 1970s when the IRYDA initiated the channelisation of the Cigüela, Zancara and Guadiana rivers in order to transform marshlands into irrigation fields (Cruces de Abia and Martínez Cortina 2000). This project was continued throughout the 1970s with the construction of eight long deep drainage channels across the wetland, the channelisation of 40 kilometres of the Guadiana river bed and the destruction of watermills in the wetlands which helped with water retention (ABC 1980; Alvarez-Cobelas et al. 2001). Additionally, five dams in the Upper Guadiana River basin were built during the twentieth century adding 128.6 Mm³ of storage capacity. At the end of the 1980s, the total storage capacity in the basin reached more than 7,000 m³ (Table 7.4 and Figure 7.20). Furthermore, this infrastructure reduced the flooding patterns of the Las Tablas de Daimiel wetland by 25 percent during the period 1974-1994 (Bromley et al. 2001).

³⁵⁵ BOE, 18th of July 1956, Num.200, pages 4693-4695.

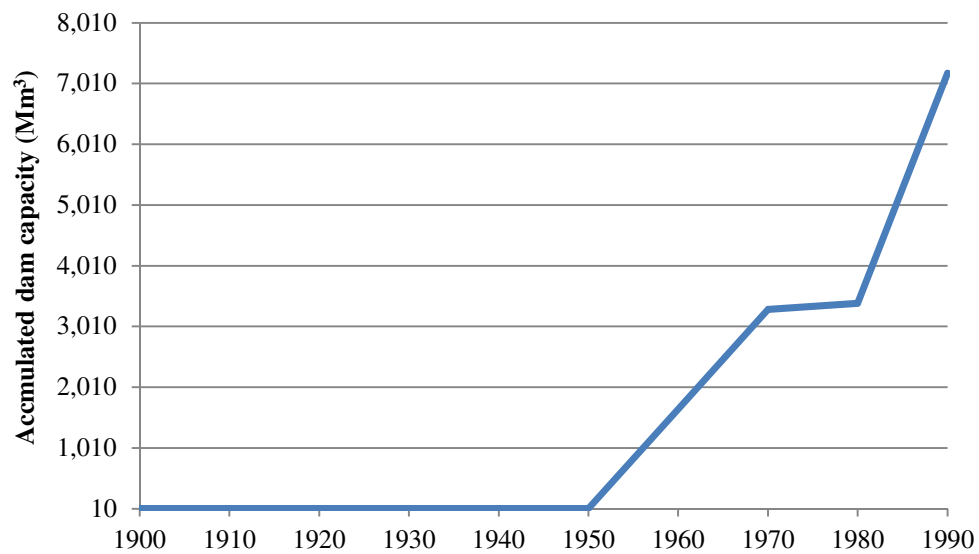
Table 7.4 Dams on the Upper Guadiana River

<i>Dams</i>	<i>Height (m)</i>	<i>Length (m)</i>	<i>Capacity (Mm³)</i>	<i>Year</i>
Gasset	19	178	23 (in 1957) 41.7 (in 1984)	1909, enlarged in 1957 and 1984
Peñarroya	50	250	50	Started in 1959, finished in 1966
El Vicario	21	173	7 (in 1973) 33 (in 1989)	1973, enlarged in 1989
Puente Navarro (*)	9	380	2.2	1987
Vallehermoso	25	268	7	1988

Note: (*) The Las Tablas de Daimiel wetland has an additional dam (El Morenillo dam) built in 1988 used only to maintain a constant level of water in the wetland.

Source: Author based on CHG 2009.

Figure 7.20 Accumulated dam capacity in the Guadiana River Basin per decade (1900-1990)



Source: Author adapted from data by Pinilla 2006.

7.4.2.4 Reaching the bottom: the declaration of overexploitation of the Mancha Occidental aquifer

As a result of the increase in groundwater consumption in La Mancha at the end of the 1970s, the first signs of alarm about the overexploitation of the Mancha Occidental aquifer began to appear. In 1979, a report from the geological service of the Ministry of Public Works (Report 11/1979) warned of hydrological disequilibrium between abstractions and recharge, pointing out the possibility that the Las Tablas de Daimiel wetland could become a recharge pond for the aquifer instead of a natural emerging spillover from the water table (Garrido Roselló 1991). Another study issued by the IRYDA in 1980 referred to the decrease in groundwater levels in La Mancha due to the increase in groundwater abstractions over the previous 20 years. Due to the continuous increase in groundwater abstractions, the water table level dropped deeper than the depth of wells drilled for irrigation, causing in many cases the subsequent drilling of new wells or the deepening of existing ones (IRYDA 1980).

In 1977, 1986 and 1987, the depletion of groundwater levels brought the first instances of spontaneous burning peat around the wetland and near the *Ojos del Guadiana*³⁵⁶ (Moreno et al. 2011). Although these were just punctual episodes occurring in relatively wet soil conditions with a still shallow water table (less than 1 metre below the surface), they indicated a general tendency that was affecting the

³⁵⁶ Located around 12 kilometres northeast of Daimiel, the *Ojos del Guadiana* (Eyes of the Guadiana) are a natural water surfacing phenomenon caused by the combination of a depression of the terrain in the Mancha Occidental aquifer and a naturally high water table discharging into the surface. Naturally occurring springs (i.e. the so-called ‘Ojos’) occur where the discharging water table intersects the topographical surface. This phenomenon, in the case of small springs or natural ponds, is also the origin of the Las Tablas de Daimiel wetland, where the naturally rising water table discharges in the surface and meets the Guadiana and Azuer rivers (Martínez Cortina 2001).

whole aquifer (Moreno et al. 2011) (Photograph 7.1).³⁵⁷ Also, the *Ojos del Guadiana*, part of the iconic landscape of La Mancha, stopped surfacing in 1983 (Martínez Cortina 2001).³⁵⁸

Photograph 7.1 The effects of groundwater overexploitation on the environment: the combustion of peatland in the Las Tablas de Daimiel wetland



Note: The sign reads ‘Dangerous Area. Peatland with risk of self-combustion.’
Source: Author.

The first declaration of overexploitation of the Mancha Occidental aquifer was issued in February 1987 by the governing board of the Guadiana River basin authority.³⁵⁹ This declaration included: the prohibition of drilling new wells or deepening existing ones; the freezing of any new groundwater abstraction concessions

³⁵⁷ In 2009 a series of two surface flaming fires, the more serious of which was caused by a lower water table and drier soil, extended over long distances and became active between August and December 2009 (EL PAIS 2009; Moreno et al. 2011).

³⁵⁸ That is until March 2012 when the *Ojos del Guadiana* reappeared for the first time since the 1980s (EL PAIS 2012a) and the Guadiana started flowing again into the Las Tablas de Daimiel Wetland in November 2012 (EL PAIS 2012b). Although hydrological data seemed to confirm that groundwater levels were recovering in La Mancha, some critical voices (e.g. WWF 2012; Martínez-Santos et al. 2008) have warned that such recovery might not be the result of state-sponsored recuperation plans.

³⁵⁹ This is according to article 54 of the 1985 Water Law and article 171 of the Regulation of public water resources (*‘Dominio Publico Hidráulico’* in the original Spanish language). *Confederación Hidrográfica del Guadiana*, Board meeting, 4th of February 1987, Ministry of Public Works and Urbanism (www.chguadiana.es, last accessed 13th of November 2012).

for a period of 5 years; the limitation of groundwater abstraction for existing groundwater users; and the obligation for users (whether irrigators or not) to create a community of groundwater users. This community would have the purpose of cooperating in the management and control of the newly established groundwater abstraction regime (García Carretero 1997).

In 1987, once the declaration of overexploitation was approved, the River Basin Authority limited the groundwater abstraction capacity of each farmer with a registered well to a 'normal consumption' of 4,278 m³ per hectare per year. In those growing vines, groundwater use was limited to 2,000 m³ per hectare per year. The limitations affecting the abstraction of groundwater for each well were also based on the total amount of land used for irrigation (Rosell Foxà 2001). With this new regime of groundwater abstraction, a 5-hectare farm would be able to use its total share of groundwater (i.e. 4,278 m³) whereas a farm with 20 hectares would only be allowed to use 2,352 m³ (*ibid.*). Moreover, a farm of 100 hectares would be limited to use only 1,375 m³ per hectare (*ibid.*).

Additionally, several infrastructure projects were implemented to prevent further degradation of the wetland. In 1988, a Regeneration Plan was implemented with the objective of artificially managing the wetland (Cirujano et al. 1996). With this Regeneration plan, two small dams were built within the wetland's designated national park area (the Puente Navarro and El Morenillo dam) to retain water in the wetland (Álvarez-Cobelas et al. 2008, Castaño-Castaño et al. 2008). Also, a 150 kilometre deviation from the Tajo-Segura³⁶⁰ water transfer into the Cigüela River was proposed in 1988 and finalised in 1994.³⁶¹

³⁶⁰ The Tajo-Segura water transfer is a strategic infrastructure for irrigation in Spain's southeast regions and the largest water transfer in Spain. Planned in 1966/1967 and completed in 1978, the Tajo-Segura water transfer consists of a 256-kilometre canal and a series of reservoirs and dams

Another measure contemplated by the 1985 Water Law was the creation of a community of groundwater users to help implement the new regime of groundwater abstractions. In La Mancha, the General Community of Irrigators of Aquifer 23³⁶² was created in 1996 after the final declaration of overexploitation of the aquifer was issued on the 15th of December 1994.³⁶³ The General Community operates as a federal structure unifying 20 individual Irrigation Communities from 20 different municipalities and representing about 17,000 farmers (Lopez-Gunn 2003).³⁶⁴

Despite these measures, the decrease in groundwater levels across the Mancha Occidental aquifer continued, and in 1996 the piezometer controlling the groundwater levels at the iconic *Ojos del Guadiana* registered a decrease to a minimum record of almost 41 metres (Figure 7.21). This lack of significant improvement in groundwater levels can be attributed to widespread unregulated groundwater abstractions enabled by the 1985 Water Law and European Community subsidies between 1986 and 1992 (Martínez-Santos et al. 2008). These subsidies were linked to the Common Agricultural Policy favouring water intensive crops such as corn, beetroot and alfalfa once Spain entered the European Community in 1986 (Martínez-Santos et al. 2008;

regulating an average flow of 33 m³ per second. Between 1979 and 2002 this water transfer had carried 331 Mm³ per year (Morales Gil et al. 2005).

³⁶¹ This option was consolidated in 2009 when an emergency water transfer was approved in order to bring water back to the wetland after an especially dry summer, which provoked the combustion of underground peat (Consejo de Ministros 2009).

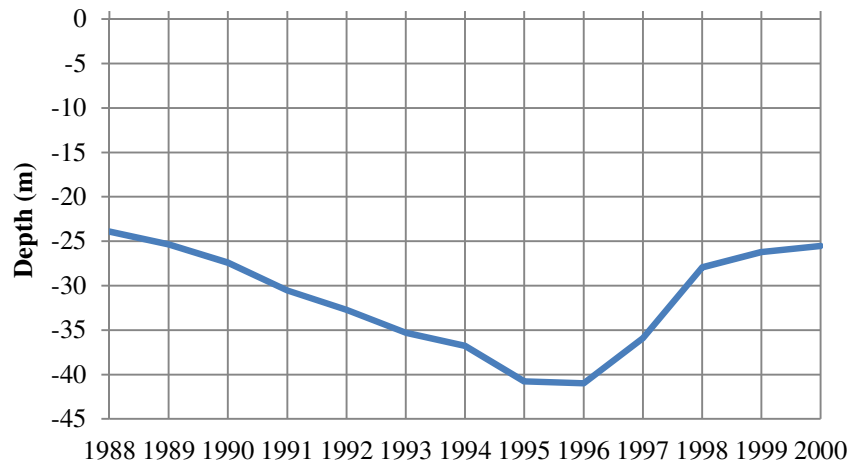
³⁶² *Language note:* ‘Comunidad General de Regantes del Acuífero 23’ in the original Spanish language.

³⁶³ The governing board of the Guadiana River Basin Authority approved the definitive declaration of overexploitation for the Mancha Occidental aquifer on the 15th of December 1994 (www.chguadiana.es, last accessed 13th of November 2012).

³⁶⁴ The origin of some of these 20 individual irrigation communities (or Water users Associations following Lopez-Gunn 2003) dates back to 1989 and their size varies according to the number of hectares for irrigation declared by its members. The community of irrigators of Alcázar de San Juan is the largest, with more than 35,000 hectares and 1,431 members, although the Community with the largest number of members is Daimiel with 2,288 members (Lopez-Gunn and Hernández-Mora 2001).

Pulpón 2009). Thus, intensive irrigation continued in La Mancha despite legal sanctions³⁶⁵ and monitoring of illegal groundwater abstractions.^{366, 367}

Figure 7.21 Annual average piezometric level at the *Ojos del Guadiana* (1988-2000)



Note: The average piezometric depth is based on readings from the water supply well for Daimiel at the *Ojos del Guadiana*.

Source: Based on data from the Centro de Interpretación del Agua, Daimiel.

Additionally, a 5-year agro-environmental plan was set up in 1993 by the European Commission to compensate farmers wishing to stop or reduce groundwater

³⁶⁵ Sanctions for an aquifer under declaration of overexploitation were in place according to the 1985 Water Law. These refer to the deepening of existing wells, change of well location and drilling of a new well. These sanctions can range from 3,000 to 30,000 euros per farmer (Lopez-Gunn 2003).

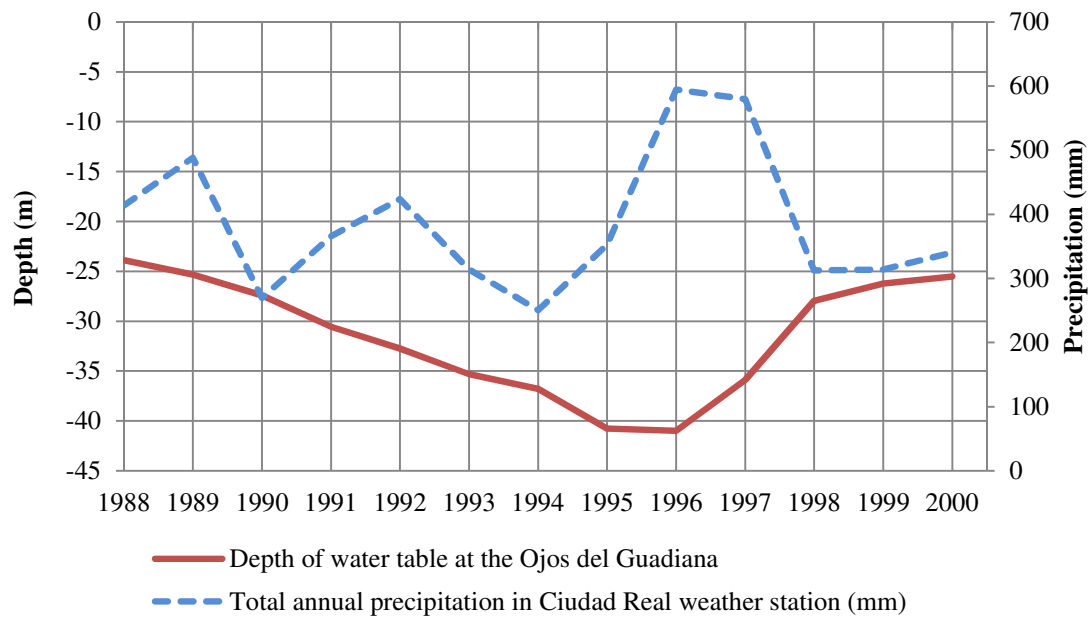
³⁶⁶ Monitoring and sanctioning measures are difficult to implement in the Mancha Occidental aquifer, occurring only for those farms subscribed to the European Union programme. It was only from 1996 onwards that water meters were installed and systematically read (Lopez-Gunn 2003). A system of remote sensing control and a service of guards overseeing extractions were also set up. The problem remains, however, as there are only four guards for an area of 5,500 km² (i.e. the total surface of the Mancha Occidental aquifer) and the River Basin Authority has neither facilitated the work of the water users associations nor devolved or decentralised any powers (Lopez-Gunn 2003).

³⁶⁷ A posteriori, the set of policies to control and reduce the groundwater abstraction levels in La Mancha include the PEAG (Special Plan for the Upper Guadiana), approved by Royal Decree on the 11th of January 2008. On the 14th of June 2008 UNESCO threatened to cancel the status of the Las Tablas de Daimiel as a biosphere reserve. UNESCO gave the Spanish government until 2011 to regenerate the wetland or it would no longer be declared a protected reserve in 2015 (EL PAÍS 2008). The PEAG plan aimed at achieving a sustainable use of the aquifers in the Upper Guadiana river basin by transforming private groundwater abstraction rights into concessions, public acquisition of private groundwater abstraction and land, and also by establishing contracts to exchange groundwater abstraction rights between users. Its target was to purchase 130 Mm³ between 2008 and 2015 and established a parallel process of land purchase around the National Park of Las Tablas de Daimiel (Lopez-Gunn et al. 2010; Ministry of Environment, Special Plan for the Upper Guadiana, Annex 1, Rules, www.chguadiana.es, last accessed 21st of November 2012).

use for irrigation (Fornés et al. 2000; Martínez-Santos et al. 2008).³⁶⁸ The European budget provided 75 percent of the funds for the programme with the Spanish Ministry of Environment contributing 12.5 percent and the regional government of Castilla-La Mancha another 12.5 percent. The programme was extended for the period 1998-2001 with the aim of further reducing groundwater abstraction in the Guadiana river basin (Martínez-Santos et al. 2008; Rosell and Viladomiu 1997). According to Rosell Foxà (2001), out of 8,000 farmers in the aquifer, only 2,587 farmers had adhered to this programme by 1998, that is farmers who “had forfeited their pumping rights in exchange for economic compensation” (Martínez-Santos et al. 2008: 516). As Martínez-Santos et al. (*ibid.*) point out, however, the relative success of this measure can be attributed to the passivity of farmers and insufficient incentives to modernise irrigation systems. At the same time, the agro-environmental plan did not cover irrigated surfaces with groundwater abstractions nor recognised by the Guadiana River Basin Authority (Rosell and Viladomiu 1997). Additionally, an extremely wet period between 1995 and 1997 could have masked the results of such a policy (Martínez-Santos et al. 2008) (Figure 7.22).

³⁶⁸ In terms of groundwater abstractions, the goal of the agro-environmental plan was to reduce by 240 Mm³ per year the total groundwater abstraction by farmers in exchange for variable economic compensation for 100 percent, 70 percent or 50 percent of the groundwater abstracted volume (Rosell Foxà 2001).

Figure 7.22 Average piezometric levels at the *Ojos del Guadiana* and precipitation in Ciudad Real (1988-2000)



Note: Average piezometric level water is based on readings from the water supply well for Daimiel at the *Ojos del Guadiana*.

Source: Based on data from AEMET and Centro de Interpretación del Agua, Daimiel.

7.5 Discussion: bringing the state back into groundwater studies in

La Mancha

As this chapter has examined, the role of the state, through agrarian subsidies and groundwater abstraction legislation, sustained the development of groundwater irrigation in La Mancha. Coupled with colonisation and irrigation politics, these policies laid down the foundations for the development of private and individual irrigation. A direct quote by Velasco Lizcano (2002: 210-211) from a gathering in Ciudad Real gives a sense of this direct public endorsement of irrigation and groundwater abstraction by the state in La Mancha:

“[...] the 13th of July 1973, at the Provincial Delegation of Agrarian Unions in Ciudad Real and in front of a conference room full of farmers and agrarian landowners, the Administration wanted to inform the interested parties about a hydrological study of the Province: the very recently finished project for the investigation of the medium and Upper Guadiana Basin. For that purpose a large amount of important authorities were gathered (amongst them the General Director of Mines and the Director of the Geological and Mining Institute of Spain, as well as the Civil Governor and other authorities) along with scientists and technical experts from the different Departments and Organisms involved with the management of water. [...] Don José Abad, General Director of Mines said: ‘there are encouraging perspectives of having water, which would mean the transformation of agriculture in the affected regions. With this we would prevent emigration from these villages that at the moment do not have means to subsist.’”³⁶⁹

Agriculture production changed as a result of state policies which initiated the transformation of the countryside from dry farming into irrigation. The advent of intensive irrigation for agriculture and state-sponsored economic development became the decisive factor in the use of groundwater resources found in abundance in La Mancha. This sustained the emergence of groundwater socio-ecologies linked to the intensive use of this resource in order to satisfy large demands of agricultural products that would then be exported or consumed nationally.

Based on this chapter, it is possible to revisit the role attributed to private initiative and the individualism of farmers in the development of groundwater-fed

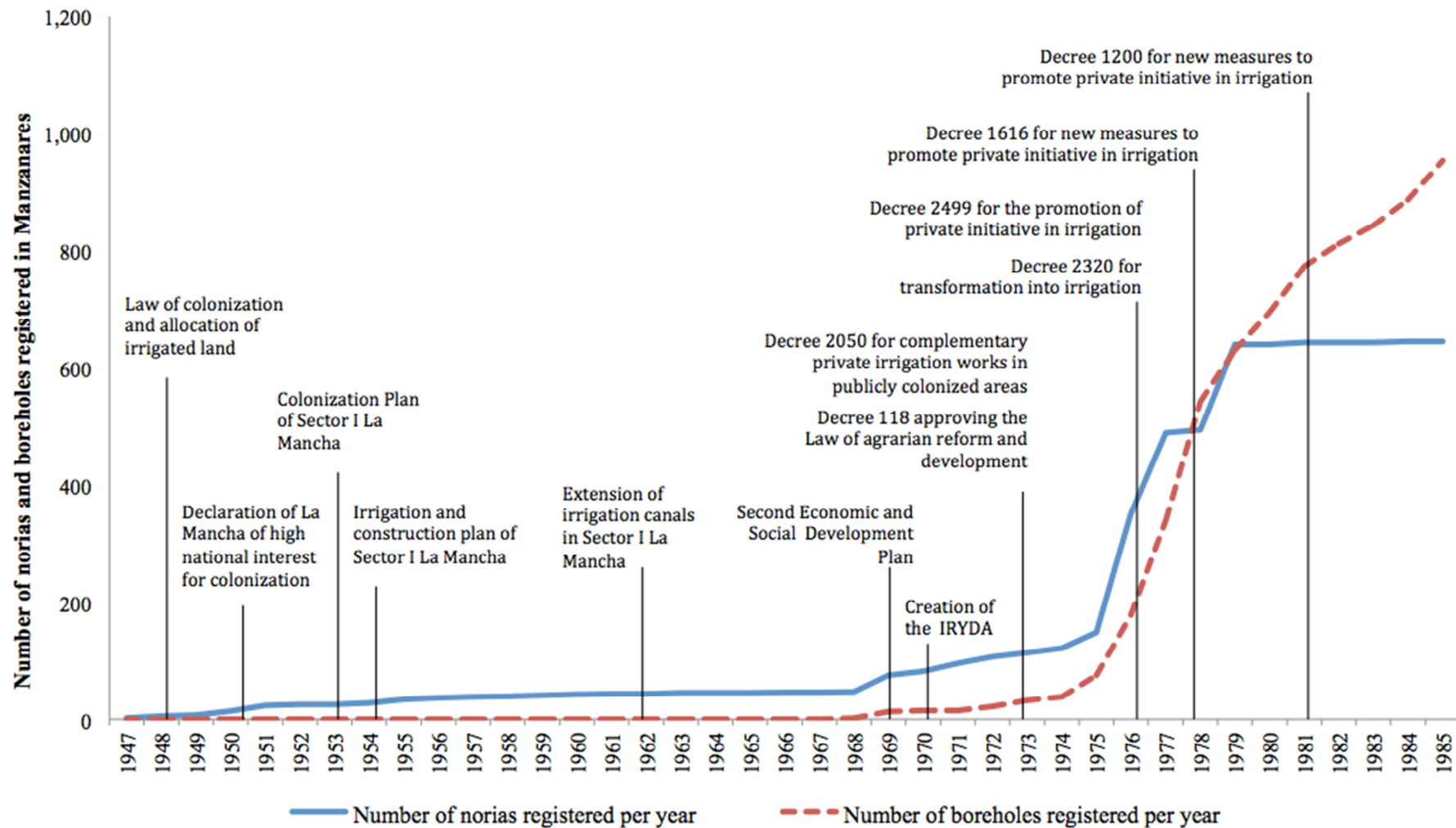
³⁶⁹ Author’s translation from original quote in Spanish.

irrigation – i.e. the ‘silent revolution’ thesis (Fornés et al. 2005); Llamas and Martinez Santos 2005a), and to postulate that the state had a major role in the development of irrigation in La Mancha.³⁷⁰ Due to a lack of regulation, legal checks or balances, an atomised and anarchic technology adoption process followed, bringing environmental degradation and the production of groundwater scarcity for ecosystems that was outside the control of the state.

In La Mancha, the study of the degradation of the environment has to be contextualised by broadening the scope of water studies and acknowledging the historical processes linking water management with society, irrigation and politics. It also has to include the role of the state, substantiated by the socio-political and historical study of irrigation policies. Thus, state decrees promoting private irrigation match the evolution of the number of groundwater abstraction devices in Manzanares (Figure 7.23). Direct state-rule through colonisation and irrigation politics and the creation of irrigated landscapes around towns like Llanos del Caudillo were complemented and extended by processes of indirect state-rule through the promotion of private irrigation and the access to markets for crops.

³⁷⁰ In India, Mosse (1997) has already made us aware of the fact that socio-cultural structures underlying water management structures go deeper into society and history than irrigation technology and design itself, and that irrigation structures did not come into being as autonomous systems “isolated from the state” (Mosse 1997: 477).

Figure 7.23 State decrees, colonisation and the adoption of groundwater abstraction technology for irrigation in La Mancha (1947-1985)



Source: Author.

Chapter 8 . Conclusions

The groundwater ‘silent revolution’ thesis (Fornés Azcoiti et al. 2005; Llamas and Martínez-Santos 2005a) has helped characterise the intensive adoption of modern groundwater abstraction technology in Spain and around the world (e.g. Birkenholtz 2006, 2009a; Shah 2009). By asserting that farmers’ private initiative to maximize revenues with the availability of new technology, the silent revolution links groundwater development by individual farmers with over-abstraction and ecological degradation of groundwater resources. The state emerges often as a distant and passive actor with farmers the main protagonists in environmental degradation for private profit. However, limited empirical data fail to substantiate the hypothesis and describe the underlying socio-political processes affecting local rural communities and management of groundwater resources. Similarly, the study of the hydraulic mission in Spain (e.g. Lopez-Gunn 2009; Sauri and del Moral 2001; Swyngedouw 2007) has concentrated on general state-level socio-political processes helping unravel the nature of the state in the management and control of water resources. Notwithstanding, this approach also lacks of empirical substantiation and local focus, leaving largely unexplored the impacts of state politics on local communities.

A major contribution of this research to the literature has been to broaden the political and institutional analysis of groundwater use including the explicit role of the state in technological change and farmer responses at the local level. Moreover, the empirical and theoretical motivation for this thesis also arose from the need to to unpack the ‘hydraulic mission’ (Molle et al. 2009) in the context of studies on water politics in Spain (Swyngedouw 1999, 2007), and to introduce ‘scale’ (Perry 1988) as an essential component of state-led water politics. Original empirical data from both

previously unreported archive resources and records of groundwater technology adoption over decades provide unique insights into the relative roles and impacts of the state, market and farmers on the development of groundwater abstraction technology. Findings put forward new insights into both the direct and indirect mechanisms by which the state influences irrigation technology, market formation and performance with associated impacts on groundwater use. The data set from the Community of Irrigators in Manzanares helped empirically establish for the first time the sequence of historical events and mapped out the various policies affecting the adoption of groundwater abstraction technology in La Mancha. Archive research on state colonisation and irrigation policies in the same area complemented these data and contextualised within a wider political framework the development of public irrigation plans in La Mancha. Thus, these results demonstrate the validity but narrow scope of the existing 'silent revolution' hypothesis with significant implications for groundwater research and policy in Spain and beyond.

Theoretically, this research focused on the hybrid nature of irrigation technology to express its material and political duality (Latour 1993, 2004; Mollinga 2003). The use of governmentality (Agrawal 2005; Foucault 1988a) expanded this view and introduced different modalities of state-rule and state politics into the study of irrigation technology. This has helped substantiate the role of the state in the development of groundwater abstraction technology and allowed bridging the scale barrier between centralising state-led irrigation policies and the effects on local communities (i.e. the creation of irrigation subjects in Llanos del Caudillo).

Through the case study of Manzanares and Llanos del Caudillo in La Mancha, this study has emphasised that the development of irrigation with groundwater in La Mancha sits at the intersection between the state, farmers, the use of technology,

access to markets and the environment. However, each one of these components is necessary but not sufficient. The state sponsored irrigation through direct colonisation of land but also through subsidies and marketization of products. Local farmers at the same time saw the opportunity to increase revenues by adopting new agrarian techniques and accessed newly created markets while tapping into a shallow aquifer. And finally, the introduction of modern drilling techniques and groundwater abstraction technology sustained this process. Thus, the establishment of groundwater socio-ecologies in La Mancha results from the historical coalescence of these different aspects within a specific context of indirect agrarian subsidies, de-regulation of groundwater abstraction rights, and direct state rule over settlers. As a result, water scarcity became a product of the constant interaction between farmers, the state, technology and the environment.

The structure of this concluding chapter is the following. First, it summarises the hypotheses and findings of this thesis reflecting the main characteristics and impacts of the adoption process of groundwater abstraction technology and the role of the state in the development of irrigation in La Mancha. After this section, this chapter puts forwards a set of research topics for further consideration outside the scope of this thesis but still relevant to the understanding of groundwater socio-ecologies in La Mancha.

8.1 The role of the state in the adoption of groundwater abstraction technology in La Mancha

This research has established that a process of state rule sustained the intensive adoption of technology for groundwater abstraction in La Mancha. This

‘silent revolution,’ previously seen as dependent on the explosive growth of irrigation from individually owned groundwater wells, was sustained by direct and indirect state intervention. As described in Chapters 4, 5, and 7, the establishment and growth of irrigation in La Mancha became directly and indirectly dependent on state intervention and state agrarian reform policies. Thus, socio-political processes involved in the development of groundwater at the local level point centripetally towards the state. The state, directly through colonisation plans in Llanos del Caudillo by the INC, and indirectly through subsidies, agrarian credit available for farmers and other policies aiming at supporting the modernisation of agriculture, was essential in the development of groundwater in La Mancha (Table 8.1).

Table 8.1 State direct and indirect rule over irrigation in La Mancha

<i>Direct rule</i>	(i) Establishment of colonisation areas (ii) Respect of land property (iii) Creation of irrigation subjects: the settlers of Llanos del Caudillo (iv) Direct hierarchical and administrative control over settlements (v) Introduction of groundwater abstraction technology and scientific studies in colonised areas
<i>Indirect rule</i>	(i) Funding of subsidies for the development of modern irrigation structures (ii) Public spending in large infrastructure schemes – modernisation of the countryside and agrarian revolution (iii) <i>Laissez faire</i> : lack of rule of water abstractions with existing 1879 water law

Source: Author.

Following del Moral (1999: 183), the INC’s colonisation activities ‘unblocked’ the irrigation of large areas of land. In La Mancha, colonisation and state irrigation plans developed the first hydrogeological studies and introduced modern groundwater abstraction technology as the spark that triggered the development of intensive groundwater irrigation in La Mancha (Chapter 5). The development of technical and hydrogeological knowledge was also accompanied by the arrival in La

Mancha of irrigation expertise and know-how with drilling companies from other regions in Spain such as Mallorca, Murcia and Valencia. Foremen coming to work for the INC in the colonised areas were originally from these same regions and were brought to train the settlers in the colonised areas.

Through different decrees between 1976 and 1982, the availability of more than 86,000 million pesetas³⁷¹ in state sponsored credits to fund private irrigation initiatives became essential to sustain the development of new groundwater abstraction technology (Chapter 7). Additionally, state subsidies for diesel and also for agricultural production (up to 135,000 million pesetas in 1985³⁷²) drove the increase in demand for groundwater abstraction technologies. State-subsidies prioritising investments in irrigation structures and the modernisation of agriculture also served as an incentive for farmers to invest in new boreholes. These subsidies along with rapid revenues obtained from crop productivity made the development and drilling of boreholes appealing and also allowed most farmers to rapidly recover those initial investments. Moreover, these financial incentives were essential in sustaining and scaling up the rate of adoption of modern boreholes in La Mancha. The effect of such financial incentives set up by the state and high revenues from crops in the market ‘democratised’ the access to groundwater abstraction technology for less wealthy farmers.

Additionally, the role of the state in the development of groundwater abstraction technology has been accentuated by considering the material and political aspects of irrigation technology serving economic, political and ideological purposes (Chapter 2, 4, and 5). Publicly funded state irrigation programmes such as Llanos del

³⁷¹ Equivalent to approximately 782 million USD in 1982 (with the currency exchange rate peseta/USD in 1982 = 109.92. Carreras de Odriozola and Tafunell Sambola 2006).

³⁷² Equivalent to approximately 1,230 million USD in 1982 (with the currency exchange rate peseta/USD in 1982 = 109.92. *ibid.*).

Caudillo aimed at structuring agrarian society around farmers' productivity in a political and ideological context of dictatorial rule. In Llanos del Caudillo, the drilling, operation and maintenance of groundwater wells (i.e. the material aspects of groundwater technology) by the state sustained the creation of a new irrigated landscape. New means of agricultural production and social organisation in new settlements appeared linked to state politics through public colonisation and irrigation plans. As a political technology, the operation of wells by the INC connected social and political structures with the natural environment. Furthermore, boreholes drilled by the INC enabled public-state control over farmers and the creation of a new polity in the form of irrigation towns, integrated within a system of control and surveillance of new irrigation subjects – i.e. the settlers (Chapter 4 and 5). Thus, the effects of the use of modern technology led to the economic development of the countryside but also the ideological and symbolical development of Franco's Regime through an agrarian revolution.

The development of groundwater abstraction technology by farmers also benefited from a *laissez faire* attitude from the state, or 'active passivity' as Geertz (1980: 131) has called it (Chapter 7). The structure of water abstraction rights benefitted from a historical lack of checks and balances arising from a lax institutional and regulation system inherited from the 1879 Water Law. With the new 1985 Water Law, the reticence of groundwater users to lose any formal historical private rights was coupled with the inability, lack of funds and the politically controversial aspect of the enforcement of control measures by the state. This led to a situation where thousands of wells have been drilled outside the regulatory framework established by the 1985 Water Law (Fornés Azcoiti et al. 2005).

8.2 The characteristics of the adoption of groundwater abstraction technology in La Mancha

Data from the Community of Irrigators in Manzanares corroborates the thesis of a ‘silent revolution’ with a quick and intense groundwater abstraction phenomenon occurring in La Mancha in the 1960s and 1970s. However, analysis of the Manzanares data set has also helped characterise this process and establish its evolution in time. According to the data analysis, although the adoption process of groundwater abstraction technology in Manzanares spanned from 1968 to 1979, the real explosion in the use of technology happened in the year 1975. It is in this year when it is possible to observe an inflexion point in the total number of drilling permits for norias and boreholes.

The curves depicting the adoption of groundwater lifting technologies in Manzanares also indicate a coexistence period between traditional and modern groundwater technologies from the early 1950s to 1985 when a similar number of norias and boreholes were operating in La Mancha. Analysis of the curves suggests that the adoption of traditional water lifting technologies reached its peak in 1979 and later stagnated due to a number of factors making it obsolete in comparison to modern boreholes (e.g. design characteristics, depth of water table, need for higher groundwater abstraction volumes). The existence, at least at first, of a shallow aquifer allowed traditional norias to be used in La Mancha prior to the ‘silent revolution’. The use of modern boreholes in Manzanares however was limited to the early 1970s and onwards. Until then, modern pumps were rare and had little impact on the extension and use of traditional water lifting technologies. Except for colonisation towns such as Llanos del Caudillo benefitting from government investment and infrastructure

(Chapter 5), irrigated agriculture was still maintained by traditional water lifting technologies until the mid 1970s. In 1975 however this trend was altered and a change in the pattern of adoption of groundwater abstraction technology appeared in La Mancha: boreholes became prevalent and the use of traditional norias residual. The crossover between both technologies suggests that traditional norias were still in use until water levels reached a certain depth (around 25-30 metres). After this depth, modern water lifting technologies took over due to design limitations of the norias as well as benefits boreholes provided to farmers and state subsidies for the amelioration and modernisation of irrigation. Thus, boreholes in La Mancha can be seen as an innovation with a high degree of relative advantage³⁷³ with regards to traditional groundwater abstraction technologies. As described in Chapter 6, the development of modern groundwater abstraction technologies in La Mancha was sustained by the demonstrated benefits of this type of technology for irrigation over the traditional design of wooden and iron norias.

Groundwater abstraction technology was also subject to endowed economic and financial capital determining the use of diesel versus electric engines (Chapter 6). Access to electric engines was limited by income given its higher investment and installation costs (since most of the countryside was without electricity). However, state subsidies for diesel allowed farmers to access cheaper technology and abstract water. Relative socio-economic homogeneity in terms of geographical proximity and similar land ownership structures within the population of farmers sustained the adoption of groundwater abstraction technologies. Geographical proximity also facilitated communication between farmers who shared the experience from other

³⁷³ The term 'relative advantage' refers to Rogers' (2003) characteristics of technology innovations where the 'relative advantage' of a technology innovation indicates the degree of improvement brought by such innovation.

areas already irrigated (e.g. Llanos del Caudillo) leading in many cases to imitation across the community.

8.3 The production of groundwater socio-ecologies and scarcity in La Mancha

Changes in agrarian mechanisation, such as groundwater-fed irrigation with boreholes, sustained the development of intensive agrarian production and the green revolution in La Mancha. This revolution represented “a true industrialisation of the agrarian space” with wider economic consequences within the agrarian production sector in Spain (Ortega Cantero 1983: 132). As observed in Chapter 7, increase in agricultural production and irrigated land surface drove the economic development of La Mancha and sustained the development of intensive agrarian production. As a result, the natural, social and economic landscape of La Mancha changed through the intensive use of groundwater, commodification of cash crops such as alfalfa and beetroot and access to new markets for new agricultural products. This green revolution occurred through state intervention including agrarian reform, political economy measures and public subsidies. A large population of farmers in La Mancha accessed economic development and higher revenues by installing boreholes, an effective and modern type of technology capable of high abstraction yields. The rapid expansion of irrigation through new boreholes, modern pumps and subsidised diesel prices helped farmers diversify and increase the irrigated surface of water-intensive crops whilst ensuring an economically sustainable source of income.

Access to a minimum farm size by farmers was also a relevant factor in the development of groundwater abstraction technology in La Mancha (Chapter 5 and

Chapter 6). Although Shah (2009) has posited that the development of groundwater socio-ecologies in Spain is mainly driven by the scarcity of surface water, this research has shown that access to a minimum farm size was also relevant for the development of groundwater-fed irrigation in La Mancha. On the one hand, access to land and the development of irrigation in La Mancha was viewed by the state as an internal geopolitical process, preserving the structure of rural communities and serving the ideological purpose of maintaining the hierarchy of state power. On the other hand, the ownership of land prior to the advent of modern boreholes in Manzanares sustained the initial investment in irrigation for farmers. As the socio-economic characteristics of groundwater technology adopters show (Chapter 6), structures of land ownership with a majority of small and medium size farms (5 to 30 hectares) were maintained throughout the process of adoption of modern technology. In the colonised areas, access to land ownership by farmers facilitated the fascist political discourse by participating in the political, symbolic and ideological construction of a new community of farmers. It also made them dependent on private property therefore constructing them as more ideologically conservative. The power relations established between settlers and the state were based on state rule within colonisation sites. These relations underpin various forms of society construction and social interaction in the newly created towns and irrigated landscapes as well as producing new 'irrigation subjects'.

The depletion of groundwater reserves in La Mancha exemplifies the complex and intertwined reality between natural and social systems. Historical non-regulation of groundwater abstraction and the impact of the state has resulted in the depletion of aquifer levels and the social and political production of groundwater scarcity. The effect of adoption of modern irrigation coupled with state subsidies and a lack of

regulation of water abstraction rights resulted in environmental stress and groundwater depletion: an instance of produced water scarcity due to the ‘active passivity’ of the state. Thus, the production of scarcity in La Mancha sits at the intersection of state practices, technology use and farmers’ individual behaviour. These processes have had serious environmental consequences such as the underground burning peat in the Las Tablas de Daimiel wetland. Thus, as shown in this research, the understanding of environmental degradation in La Mancha has benefited from the historical study of the role of the state in groundwater irrigation.

8.4 Hybrid technologies, irrigation communities and environmental degradation in Spain

This research has brought together three analytical perspectives in order to examine the role of the state in the development of groundwater abstraction technology and environmental degradation in La Mancha. By bringing together pre-existing research on the ‘silent revolution’; an understanding of the hydraulic mission and agriculture and irrigation politics in Spain; and a characterisation of groundwater abstraction technologies as hybrid material/symbolic structures, this research has outlined the various mechanisms used by the state in the development of groundwater abstraction, irrigation and environmental degradation in La Mancha. Following this analytical focus, this research has shed light on the creation of farming and irrigation communities in Llanos del Caudillo and Manzanares, contextualising the production of groundwater scarcity as the result of state practices, farmers’ individual behaviour, access to technology and markets.

As this research has also shown, the social, political and technological aspects of irrigation technology cannot be dissociated analytically. Boreholes populate the irrigated landscapes of La Mancha and bring together the human and non-human in environmental studies (Birkenholtz 2009b). The material characteristics of groundwater wells have been described and explored in detail in Chapters 2 and 6. These findings have helped characterise and describe in detail for the first time, the specificities of the process of adoption of groundwater abstraction technology in La Mancha. However, this information does not suffice to explain the particular processes and dynamics of the development of technology for irrigation in La Mancha. As also explored in Chapter 2 these technological devices can be characterised as hybrid structures, with both material form and symbolic characteristics. Adding this dimension enables the understanding of the social, political and economic processes revolving around the sponsorship of groundwater technology in La Mancha by the state (Chapter 4, 5, and 7). Theories of governmentality focusing on colonisation and irrigation politics as technologies of power have facilitated the understanding of the direct engagement by the state in the development of irrigation communities in La Mancha (Chapter 4 and 5 with the creation of Llanos del Caudillo). Furthermore, they have enabled the analysis of the production of specific individuals (i.e. the settlers as ‘irrigation subjects’) as part of a larger programme of territorial and population control in the hands of the state. Moreover, study of the political economy of irrigation and agriculture development in Spain, referring particularly to state credit and subsidies for farmers (Chapter 7) has helped characterise the indirect means used by the state to foster modern irrigation.

In order to understand the reality of environmental degradation and decreasing groundwater levels in La Mancha, the relationship between technology adoption, state

politics, and local communities has to be properly understood both in its form and also through time. The use and development of groundwater abstraction technology for irrigation in La Mancha intersects with particular historical periods in Spain. Franco's dictatorship undertook extensive development plans in the area in the 1950s and 1960s and introduced modern techniques and knowledge from the outside in order to irrigate the plains of La Mancha. It was also in this period that the state carried out the first geological studies, mapping and quantification of groundwater resources in the area. The rapid spread of boreholes that followed a decade later responded also to state intervention, this time indirectly through subsidized diesel for pumps, subsidised schemes for irrigation modernisation and state credit, representing an important economic effort to modernise traditional irrigation and farming. The results of this process were the intensive abstraction of groundwater by farmers, unconstrained by a permissive water law and lack of regulation of groundwater abstraction rights. Focusing on both the historical development of groundwater abstraction technology and the role of the state brings to life mechanisms inherited from past political regimes, previously concealed by a narrative of individual development, market forces and short term economic benefits, as postulated by the authors of the 'silent revolution' thesis.

In this research, the development of irrigation through boreholes is also shown to be part of a wider plan to promote agricultural development and modernisation in impoverished areas. However, irrigation and colonisation plans also appear as part of a deeper and more fundamental system of political and ideological legitimization, established on the basis of creating 'irrigation subjects' in towns such as Llanos del Caudillo. State use of specific technologies of control over these subjects – physical, administrative and ideological – portrays a vast operation put in place by the regime in

order to sustain and perpetuate itself. Thus, the borehole takes a prominent role, not as the fundamental element driving the development of irrigation and groundwater socio-ecologies in La Mancha, but as the main instrument used by farmers and the state to fulfil their various objectives.

As examined in this research, groundwater abstraction structures represent linkages between society and nature, farmers and groundwater. The ramifications expanding from the explored material/symbolic duality of boreholes reach social, political, economic and environmental spheres: from individual farmers at the local level to the centralising bureaucracies of the INC, the Ministry of Agriculture, the state's economic policies and planning, and the burning wetlands of La Mancha. These structures bring form and substance to the processes of social and economic development as well as environmental degradation in La Mancha. As Robbins pointed out, groundwater wells appear as 'agents of socio-ecological change' (Robbins 2001a in Birkenholtz 2009b: 133). Thus, groundwater management practices have unfolded through time, sustaining and assembling together individuals, the state and the environment.

With the presence of an initially shallow groundwater table, the ecological and natural reality of La Mancha both enabled and constrained such a process, establishing natural boundaries to the expansion of irrigation. This process was exacerbated by a lack of a proper legal and regulatory framework at the time. The production of scarcity, which went from a local to a regional scale, was ensured at the individual level by anarchic practices, a lack of state regulation and direct and indirect rule in irrigation modernisation. It is the coalescence of these two processes that ultimately drove the depletion of groundwater reserves in the aquifer. The point emphasised in this thesis is that the local and regional production of water scarcity

was not driven largely by farmers themselves but was produced externally by central state politics. Such instances of ‘produced localities’, borrowing Appadurai’s words (Appadurai 1997 in Mosse 1997: 498), revolved around the drilling, operation and use of groundwater abstraction technology, which in turn produced irrigation subjects as well as specific endangered environments.

8.5 Further research

8.5.1 Systems of landownership, local patronage and groundwater socio-ecologies in Spain and La Mancha

Landownership in Spain is part of a history of privilege, class and power. Large estates in Central Spain were acquired in the nineteenth century by wealthy bourgeoisie and landowners during the different public land seizure, perpetuating rigid social and political divides in the countryside. As Edward Malefakis (1970: 12) wrote, Spain has a long history based on the pre-eminence of agriculture and “an understanding of Spanish land tenure is essential to a comprehension of the economic, social, and political life of Spain.” Power and authority were articulated through landownership, diffused networks of patronage, alliances, power and social favours (i.e. *caciquismo*) in the nineteenth and early twentieth century. Moreover, subterfuges established by the state during Franco’s regime allowed private owners in ‘colonisable areas’ to preserve part of their wealth through claims against, or compensation for, land expropriation. Considering these observations, the question that arises is whether these existing structures of landownership have had an impact

on the development of modern irrigation in La Mancha.³⁷⁴ Landownership structures played a key role in La Mancha due to the fact that they were closely tied to social and political power as well as wealth. A potential avenue for future research would be considering the links between the system of landownership and the adoption of modern irrigation technology and groundwater socio-ecologies.³⁷⁵

8.5.2 Social capital in groundwater socio-ecologies

In Spain, Putnam's concept of social capital³⁷⁶ has been applied to explain the behaviour of irrigators in instances of formally established institutional arrangements after the 1985 Water Law (Lopez Gunn 2003, 2012). However, studies examining the role of social capital in groundwater management in previous historical periods are yet to be conducted. While the process of adoption of groundwater technology during the 1960s and 1970s was devoid of any formally institutionalised structure regulating

³⁷⁴ In Castilla-La Mancha, social and economic structure found its roots in landownership, which varied in each of the five provinces (Albacete, Ciudad Real, Cuenca, Guadalajara, Toledo) (Carrion 1975). According to Moreno Luzón (2001), it is in the province of Ciudad Real where the aristocracy had the most prominent role in Castilla-La Mancha during the Restoration through the ownership of large land plots acquired during the land public land seizure. In Manzanares, municipality pertaining to the province of Ciudad Real, the link between agrarian bourgeoisie and political power was also consolidated through landownership. Mayors were always elected amongst the largest tax contributors, which were at the same time closely connected with the notable men of the district" (Bermúdez 2008: 28). According to Bermúdez, "the concentration of land property in the hands of a few large landowners gave place to multiple situations of dependency of the lower social classes" (*ibid.*).

³⁷⁵ As shown by Shah (2009) in South Asia, the study of groundwater socio-ecologies has to be substantivised with a consideration of land ownership structures as their result has an impact on the development of groundwater abstraction technology for irrigation. As Dubash (2002: 14) also proved in India, "the distribution of landownership and the extent of land subdivision and fragmentation affect the development and use of groundwater. More precisely, the relative fit between the scale of available irrigation and the scale of cultivation influences the economic viability of groundwater irrigation in any given region."

³⁷⁶ Since its origin in the 1980s, the concept of social capital has been the subject of a renewed strand of studies (Portes 1998), and has influenced the work of anthropologists, political scientists and development economists in the 1990s (e.g. Mosse 2006; Putnam 1993, 1995; Pretty and Ward 2001). In particular, Robert Putnam's (1993) construction of social capital helps elucidate what Mosse (2006: 712) has called the interactions amongst individuals facilitated by networks, norms and trust enabling "coordination and cooperation for mutual benefit."

groundwater management, it is unclear as to whether it was also devoid of social structures or social interaction. Were there any forms of collective action during the irrigation-led agrarian boom in La Mancha? And if so how did they structure social, political and economic relations in the countryside? Moreover, how is the link between social capital and land ownership maintained and reproduced in La Mancha and what has been its impact on groundwater technology adoption?

8.6 Final considerations

One of the main purposes of this research has been to complement the focus of the hydraulic mission on surface water in Spain and extend it to groundwater with the case study of irrigation politics in La Mancha. With data collected from Manzanares, this research has emphasised the relationship between irrigation technology, groundwater and the state and has also illustrated with empirical data the development of groundwater technology and its effects on society and the environment (Table 8.2).

This research has confirmed that there was a ‘silent revolution’ in La Mancha between 1965 and 1975 and established its main characteristics, intensity and evolution. The trend of technology adoption suggests a process of progressive accumulation leading to the development of modern agrarian production systems. The slow accretion of changes in agrarian production systems as well as different policies, subsidies, colonisation plans and the promotion of private irrigation prepared the ground for the explosion of groundwater abstraction technologies.

Table 8.2 Effects of the development of modern groundwater-fed irrigation in La Mancha

<i>Effects</i>	<i>Description</i>
<i>Technical</i>	Development of new hydraulic infrastructures and introduction of new groundwater abstraction technology
<i>Social</i>	Creation of new towns, new social structures and new communities of 'irrigation subjects'
<i>Political</i>	Developing power structures and ideology during Franco and maintenance of land property in the countryside
<i>Economic</i>	Introduction of intensive agrarian production for markets: new crops and productivity increase
<i>Environmental</i>	Depletion of groundwater reserves, disappearing flooded surface of the Las Tablas de Daimiel wetland and instances of burning peat

Source: Author.

This thesis has also demonstrated the crucial role of the state in the development of irrigation and agrarian transformation in Spain. A series of subsidies and state policies aimed at the development of agriculture with irrigation fuelled this phenomenon. Building on this, a key policy direction to consider is that when state-sponsored irrigation is developed (such as in Spain between the 1960s and 1980s) it has to be complemented with regulation and control of groundwater abstractions, water use and the impacts on the environment. As this thesis has established, the lack of regulation existing as a consequence of the system of private groundwater rights and the lack of appropriate controls in Spain resulted in the depletion of groundwater levels and the development of an unsustainable socio-economic and natural disequilibrium.

Despite changes in legislation brought by the new 1985 Water Law sustained the creation of collective aquifer management institutions with regulatory powers, the acceptance of this new regulatory framework by water users remains incomplete due to a highly politicised water management arena. Moreover, the lack of trust by many

individual farmers has also undermined the potential benefits and effectiveness of the associations of groundwater users for local communities of irrigators (Fornés Azcoiti et al. 2005).³⁷⁷ Despite different state-wide programs since the mid-1990s to establish an inventory of groundwater rights, the results have been partial and inconsistent due to lack of funding and difficulties in obtaining the cooperation of farmers and well owners (*ibid.*).

In La Mancha, the historical legacy of state water politics and colonisation has marked the development of groundwater. By recounting the use and development of groundwater abstraction technology, this research has contributed to bringing the state back to the centre of historical studies on irrigation in Spain. This thesis has established the imprint of state policies on the development of irrigation and groundwater through both direct and indirect rule. As a result of these findings, a proposition that arises is that it is essential to understand the evolution of state politics, institutions and government structures as part of an imbricate historical socio-political and ecological system. Contemporary water politics in Spain must take account of historically relevant events in order to bring reflexivity, new insights and understanding to the role of state politics and society in the management of groundwater.

This study has also shown that the state under Franco had a political and ideological incentive to develop public irrigation and colonisation in La Mancha. This was achieved through the establishment of hierarchical relations of control between the settlers and the INC in order to develop parts of the countryside. Technology helped articulate the relationship between the state, society and nature and sustained a

³⁷⁷ As a result of this situation, although the existing number of wells at the national level is officially around half a million, studies have ventured to suggest that up to 2 million wells might exist in Spain (Molinero et al. 2011).

whole new polity: new settlers linked to the land and water through relations of hierarchy, power and state authority.

Relationships between farmers, society and the environment have dramatically evolved in the last 50 years. From low-intensity and low-impact technologies such as norias to the intensive drilling of modern boreholes, the depletion of groundwater reserves has historically followed state incentives and market demand for more crops. This research posits the ‘anarchy’ (Shah 2009) of the ‘silent revolution’ (Fornés et al. 2005; Llamas and Martinez-Santos 2005a) in La Mancha as a by-product of groundwater abstraction rules and agrarian policies coined by the state. Thus, the proximate image of groundwater irrigation as atomised and individualistic gives way to a narrative of state ideology, politics and investment; producing both irrigated landscapes and farmers as the objects of irrigation policy driven by state rule. In some areas such as Llanos del Caudillo, farmers became directly dependent on the state’s colonisation practices for the construction of new towns and the development of agriculture. More widely, farmers relied on state subsidies and the public financing of irrigation modernisation systems for agriculture. Against this backdrop, the final consideration emerging from this thesis is that in order to understand the origin and history of the burning peats of the Las Tablas de Daimiel wetland we have to bring the role of the state back into the study of agriculture and irrigation in Spain.

Chapter 9 References

INC documents

INC 1945 *Informe sobre aplicación de las Leyes de Colonizaciones de interés local en la provincia de Ciudad Real*, Memoria, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1950 *Informe sobre posibilidades de alumbramiento de aguas subterráneas, para riego, en la “Zona Mancha de Ciudad Real” y Anteproyecto de puesta en riego de dicha zona*, Abril, Ministerio de Agricultura, Instituto Nacional de Colonización, Valencia.

INC 1952a *Informe sobre el Problema social de Manzanares (Ciudad Real)*, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1952b *Colonización de la Zona “La Mancha” de Ciudad Real: Antecedentes, trabajos previos realizados de captación y aforo de aguas subterráneas y necesidad de disponer de energía eléctrica para proseguir estos trabajos y los definitivos de transformación y explotación en regadío de la Zona*, Mayo, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1953a *Nuevo Pueblo: Proyecto de 102 viviendas y dependencias agrícolas, Sector Primero de la Mancha (Ciudad Real)*, Tomo I, Memoria y Planos, Febrero, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1953b *Nuevo Pueblo: proyecto de centro cívico, 82 viviendas de colonos y 24 de obreros agrícolas, Sector 1º de la Mancha (Ciudad Real)*, Diciembre, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1953c Proyecto de riego de la zona La Mancha, sector I pozos 102, 103, 118, 119, enero 1953 Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1953d Proyecto de Riego de la Zona “La Mancha” Sector I subsectores: 105, 106, 107, 110, 111, 112, 116, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1953e Proyecto de Riego de la Zona “La Mancha” Sector I subsectores: 108, 109, 114, 115, noviembre 1953, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1954a *Plan de obras para la puesta en riego y colonización del Sector I de la Zona “La Mancha”*, Febrero, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1954b *Proyecto de parcelación del Sector I de la Zona “La Mancha”*, Mayo, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1954c Proyecto de Riego de la Zona “La Mancha” subsectores 104, 113, 117, 120, 121, 122, 123, Enero 1954, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1955a *Plan de explotación para 1955 del Sector I de la Zona “La Mancha”*, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1955b *Informe sobre selección de colonos para el Sector I de la Zona “La Mancha”*, Enero, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1956a Informe sobre la demarcación territorial de la entidad local menor correspondiente al pueblo “Llanos del Caudillo” situado en el Sector I de la Zona de “La Mancha”, Enero, Manzanares (Ciudad Real), Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1956b Informe sobre la declaración de puesta en riego de los subsectores 101, 102, 103, 108, 109, 114, 115, 118 y 119 del Sector I de la zona de la “La Mancha”, Manzanares (Ciudad Real), Marzo 1956, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1957a *Proyecto de saneamiento del nuevo Pueblo “Llanos del Caudillo” en el Sector I de la Zona de “La Mancha” (Ciudad Real)*, Octubre, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1957b Proyecto de regueras secundarias del subsector 106 del Sector I de la zona de “La Mancha”, marzo 1957, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1959 Proyecto de redes de acequias y caminos de los subsectores 113, 117 y 124, Zona de “La Mancha” Sector I, Febrero 1959, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

INC 1960 *Proyecto de Plan General de Colonización de la Zona Regable del Pantano de Peñarroya, Segunda Parte*, Junio, Ciudad Real, Ministerio de Agricultura, Instituto Nacional de Colonización.

IRYDA 1980 *Proyecto de adaptación y acondicionamiento de redes de riego a nuevas captaciones del sector I de la Zona regable de la Mancha (Ciudad Real)*, Mayo, Ministerio de Agricultura, Instituto Nacional de Reforma y Desarrollo Agrario.

General References

Abad, C. and J.M. Naredo 1997 “Sobre la modernización de la agricultura española (1940-1995): de la agricultura tradicional a la capitalización agraria y la dependencia social”, in Gómez Benito, C. and J.J. González Rodríguez (eds.) *Agricultura y sociedad en la España contemporánea*, Madrid: Centro de Investigaciones Sociológicas, 249-316.

ABC 1970 “Entrega de títulos de propiedad a colonos”, Jueves 12 de Marzo de 1970, <http://hemeroteca.abc.es/nav/Navigate.exe/hemeroteca/madrid/abc/1970/03/12/049.html>, (last accessed 29th of January 2013).

ABC 1980 “Las Tablas de Daimiel, salvadas de la muerte”, 9th July 1980, <http://hemeroteca.abc.es/nav/Navigate.exe/hemeroteca/madrid/blanco.y.negro/1980/07/09/040.html>, (last accessed 25th of January 2013).

Abellán, J.L. 1973 *Sociología del 98*, Barcelona: Barcelona.

Agarwal, A. and S. Narain (eds.) 1997 *Dying wisdom: rise, fall and potential of India's traditional water harvesting systems*, New Delhi: Centre for Science and Environment.

Agrawal, A. 2005 *Environmentality. Technologies of government and the making of subjects*, Durham and London: Duke University Press.

Aguilera-Klink, F., Pérez-Moriana, E., and J. Sánchez-García 2000 The social construction of scarcity. The case of water in Tenerife (Canary Islands), *Ecological Economics*, 34(2), 233-245.

Alares López, G. 2010 “El vivero eterno de la esencia española. Colonización y discurso agrarista en la España de Franco” in Sabio Alcutén, A. (coord.) *Colonos, territorio y Estado. Los pueblos del agua de Bárdenas*, Zaragoza: Institución “Fernando el Católico”, 57-80.

Alatout, S. 2008 ‘States’ of scarcity: water, space, and identity politics in Israel, 1948-59, *Environment and Planning D: Society and Space*, 26(6) 959-982.

Alatout, S. 2009 Bringing Abundance into Environmental Politics: Constructing a Zionist Network of Water Abundance, Immigration, and Colonization, *Social Studies of Science*, (39)3, 363-394.

Alemaný Gomez, M.C. 2009 “Bodies, machines and male power” in Johnson, D.B. and J.M. Wetmore (eds.) *Technology and society: building our sociotechnical future*, Cambridge: MIT Press, 389-405.

Allaire, G., Blanc, M., Compés Lopez, R., Csíste, A., Granberg, L., Marmont, M., and T. Varley 2003 “Introduction” in Blanc, M. (ed.) *Innovations, institutions and rural change*, Cost Action A12, Luxembourg: Office for Official Publications of the European Communities, 7-18.

Allan, J.A. 2005 Water in the Environment/Socio-Economic Development Discourse: Sustainability, Changing Management Paradigms and Policy Responses in a Global System, *Government and Opposition*, 40(2), 181-199.

Álvarez-Cobelas, M., Sanchez Carrillo, S., Cirujano, S., and D.G. Angeler 2008 Long-term changes in spatial patterns of emergent vegetation in a Mediterranean floodplain: natural versus anthropogenic constraints, *Plant Ecology*, 194(2) 257-271.

Alvaro Tordesillas, A. 2010 Referencias internacionales en los pueblos de colonización españoles, *Ciudades*, 13, 183-200.

Anes, G. 1996 “Del “Expediente de Ley Agraria” al Informe de Jovellanos”, in García Sanz, A. and J. Sanz Fernández (coord.) *Reformas y políticas agrarias en la historia de España (De la Ilustración al primer franquismo)*, Madrid: Ministerio de Agricultura, Pesca y Alimentación, 69-103.

Appu, P.S. 1974 The bamboo tubewell: a low cost device for exploiting ground water, *Economic and Political Weekly*, 9(26), A63-A65.

Aragón Cavaller, J.R. 2002 “Hidromitos de la cuenca alta del Guadiana” in Coletto, C. et al. (eds.) *Conflictos entre el desarrollo de las aguas subterráneas y la conservación de los humedales: la cuenca alta del Guadiana*, Madrid: Fundación Marcelino Botín, Ediciones Mundi-Prensa, 69-101.

Araque Jiménez, E., Sánchez Martínez, J.D., Gallego Simón, V.J., and A. Garrido Almonacid 2006 Balance de la actuación del Instituto Nacional de Colonización en la provincia de Jaén, *Investigaciones Geográficas*, 41, 15-32.

Archer, K.J. and S. Lemeshow 2006 Goodness-of-fit test for a logistic regression model fitted using survey sample data, *The Stata Journal*, 6(1), 97-105.

Baigorri, A. 1978 “Las trampas de la colonización: las reservas y tierras exceptuadas” in Gaviria et al. (coord.) *Extremadura saqueada: recursos naturales y autonomía regional*, Barcelona: Ruedo Ibérico, 262-276.

Baker, A.R.H. 1992 “Introduction: on ideology and landscape” in Baker, A.R.H., and G. Biger (eds.) *Ideology and landscape in historical perspective: essays on the meanings of some places in the past*, Cambridge: University of Cambridge, 1-14.

Bakker, K. 2000 Privatizing water, producing scarcity: the Yorkshire drought of 1995, *Economic Geography*, 76(1), 4-27.

Bakker, K. 2002 From state to market? Water mercantilization in Spain, *Environment and Planning A*, 34(5), 767-790.

Bakker, K. and G. Bridge 2006 Material worlds? Resource geographies and the 'matter of nature', *Progress in Human Geography*, 30(5), 5-27.

Balfour, S. 1997 *The end of the Spanish empire, 1898-1923*, Oxford: Clarendon Press.

Barciela López, C. 2005 *Estadísticas Históricas de España: Siglos XIX-XX, Volume I*, Bilbao: Fundación BBVA.

Barciela López, C. and M. I. López Ortiz 2003 “El fracaso de la política agraria del primer franquismo, 1939-1959. Veinte años perdidos para la agricultura española” in Barciela López, C. (ed.) *Autarquía y mercado negro: el fracaso económico del primer franquismo 1939-1959*, Barcelona: Crítica, 55-93.

Barker, R. and F. Molle 2002 *Perspectives on Asian irrigation*, Paper presented at the Conference on Asian irrigation in Transition-Responding to the Challenges ahead, 22-23 April 2002 Workshop, Asian Institute of Technology, Bangkok, Thailand.

Baudrillard, J. 1994 *Amérique*, Paris: B. Grasset.

Bellaby, P. 1991 "Histories of sickness: making use of multiple accounts of the same process" in Dex, S. (ed.) *Life and work history analyses: qualitative and quantitative developments*, Sociological Review Monograph 37, London: Routledge, 20-42.

Bermúdez, A. 2008 *Manzanares bajo el reinado de Alfonso XIII (1902-1931)*, Manzanares: Ayuntamiento de Manzanares, http://biblioteca2.uclm.es/biblioteca/ceclm/libros/Bermudez_Manzanares.pdf, (last accessed 16th of November 2011).

Bernard, H.R., Killworth, P., Kronenfeld, D., and L. Sailer 1984 The problem of informant accuracy: the validity of retrospective data, *Annual Review of Anthropology*, 13, 495-517.

Berney, L. R. and D. B. Blane 1997 Collecting retrospective data: accuracy of recall after 50 years judged against historical records, *Social Science and Medicine*, 45(10), 1519-1525.

Berzas, J. J., Garcia L.F., Rodriguez, R.C., and P.J. Martin-Alvarez 2000 Evolution of the water quality of a managed natural wetland: Tablas de Daimiel national park (Spain), *Water Research*, 34(12) 3161-3170.

Bender, B. 2006 "Place and Landscape", in Tilley, C. Y., Keane, W., Kuechler, S., Rowlands, M., and P. Spyer (eds.) *Handbook of material culture*, London: SAGE Publications, 303-314.

Bernal, V. 1997 Colonial Moral Economy and the Discipline of Development: The Gezira Scheme and "Modern" Sudan, *Cultural Anthropology*, 12(4), 447-479.

Bevir, M. 2008 What is Genealogy? *Journal of the Philosophy of History*, 2(3), 263-275.

Bolding, A. Mollinga, P., and K. van Straaten 1995 Modules for modernisation: Colonial irrigation in India and the technological dimension of agrarian change, *Journal of Development Studies*, 31(6), 805-844.

Bosque Maurel, J. 1984 Del INC al IRYDA: Análisis de los resultados obtenidos por la política de colonización posterior a la guerra civil, *Agricultura y Sociedad*, 32, 153-191.

Bourdieu, P. 1977 *Outline of a theory of practice*, Cambridge: Cambridge University Press.

Biebricher, T. 2008 Genealogy and Governmentality, *Journal of the Philosophy of History*, 2(3), 363-396.

Biggs, S.D., and E.J. Clay 1981 Sources of innovation in agricultural technology, *World Development*, 9(4), 321-336.

Birkenholtz, T. 2006 *The politics of groundwater scarcity: technology, institutions and governance in Rajasthan irrigation*, Unpublished Phd dissertation, Ohio State University.

Birkenholtz, T. 2009a Groundwater governmentality: hegemony and technologies of resistance in Rajasthan's (India) groundwater governance, *The Geographical Journal*, 175(3), 208-220.

Birkenholtz, T. 2009b Irrigated landscapes, Produced Scarcity, and Adaptive Social Institutions in Rajasthan, India, *Annals of the Association of American Geographers*, 99(1), 118-137.

Bishko, C. J. 1963 "The Castilian as Plainsman: The Medieval Ranching Frontier in La Mancha and Extremadura" in Lewis, A. R. and T. F. McGann (eds.) *The New World looks at its history: Proceedings of the Second International Congress of Historians of the United States and Mexico*, Austin: University of Texas Press, 47-69.

Blackbourn, D. 2007 *The conquest of nature: water, landscape and the making of modern Germany*, London: Pimlico.

Brass, T. 2000 *Peasants, populism and postmodernism*, London: Frank Cass.

Bromley, J., Cruces, J., Acreman, M., Martínez, L., and M.R. Llamas 2001 Problems of Sustainable Groundwater Management in an Area of Over-exploitation: The Upper Guadiana Catchment, Central Spain, *Water Resources Development*, 17(3), 379-396.

Bukowski, J. 1997 Decentralization in Spain: A Re-evaluation of Causal Factors, *South European Society & Politics*, 2(3), 80-102.

Burchell, G., Gordon, C., and P. Miller (eds.) 1991 *The Foucault effect: studies in governmental rationality*, London: Harvester Wheatsheaf.

CAMPSA various years *Memorias Anuales de la Delegacion del Gobierno en CAMPSA*, www.cne.es/cne/contenido.jsp?id_nodo=430&&keyword=&auditoria=F, (last accessed 25th of January 2013).

Canales Martínez, G., and D. Jerez Cordero 1993 La actuación del Instituto Nacional de Colonización en el municipio de Hellín (Albacete), *Investigaciones Geográficas*, 11, 71-92.

Callon, M. 1987 "Society in the making: the study of technology as a tool for sociological analysis" in Bijker, W.E., Hughes, T.P., and T. Pinch (eds.) *The social construction of technological systems*, Cambridge, London: The MIT Press, 83-103.

Caro Baroja, J. 1983 *Tecnología popular española*, Madrid: Editorial Nacional.

- Calvo-González, O. 2006 Neither a carrot nor a stick: American foreign aid and economic policymaking in Spain during the 1950s, *Diplomatic History*, 30(3), 409-438.
- Caprotti, F. 2007 Destructive creation: fascist urban planning, architecture and New Towns in the Pontine Marshes, *Journal of Historical Geography*, 33(3), 651-679.
- Caprotti, F. 2008 Internal colonisation, hegemony and coercion: Investigating migration to Southern Lazio, Italy, in the 1930s, *Geoforum*, 39, 942-957.
- Carr, R. 1966 *Spain, 1808-1939*, Oxford: Clarendon Press.
- Carr, R., and J.P. Fusi Aizpurua 1979 *Spain: Dictatorship to Democracy*: London: George Allen & Unwin.
- Carreras de Odriozola, A., and X. Tafunell Sambola 2006 *Estadísticas históricas de España, siglos XIX-XX, Volume 2*, Bilbao: Fundación BBVA.
- Carrión, P. 1972 *Los Latifundios en España: Su importancia, Origen, Consecuencias y solución*, Barcelona: Ariel.
- Castaño-Castaño, S., Martinez-Santos, P., and P.E. Martinez-Alfaro 2008 Evaluating infiltration losses in a Mediterranean wetland: Las Tablas de Daimiel National Park, Spain, *Hydrological Processes*, 22(26), 5048-5053.
- Castelló Muñoz, E. 1972 La capitalización agraria española, *Revista de Estudios Agrosociales*, 78(2), 23-45.
- Castree, N. 2000 Marxism and the Production of Nature, *Capital & Class*, 24(5), 5-36.
- Castro, E., Kaika, M., and E. Swyngedouw 2003 London: Structural Continuities and Institutional Change in Water Management, *European Planning Studies*, 11(3), 283-298.

Cazorla-Sánchez, A. 1999 Dictatorship from Below: Local Politics in the Making of the Francoist State, 1937-1948, *The Journal of Modern History*, 71(4), 882-901.

Cervantes, M. de 2003 *The history and adventures of the Renowned Don Quixote*, Athens and London: The University of Georgia Press.

Cervantes, C.R. 2007 El control del agua: tecnología y sistemas de extracción hidráulica en la comarca del Campo de Cartagena, 1880-1980, *Revista Murciana de Antropología*, 14, 127-141.

Chandra, K. 2007 “Counting heads: a theory of voter and elite behavior in patronage democracies” in Kitschelt H. and S. I. Wilkinson (eds.) *Patrons, Clients and Policies: Patterns of Democratic Accountability and Political Competition*, Cambridge: Cambridge University Press, 84-109.

CHG 2009 *Confederación Hidrográfica del Guadiana Memoria 2007-2008*, http://www.chguadiana.es/corps/chguadiana/data/resources/file/memoria_07_08.pdf, (last accessed 25th of January 2013).

Cirujano, S., Casado, C., Bernués, M., and J.A. Camargo 1996 Ecological study of las Tablas de Daimiel National Park (Ciudad Real, Central Spain): differences in water physico-chemistry and vegetation between 1974 and 1989, *Biological Conservation*, 75(3), 211-215.

Colino, C. 2008 The Spanish model of devolution and regional governance: evolution, motivations and effects on policy making, *Policy & Politics*, 36(4), 573-586.

Conan, C., de Marsily, G., Bouraoui, F., and G. Bidoglio 2003 A long-term hydrological modelling of the Upper Guadiana river basin (Spain), *Physics and Chemistry of the Earth*, 28(4-5), 193-200.

Consejo de Ministros 2009, Referencia del Consejo de Ministros, Viernes 6 de Noviembre 2009.

Conway, M. A. and C. Loveday 2010 “Accessing autobiographical memories” in Mace, J. H. 2010 (ed.) *The act of remembering: toward an understanding of how we recall the past*, Oxford: Blackwell Publishing Ltd., 56-70.

Corral Broto, P. 2008 *La transición de la naturaleza: el medio ambiente como sujeto historiográfico en el marco de la transición democrática española*, I Encuentro de Jóvenes Investigadores en Historia Contemporánea de la Asociación de Historia Contemporánea, Zaragoza, 26-27 September 2007, <http://ifc.dpz.es/recursos/publicaciones/27/15/74.pablocorral.pdf>, (last accessed 29th of January 2013).

Costa Martínez, J. 1911 *Política Hidráulica (Misión Social de los Riegos en España)*, Madrid: Biblioteca Costa.

Cosgrove, D. 1993 “Landscapes and Myths, Gods and humans in Bender, B. (ed.) *Landscape: politics and perspectives*, Providence: Berg, 281-305.

Costejà, M., Font, N., Rigol, A., and J. Subirats 2004 “The evolution of the water regime in Spain”, in Kissling-Näf I., and S. Kuks (eds.) *The evolution of national water regimes in Europe. Transitions in water rights and water policies*, Dordrecht: Kluwer Academic Publishers, 235-264.

Cruse, L. and V. P. Gandhi (eds.) 2009 *Reforming institution in water resource management: policy performance for sustainable development*, London: Earthscan.

Cronon, W. 1992 A Place for Stories: Nature, History and Narrative, *The Journal of American History*, 78(4), 1347-1376.

Crow, J.A. 2005 *Spain: the root and the flower. An interpretation of Spain and the Spanish people*, Berkeley: University of California Press.

Cruces de Abia, J. and L. Martínez Cortina 2000 La Mancha húmeda: explotación intensiva de las aguas subterráneas en la Cuenca alta del río Guadiana, *Papeles del Proyecto Aguas Subterráneas*, Serie A, Num.3, Santander: Fundación Marcelo Botín.

Cruces de Abia, J., Hernández, J.M., and G. López Sanz (coord.) 1998 *De la noria a la bomba. Conflictos sociales y ambientales en la cuenca alta del río Guadiana*, Bilbao: Bakeaz.

Cruz-Villalon, J. 1987 Political and economic change in Spanish agriculture, 1950-1985, *Antipode*, 19(2), 119-133.

Cuadra García, C. 1991 “El Guadiana” in Segura Graiño, C. (dir.) Historia de los regadíos en España (...a.C. - 1931), Madrid: Ministerio de Agricultura, Pesca y Alimentación, 586-595.

Dean, M. 1999 *Governmentality: power and rule in modern society*, London: SAGE.

del Moral, L. 1999 “La Política Hidráulica en España de 1936 a 1996” in Garrabou, R., and J.M. Naredo (eds.) *El Agua en los Sistemas Agrarios. una Perspectiva Histórica*, Madrid: Fundación Argentaria, 181-195.

del Moral, L., and C. Giansante 2000 Constraints to Drought Contingency Planning in Spain: The Hydraulic Paradigm and the Case of Seville, *Journal of Contingencies and Crisis Management*, 8(2), 93-102.

Del Río Cisneros, A. (ed.) 1975 Pensamiento político de Franco: antología, Tome I and II, Madrid: Ediciones del Movimiento.

Dex, S. and A. McCulloch 1998 The reliability of retrospective unemployment history data, *Work, Employment & Society*, 12(3), 497-509.

Díaz, M.B. 1897 *Importancia de la canalización del Guadiana para el desarrollo de la riqueza agrícola e industrial de la Mancha*, Ciudad Real.

Dominguez Castro F., Santisteban, J.I., Barriendos, M., and R. Mediavilla 2008 Reconstruction of drought episodes for central Spain from rogation ceremonies recorded at the Toledo Cathedral from 1506 to 1900: A methodological approach, *Global Planetary Change*, 63(2-3), 230-242.

Doordan, D.P. 1983 The political content in Italian architecture during the Fascist era, *Art Journal*, 43(2), 121-131.

Dommen, A.J. 1975 The bamboo tubewell: a note on an example of indigenous technology, *Economic Development and Cultural Change*, 23(3), 483-489.

Downing, T.E., and K. Bakker 2000 “Drought discourse and vulnerability” in Wilhite, D. A. (ed.) *Drought: A Global Assessment. Volume 2*. London: Routledge 213-230.

Driever, S. L. 1998 “And since heaven has filled Spain with goods and gifts”: Lucas Mallada, the Regenerationist movement, and the Spanish environment, 1881–90, *Journal of Historical Geography*, 24(1), 35-52.

Driscoll, F.G. 1989 *Groundwater and wells*, Minnesota: Johnson Filtration Systems.

Dubash, N.K. 2002 *Tubewell capitalism. Groundwater development and agrarian change in Gujarat*, Oxford: Oxford University Press.

EL PAÍS 2008 “La Unesco planea desproteger las Tablas de Daimiel”, 1st June 2008, http://elpais.com/diario/2008/06/01/sociedad/1212271204_850215.html, (last accessed 25th of January 2013).

EL PAÍS 2009 “Un insólito incendio subterráneo azota las Tablas de Daimiel,” 12-10-2009, http://elpais.com/diario/2009/10/12/sociedad/1255298402_850215.html, (last accessed 29th of January 2013).

EL PAIS 2012a “El Guadiana reabre los ojos”, 31st March 2012,
http://sociedad.elpais.com/sociedad/2012/03/31/actualidad/1333217834_215534.html,
(last accessed 25th of January 2013).

EL PAIS 2012b “El Alto Guadiana vuelve a correr”, 13th November 2012,
http://sociedad.elpais.com/sociedad/2012/11/12/actualidad/1352755578_374586.html,
(last accessed 25th of January 2013).

Escobar, A. 1999 *After Nature: Steps to an Antiessentialist Political Ecology*, Current Anthropology, 40(1), 1-30.

EUA 1985a *Historia y Evolución de la Colonización agraria en España, Análisis del proceso colonizador, entrevistas en profundidad, relación de autores de los planes*, Equipo de Urbanismo y Arquitectura, Instituto Nacional de Reforma y Desarrollo Agrario, Instituto de Estudios Agrarios, Pesqueros y Alimentarios, Instituto de Estudios de la Administración Local, Dirección General de Arquitectura y Vivienda.

EUA 1985b *Historia y Evolución de la Colonización agraria en España, Análisis económico del proceso colonizador*, Equipo de Urbanismo y Arquitectura, Instituto Nacional de Reforma y Desarrollo Agrario, Instituto de Estudios Agrarios, Pesqueros y Alimentarios, Instituto de Estudios de la Administración Local, Dirección General de Arquitectura y Vivienda.

Evans, P. B., Rueschemeyer, D., and T. Skocpol (eds.) 1985 *Bringing the State back in*, Cambridge: Cambridge University Press.

Fabeiro, C., Martin de Santa Olalla, F., Lopez, R., and A. Dominguez 2003
Production and quality of the sugar beet (*Beta vulgaris* L.) cultivated under controlled deficit irrigation conditions in a semi-arid climate, *Agricultural Water Management*, 62, 215-227.

Falkenmark, M., Andersson, L., Castensson, R., and K. Sundblad 1999 *Water: a reflection of land use. Options for counteracting land and water mismanagement*, Stockholm: Swedish Natural Science Research Council.

Falkenmark, M. and J. Rockstrom 2006 The New Blue and Green Water Paradigm: Breaking New Ground for Water Resources Planning and Management, *Journal of Water Resources, Planning and Management*, 132(3), 129-132.

Feitelson, E. and I. Fischhendler 2009 Spaces of water governance: The case of Israel and its neighbours, *Annals of the Association of American Geographers*, 99(4), 728-745.

Fernández García, E. 2008 Las políticas redistributivas de la España no democrática: del objetivo industrializador al sostenimiento de los ingresos de los agricultores (1950-1975), *Investigaciones de Historia Económica*, 12, 11-42.

Fernández Rodríguez, T.R. 1973 Las competencias administrativas en material de aguas subterráneas, *Revista de Administración Pública*, 72, 9-25.

Flores Soto, J. A. 2010 El debate de lo vernáculo en España durante la primera mitad del s.XX. La arquitectura popular como inspiración en la búsqueda de lo esencial en la arquitectura. De la búsqueda del estilo nacional a la arquitectura de colonización, *El Genio Maligno: Revista de Humanidades y Ciencias Sociales*, 6, 85-112.

Fontein, J. 2006 Languages of land, water and ‘tradition’ around Lake Mutirikwi in southern Zimbabwe, *Journal of Modern African Studies*, 44(2) 223-249.

Fornés, J.M., and A. Senderos 2002 “Las aguas subterráneas en la enseñanza española”, *III Congreso Ibérico sobre Gestión y Planificación del Agua: la Directiva Marco del Agua: Realidades y Futuros*, Sevilla, 13 - 17 noviembre de 2002, 582 -587, http://grupo.us.es/ciberico/archivos_acrobat/sevilla4fornes.pdf, (last accessed 6th of December 2012).

Fornés, J.M., de la Hera, A., and M.R. Llamas 2005 The silent revolution in groundwater intensive use and its influence in Spain, *Water Policy*, 7(3), 253-268.

Fornés, J., Rodríguez, J.A., Hernández, N., and M.R. Llamas 2000 Possible solutions to avoid conflicts between water resources development and wetland conservation in the “La Mancha Húmeda” Biosphere Reserve (Spain), *Physics and Chemistry of the Earth*, 25(7-8), 623-627.

Fornés Azcoiti, J.M., de la Hera Portillo, A., R. Llamas Madurga 2005 La propiedad de las aguas subterráneas en España: la situación del registro/catálogo, *Ingeniería del Agua*, 12(2), 125-185.

Foucault, M. 1980 *Power/Knowledge*, New York: Pantheon Books.

Foucault, M. 1988a “Technologies of the Self” in Foucault, M., Martin, L.H., Gutman, H., and P.H. Hutton (eds) *Technologies of the Self: A Seminar with Michel Foucault*, London: Tavistock Publications, 16-49.

Foucault, M. 1988b “The Political Technologies of Individuals” in Foucault, M., Martin, L.H., Gutman, H., and P.H. Hutton (eds) *Technologies of the Self: A Seminar with Michel Foucault*, London: Tavistock Publications, 145-162

Foucault, M. 1991 *Discipline and Punish: the birth of the prison*, London: Penguin Books.

Fox, R. (ed.) 1996 *Technological change: methods and themes in the history of technology*, Amsterdam: Harwood Academic Publishers.

Fraenkel, P. L. 1986 *Water lifting devices*, FAO Irrigation and Drainage Paper 43, Rome: Food and Agriculture Organization of the United Nations, <http://www.fao.org/docrep/010/ah810e/AH810E00.htm#Contents>, (last accessed 22th of September 2011).

Gandy, M. 2004 Rethinking urban metabolism: water, space and the modern city, *City*, 8(3), 363-379.

- García Carretero, M. 1997 “Consideraciones jurídicas entorno al Acuífero 23” in Jornada sobre las Aguas Subterráneas en el Acuífero 23 y sus posibilidades de recarga, Villarrobledo, 6 Noviembre 1997, 1-39.
- García de Coca, J.A. 1992 Análisis jurídico sobre la creación del monopolio del petróleo español, *Anales de estudios económicos y empresariales*, 7, 391-412.
- García Marchante, J. S. and M. C. Fernández Fernández 2000 *El espacio del Quijote: el paisaje de la Mancha*, Ciudad Real: Universidad de Castilla la Mancha.
- García Sanz, A. 1985 “Introducción. Crisis de la agricultura tradicional y revolución liberal (1800-1850)” in García Sanz and Garrabou (eds.) *Historia agraria de la España contemporánea*, Barcelona: Editorial Crítica, 7-99.
- Garrabou, R. 1990 Sobre el atraso de la mecanización agraria en España (1850-1933), *Agricultura y Sociedad*, 57, 41-77.
- Garrido, A., Martínez-Santos, P., and M.R. Llamas 2006 Groundwater irrigation and its implications for water policy in semiarid countries: the Spanish experience, *Hydrogeology Journal*, 14(3), 340-349.
- Geertz, C. 1980 *Negara: the theatre state in nineteenth-century Bali*, Princeton, N.J.: Princeton University Press.
- Garrido Roselló, J. E. 1991 El Parque Nacional de las Tablas de Daimiel: régimen jurídico y protección, *Estudios Territoriales*, Num.37.
- Gellner, E. 1977 “Patrons and Clients” in Gellner, E. and J. Waterbury (eds.) *Patrons and Clients in Mediterranean Societies*, London: Duckworth, 1-6.
- Gibbs, L. M. (2009) Just add water: colonisation, water governance, and the Australian inland, *Environment and Planning A*, 41(12), 2964-2983.

Giglioli, I. and E. Swyngedouw 2008 Let's Drink to the Great Thirst! Water and the Politics of Fractured Techno-natures in Sicily, *International Journal of Urban and Regional Research*, 32(2), 392-414.

Gil García, P. 2005 *Las hermandades sindicales de labradores y ganaderos, 1944-1977: historia, documentos y fuentes*, Cuenca: Ediciones de la Universidad de Castilla-La Mancha.

Giménez López, E. 1993 Fuero Alfonsino y Fuero de Poblaciones de Sierra Morena en los proyectos de Colonización de la Corona de Aragón en la segunda mitad del Siglo XVIII, *Revista de Historia Moderna*, 12, 141-184.

Giner, S. 1990 Los inicios de la mecanización en el regadío valenciano, 1850-1930, *AREAS Revista de Ciencias Sociales*, 12, 203-211.

Giner, S. and J. Carrión 1999 "El cambio técnico en los sistemas de captación e implusión de aguas subterráneas para riego en la España mediterránea" in Garrabou, R. and J.M. Naredo Pérez (eds.) *El agua en los sistemas agrarios. Una perspectiva histórica*, Madrid: Fundación Argentaria – Visor Dis., 15-39.

Giner, S. and J. Carrión 2005 El cambio tecnológico en el uso de las aguas subterráneas en la España del siglo XX. Un enfoque regional, *Revista de Historia Industrial*, 15(28), 81-114.

Giner, S., and E. Sevilla 1984 "Spain: from corporatism to corporatism" in Williams, A.M. (ed.) *Southern Europe Transformed. Political and Economic Change in Greece, Italy, Portugal, and Spain*, London: Harper and Row, 115-147.

Glick, T. F. 1970 *Irrigation and Society in Medieval Valencia*, Cambridge: Harvard University Press.

Glick, T.F. 1977 "Noria pots in Spain", in Glick, T.F. 1996 *Irrigation and Hydraulic Technology: Medieval Spain and its legacy*, Aldershot: VARIORUM, 644-650.

Glick, T.F. 1979 *Islamic and Christian Spain in the Early Middle Ages*, Princeton: Princeton University Press.

Glick, T.F. 1992 "Irrigation and hydraulic technology in Islamic Spain: methodological considerations" in Glick, T.F. 1996 *Irrigation and Hydraulic Technology: Medieval Spain and its legacy*, Aldershot: VARIORUM, 1-20.

Gómez Ayau, E. 1961 *El Estado y las grandes zonas regables*, Madrid: Ministerio de Agricultura.

Gómez Benito, C. 1995 *Políticos, burócratas y expertos: un estudio de la política agraria y la sociología rural en España (1936-1959)*, Madrid: Siglo Veintiuno de España Editores S.A.

Gómez Herráez, J.M. 1999 Patrimonios y huertos familiares. El programa distribuidor en tierras de La Mancha, 1939-1959, *Historia Agraria*, 17, 153-173.

Gómez Manzanares, R. 1971 La agricultura en el plan de desarrollo económico español, *Agriculture et développement*, 8, 46-51.

González del Barrio, J.E. 1976 La participación del agricultor en la comercialización agraria en España, *Revista de Estudios Agrosociales*, 96, 61-103.

Gutting, G. 2005 *Foucault: a very short introduction*, Oxford: Oxford University Press.

Haraway, D. J. 1991 *Simians, cyborgs, and women: the reinvention of nature*, New York: Routledge.

Hardiman, D. 1998 Well irrigation in Gujarat: Systems of use, Hierarchies of Control, *Economic and Political Weekly*, 33(25), 1533-1544.

Haydu, J. 1998 Making use of the Past: time periods and cases to compare and as sequences of problem solving, *The American Journal of Sociology*, 104(2), 339-371.

Heathcote R.L 1969. Drought in Australia: A Problem of Perception. *Geographical Review*, 59(2), 175-194.

Herath, H.M.G. 1985 Impact of Tube Well Irrigation Development in Sri Lanka: A Case Study, *Agricultural Administration*, 20(3), 125-137.

Hernández-Mora, N. 1998 *El papel de los usuarios en la gestión del agua en el Acuífero de la Mancha Occidental: Oportunidades ante una situación de conflicto y carestía*, I Congreso Ibérico sobre Gestión y Planificación de Aguas, Zaragoza, 14-18 Septiembre 1998,
http://congreso.us.es/ciberico/archivos_acrobat/zaracomun4hernandezmo.pdf, (last accessed 12th of November 2012).

Herr, R.A. 1971 *An historical essay on modern Spain*, Berkeley: University of California Press.

Hill, D. 1996 *A History of Engineering in Classical and Medieval Times*, London: Routledge.

Hinchliffe, S. 2007 *Geographies of Nature: societies, environments, ecologies*, New Delhi: SAGE Publications.

Hodges, H. 1964 *Artifacts: an introduction to early materials and technology*, London: Duckworth.

Hosmer, D.W., and S. Lemeshow 1980 Goodness of fit tests for the multiple logistic regression model, *Communications in Statistics – Theory and Methods*, 9(10), 1043-1069.

Houston, J. M. 1950 Irrigation as a solution to agrarian problems in Modern Spain, *The Geographical Journal*, 116(1-3), 55-63.

IBRD 1962 *Informe del Banco Internacional de Reconstrucción y Fomento. El desarrollo económico de España*, Madrid: Oficina de Coordinación y Programación Económica.

IBRD and FAO 1966 *El desarrollo de la Agricultura en España*, Madrid: Ministerio de Hacienda.

Israelsen, O.W. And V.E. Hansen 1965 *Principios y aplicaciones del riego*, Barcelona: Editorial Reverté.

ITGE 1989 Sistema Acuífero 23 Mancha Occidental, Instituto Tecnológico GeoMinero de España.

Jessop, B. 2006 “The state and state-building”, in Rhodes, R.A.W., Binder, S.A., and B.A. Rockman (eds.) *The Oxford Handbook of Political Institutions*, Oxford: Oxford University Press, 111-130.

Johnson, D.B. and J.M. Wetmore 2009 “Introduction” in Johnson, D.B. and J.M. Wetmore (eds.) *Technology and society: building our sociotechnical future*, Cambridge: MIT Press, xi-xv.

Juárez Sánchez-Rubio, C. and G. Canales Martínez 1988 Colonización agraria y modelos de hábitat (siglos XVIII-XX), *Agricultura y Sociedad*, 49, 333-352.

Kaika, M. 2006 Dams as symbols of modernization: The urbanization of nature between geographical imagination and Materiality, *Annals of the Association of American Geographers*, 96(2), 276-301.

Kallis, G. 2010 Coevolution in water resource development: the vicious cycle of water supply and demand in Athens, Greece, *Ecological Economics*, 69(4), 796-809.

Kenny, M. 1960 Patterns of Patronage in Spain, *Anthropological Quarterly*, 33(1), 14-23.

- Kepfield, S.S. 1993 The “Liquid Gold” Rush: Groundwater Irrigation Law in Nebraska, 1900-93, *Great Plains Quarterly*, 13(4), 237-250.
- Kobayashi, A. L. 1989 “A Critique of dialectical landscape” in Kobayashi, A. L. and S. Mackenzie (ed.) *Remaking human geography*, Boston: Unwin Hyman, 164-183.
- Koopman, C. 2008 Foucault's Historiographical Expansion: Adding Genealogy to Archeology, *Journal of the Philosophy of History*, 2(3), 338-362.
- La Tribuna de Ciudad Real 2011 “Los agricultores de Llanos del Caudillo se organizan en patrullas para evitar nuevos robos”, 1st February 2011, <http://www.latribunadeciudadreal.es/noticia.cfm/Provincia/20110201/agricultores/llanos/caudillo/organizan/patrullas/evitar/nuevos/robos/A9FF5402-A6B5-9E24-2894F6A8E777A04F>, (last accessed 27th of January 2013).
- Ladrón de Guevara Flores, M.P. 1988 *Ciudad Real en el primer tercio del siglo XX (Tierra, propiedad y cultivos, 1900-1930)*, Ciudad Real: Institution de Estudios Manchegos.
- Latour, B. 1992 “Where are the Missing Masses? The Sociology of a Few Mundane Artifacts” in Bijker, W.E. And J. Laws (eds.) *Shaping Technology/Building Society: Studies in Socio-technical Change*, Cambridge: MIT Press, 225-258.
- Latour, B. 1993 *We have never been modern*, Cambridge: Harvard University Press.
- Latour, B. 2004 *Politics of nature: how to bring the Sciences into Democracy*, Cambridge: Harvard University Press.
- Latour, B. 2005 *Reassembling the social: an introduction to actor-network theory*, Oxford: Oxford University Press.
- Lee, N. and S. Brown 1994 Otherness and the Actor Network: the undiscovered continent, *American Behavioral Scientist*, 37(6), 772-790.

- Lefebvre, H. 1991, *The production of space*, Oxford: Blackwell.
- Liceras Ruiz, A. 1988 El INC. Instrumento de la política agraria en la era de Franco, *Cuadernos Geográficos de la Universidad de Granada*, 16-17, 57-78.
- Liodakis, G. 1997 Technological change in Agriculture: A Marxist critique, *Sociologia Ruralis*, 37(1), 61-78.
- Llamas, M. R. and A. Garrido 2007 “Lessons from intensive groundwater use in Spain: economic and social benefits and conflicts,” in Giordano, M. and K.G. Villholth (eds.) *The agricultural groundwater revolution: opportunities and threats to development*, Wallingford and Cambridge: CABI Publishing, 266-295.
- Llamas, R. and P. Martínez-Santos 2005a Intensive Groundwater Use: Silent Revolution and Potential Source of Social Conflicts, *Journal of Water Resources Planning and Management*, 131(5), 337-341.
- Llamas, R., and P. Martínez-Santos 2005b *NeWater WB3 Report (WP3.4 Guadiana Basin), Baseline Condition Report (A) Upper Guadiana Basin*.
- Llamas, M.R., Fornés, J.M., Hernández-Mora, N., and L. Martínez Cortina 2001 *Aguas subterráneas: retos y oportunidades*, Madrid: Fundación Marcelino Botín.
- López-Cuervo, S. 1988 Water, a cultural heritage, *Landscape and Urban Planning*, 16(1-2), 93-103.
- Lopez-Gunn, E. 2003 The Role of Collective Action in Water Governance: A Comparative Study of Groundwater User Associations in La Mancha Aquifers in Spain, *Water International*, 28(3), 367-378.
- Lopez-Gunn, E. 2009 Agua para todos: A New Regionalist Hydraulic Paradigm in Spain, *Water Alternatives*, 2(3), 370-394.

Lopez-Gunn, E. 2012 Groundwater governance and social capital, *Geoforum*, 43, 1140-1151.

Lopez-Gunn, E., and N. Hernández-Mora 2001 “La gestión colectiva de las aguas subterráneas en La Mancha: análisis comparativo”, in Hernández-Mora, N., and M. Ramón Llamas (eds.) *La economía del agua subterránea y su gestión colectiva*, Madrid: Fundación Marcelino Botín, 405-473.

López Santamaria, F. 1954 El “Plan Badajoz”, antecedentes, contenido y ensayo sobre sus efectos, *Revista de Estudios Agro-Sociales*, 6, 45-82.

López Sanz, G. 1998 Humedales y agricultura de regadío: el caso de la Cuenca alta del río Guadiana, *Agricultura y Sociedad*, 86, 249-272.

Lorenzo Pardo, M. 1933 *Plan Nacional de Obras Hidráulicas, Tomo I*, Madrid: Ministerio de Obras Públicas.

Malefakis, E. 1970 *Agrarian reform and peasant revolution in Spain*, New Haven: Yale University Press.

Malpica Cuello, A. 1995 “El agua y el poblamiento de la Alhambra de Granada”, in Quesada Quesada, T. (ed.) *El agua en la agricultura de Al-Andalus*, Barcelona, Madrid: Lunweg, 119-131.

Maluquer de Motes, J. 1983 La despatrimonialización del agua: movilización de un recurso natural fundamental, *Revista de Historia Económica*, 1(2), 79-96.

Mangas Navas, J. M. 1984 *La propiedad de la tierra en España: los Patrimonios Públicos*, Madrid: Instituto de Estudios Agrarios, Pesqueros y Alimentarios.

Mangas Navas, J. M. 1990 *Políticas administrativa y económica de la colonización agraria: análisis institucional y financiero (1936-1977)*, Historia y Evolución de la Colonización Agraria en España Vol.II, Madrid: Ministerio de Agricultura, Pesca y

Alimentación, Ministerio para las Administraciones Públicas, Ministerio de Obras Públicas y Urbanismo.

Marshall, C. and G.B. Rossman 1999 *Designing qualitative research*, London: SAGE Publications.

Martínez Cortina, L. 2001 *Estimación de la recarga en grandes cuencas sedimentarias mediante modelos numéricos de flujo subterráneo. Aplicación a la cuenca Alta del Guadiana*, Unpublished PhD Thesis, Universidad de Cantabria, ETS Ingenieros de Caminos, Canales y Puertos.

Martínez Cortina, L. 2011 Personal communication, Madrid: IGME.

Martínez-Santos, P., and P.E. Martínez-Alfaro 2010 Estimating groundwater withdrawals in areas of intensive agricultural pumping in central Spain, *Agricultural Water Management*, 98(1), 172-181.

Martínez-Santos, P., De Stefano, L., Llamas, M.R., and P.E. Martínez-Alfaro 2008 Wetland Restoration in the Mancha Occidental Aquifer, Spain: A Critical Perspective on Water, Agricultural and Environmental Policies, *Restoration Ecology*, 16(3), 511-521.

Martínez Soto, A., and S. Martínez Rodríguez 2006 The Difficult and tortuous path of agricultural cooperative networks in Spain, 1890-1935, Working Paper, Departament d'Economia i d'Historia Econòmica, Universitat Autònoma de Barcelona, http://www.h-economica.uab.es/wps/2006_12.pdf (last accessed 12th of November 2012).

Martínez Soto, A.P., Ramón Muñoz, J.M., and S. Martínez Rodríguez 2008 *Cooperativismo y crédito agrario en España durante la dictadura franquista*, IX Congreso Internacional de la Asociación Española de Historia Económica, Murcia 9-12 Septiembre 2008.

Mehta, L. 2001 The Manufacture of Popular Perceptions of Scarcity: Dams and Water Related Narratives in Gujarat, India, *World Development*, 29(12), 2025-2041.

Mehta, L. 2005 *The Politics and Poetics of Water: the Naturalisation of scarcity in Western India*, New Delhi: Orient Longman.

Meinzen-Dick, R. 1996 *Groundwater markets in Pakistan: participation and productivity*, Research Report 105, International Food Policy Research Institute, Washington DC.

Ministerio de Fomento 1918, *Medios que se utilizan para suministrar riego a las tierras y distribución de los cultivos en la zona regable*, Resumen hecho por la Junta Consultiva Agronómica de las Memorias de 1916, remitidas por los Ingenieros del Servicio Agronómico Provincial, Tomo I, Madrid: Imprenta de los Hijos de M.G. Hernández.

Mitchell D 1996 *The lie of the land: migrant workers and the California landscape* Minneapolis: University of Minnesota Press.

Molinero, J., Custodio, E., Sahuquillo, A., and M.R. Llamas 2011 “Groundwater in Spain: Legal framework and management issues”, in Findikakis, A.N., and K. Sato (eds.) *Groundwater Management Practices*, CRC Press.

Molle, F. 2007 Scales and power in river basin management: The Chao Phraya River in Thailand, *Geographical Journal*, 173(4), 358-373.

Molle, F., and P. Wester (eds.) 2009 *River Basin Trajectories: Societies, Environment and Development*, Wallingford, Massachusetts: CABI, IWMI.

Molle, F., Mollinga, P.P., and P. Wester 2009 Hydraulic Bureaucracies and the Hydraulic Mission: Flows of Water, Flows of Power, *Water Alternatives*, 2(3), 328-349.

Mollinga, P. 2003 *On the waterfront: water distribution, technology and agrarian change in a South Indian Canal Irrigation System*, New Delhi: Orient Longman.

Mollinga, P. P. and A. Bolding (eds.) 2004 *The Politics of Irrigation Reform: Contested Policy Formulation and Implementation in Asia, Africa and Latin America*, Aldershot, Burlington: ASHGATE.

Monclús, F. J. and J. L. Oyón 1988 *Políticas y técnicas en la ordenación del espacio rural*, Historia y Evolución de la Colonización Agraria en España Vol.I, Madrid: Ministerio de Agricultura, Pesca y Alimentación, Ministerio para las Administraciones Públicas, Ministerio de Obras Públicas y Urbanismo.

Montero García, F. 1999 La Acción Católica española en el primer Franquismo, 1939-1951, IV Encuentro de Investigadores del Franquismo, Valencia 17-19 Noviembre 1999,
<http://dspace.uah.es/dspace/bitstream/handle/10017/8837/Acción%20Católica%20Franquismo.pdf?sequence=1>, (last accessed 28th of January 2013).

Montoro Rodríguez, A. et al. 2002 *An advisory service for irrigation in the plains of la Mancha, Spain*, Workshop FAO-ICID, Irrigation Advisory Services and Participatory Extension in Irrigation Management, 24 July, Montreal, Canada,
<http://www.fao.org/nr/water/docs/ias/paper15.pdf>, (last accessed 28th of October 2011).

Montoya Inglés, J. 2007 Las “viejas artes” de extracción de aguas subterráneas en el Campo de Cartagena, *Revista Murciana de Antropología*, 14, 143-164.

Morales Gil, A., Olcina Cantos, J., and A.M. Rico Amorós 1999 Diferentes percepciones de la sequía en España: adaptación, catastrofismo e intentos de corrección, *Investigaciones Geográficas*, 22, 5-46.

Moreno Luzón, J. 1998 *Romanones. Caciquismo y política liberal*, Madrid: Alianza Editorial.

Moreno Luzón, J. 2001 “Castilla-la Mancha” in Varela Ortega, J. (dir.) *El poder de la influencia. Geografía del caciquismo en España (1875-1923)*, Madrid: Marcial Pons, 151-174.

Moreno, L., Jiménez, M.E., Aguilera, H., Jiménez, P., and A. de la Losa 2011 The 2009 smouldering peat fire in Las Tablas de Daimiel National Park (Spain), *Fire Technology*, 47(2), 519-538.

Moreu Ballonga, J.L. 1996 *Aguas públicas y aguas privadas*, Barcelona: Bosch Casa Editorial S.A.

Moreu Ballonga, J.L. 2002 “Los problemas de la legislación sobre aguas subterráneas en España: posibles soluciones” in Ramón Llamas, M. (dir.) *Papeles del proyecto Aguas Subterráneas*, Santander: Fundación Marcelino Botín, 15-68.

Mosse, D. 1997 The symbolic making of a common property resource: history, ecology and locality in a tank-irrigated landscape in South India, *Development and Change*, 28(3), 467-504.

Mosse, D. 2003 *The rule of water: statecraft, ecology, and collective action in South India*, Oxford: Oxford University Press.

Mosse, D. 2006 Collective action, common property, and social capital in South India: an anthropological commentary, *Economic Development and Cultural Change*, 54(3), 695-724.

Mosse, D. 2008 Epilogue: The Cultural Politics of Water – A Comparative Perspective, *Journal of Southern African Studies*, 34(4), 939-948.

Mukherji, A. and T. Shah 2005 Groundwater socio-ecology and governance: a review of institutions and policies in selected countries, *Hydrogeology Journal*, 13(1), 328-345.

- Murviedro, C.V. 1982 El pensamiento agrario y la apuesta industrializadora en la España de los cuarenta, *Agricultura y Sociedad*, 23, 233-273.
- Mustafa, D. and M. U. Qazi 2007 Transition from *Karez* to Tubewell Irrigation: Development, Modernization, and Social Capital in Balochistan, Pakistan, *World Development*, 35(10), 1796-1813.
- Nadal Reimat E 1981, “El regadío durante la restauración: la política hidráulica (1875-1902)”, *Revista Agricultura y sociedad*, 19, 129-163.
- Naredo, J. M. 1978 “Antecedentes y características de la sociedad jerárquica que sostiene en Extremadura el expolio, con especial referencia al Plan Badajoz” in Gaviria et al. (coord.) *Extremadura saqueada: recursos naturales y autonomía regional*, Barcelona: Ruedo Ibérico, 11-25.
- Naredo, J.M., and J.M. Gascó 1990 Enjuiciamiento económico de la gestión de los humedales. El caso de las “Tablas de Daimiel”, *Estudios Regionales*, 26, 71-110.
- Naylon, J. 1959 Land consolidation in Spain, *Annals of the Association of American Geographers*, 49(4), 361-373.
- Naylon, J. 1967 Irrigation and internal colonization in Spain, *Geographical Journal*, 133, 178-191.
- North, D. C. 1990 *Institutions, institutional change and economic performance*, Cambridge: CUP.
- North, D.C. 1992 *Transaction costs, institutions, and economic performance*, San Francisco: International Center for Economic Growth,
http://pdf.usaid.gov/pdf_docs/PNABM255.pdf, (last accessed 29th of January 2013).
- Olcina Cantos, J. 2001 Tipología de sequías en España, *Ería*, 56, 201-227.

Olwig, K. 2002 *Landscape, Nature and the body Politic*, Madison: The University of Wisconsin Press.

Otero, J. 1993 *Modernización e inmovilismo en la Mancha de Ciudad Real*, Ciudad Real: Diputación Provincial de Ciudad Real.

Ostrom, E. 1990 *Governing the Commons. The Evolution of Institutions for Collective Action*, Cambridge: Cambridge University Press.

Ortega Canadell, R. 2004 Política agraria y propaganda institucional en la década de 1950, *Estudis d'Història Agrària*, 17, 645-658.

Ortega Cantero, N. 1972 Estudio de un pueblo de colonización: Vegaviana (Cáceres), *Estudios Geográficos*, 33(127), 265-311.

Ortega Cantero, N. 1979 *Política agraria y dominación del espacio*, Madrid: Ayuso.

Ortega Cantero, N. 1983 El proceso de mecanización y adaptación tecnológica del espacio agrario español, *Agricultura y Sociedad*, 27, 81-149.

Ortega Cantero, N. 1993 “Algunas orientaciones de la política agraria española posterior a la Guerra civil: de la colonización a la ordenación rural”, in Gil Olcina, A. and A. Morales Gil (eds.) *Medio siglo de cambios agrarios en España*, Alicante: Instituto de Cultura “Juan Gil-Albert”, Diputación de Alicante, 15-29.

Ortega Cantero, N. 1999 Romanticismo, paisaje y Geografía. Los relatos de viajes por España en la primera mitad del siglo XIX, *Ería*, 49, 121-128.

Ortega Cantero, N. 2007 La valoración patrimonial y simbólica del paisaje de Castilla (1875-1936), *Ería*, 73-74, 137-159.

Ortí, A. 1984 Política hidráulica y cuestión social: orígenes, etapas y significados del regeneracionismo hidráulico de Joaquín Costa, *Agricultura y Sociedad*, 32, 11-107.

Otero, I., Kallis, G., Aguilar, R., and V. Ruiz 2011 Water scarcity, social power and the production of an elite suburb: the political ecology of water in Matadepera, Catalonia, *Ecological Economics*, 70(7), 1297-1308.

Oyón, J. L. 1985 *Colonizas agrícolas y poblados de colonización: arquitectura y vivienda rural en España (1850-1965)*, PhD Thesis, Unpublished, Universitat Politècnica de Catalunya, Escola Tècnica Superior d'Arquitectura de Barcelona.

Pastötter, B. and K.T. Bäuml 2010 “Retrieval inhibition in autobiographical memory” in Mace, J. H. 2010 (ed.) *The act of remembering: toward an understanding of how we recall the past*, Oxford: Blackwell Publishing Ltd., 202-227.

Pan-Montojo, J. 2002 Asociacionismo agrario, administración y corporativismo en la dictadura de Primo de Rivera, 1923-1930, *Historia Social*, 43, 15-30.

Payne, S.G. 1961 *Falange: a history of Spanish Fascism*, Stanford: Stanford University Press.

PEAG 2008 *Plan Especial del Alto Guadiana, Anejo II. Informe de aprovechamientos sin aval*,
http://www.chguadiana.es/corps/chguadiana/data/resources/file/PEAG/7_A_II_APROV_V_SIN_AVAL.pdf (last accessed 7th of January 2013).

Peet, R. 1988 Wittfogel on the nature-society dialectic, *Political Geography Quarterly*, 7(1), 81-83.

Pemberton, H.E. 1936 The curve of culture diffusion rate, *American Sociological Review*, 1(4), 547-556.

Peng, C.J., Lee, K.L., and G.M. Ingersoll 2002 An introduction to logistic regression analysis and reporting, *The Journal of Educational Research*, 96(1), 3-14.

Peña Ortiz, M. 2010 “Los regadíos históricos manchegos: Daimiel y su entorno. Ciudad Real” in Hermosilla Pla, J. (dir.) *Los regadíos históricos españoles: paisajes*

culturales, paisajes sostenibles, Madrid: Ministerio de Medio Ambiente, y Medio Rural y Marino, 207-228.

Peperkamp, G. 1972 The activities of the National Colonisation Institute on La Mancha (Spain), *Tijdschrift voor Economische en Sociale Geografie*, 63(1), 11-24.

Peperkamp, G. 1979 Las actividades colonizadoras del I.N.C./IRYDA en las zonas de Ejea y de la Violada (Cuenca del Ebro) antes de 1974, *Geographica*, 4, 3-46.

Pérez-Díaz, V., Mezo, J., and B. Alvarez-Miranda 1996 *Política y economía del agua en España*, Madrid: Círculo de Empresarios.

Pérez Escolano, V. and Calzada Pérez, M. 2008, “Pueblos de Colonización”, in (varios autores, *Pueblos de Colonización durante el Franquismo: la arquitectura en la modernización del territorio rural*, Junta de Andalucía, 10-13.

Pérez Pérez, E. 1992 “Disposiciones decimonónicas sobre aguas. Ley de 1879,” in Gil Olcina, A., and A. Morales Gil (coord.) *Hitos históricos de los regadíos españoles*, Madrid: Ministerio de Agricultura, Pesca y Alimentación, 183-202.

Pérez Picazo, T., and G. Lemeunier 1990 “Los regadíos murcianos del feudalismo al capitalismo”, in Pérez Picazo, T. and G. Lemeunier (eds.) *Agua y modo de producción*, Barcelona: Editorial Crítica, 150-187.

Perry, P.J. 1988 Thirty years on: or, Whatever happened to Wittfogel?, *Political Geography Quarterly*, 7(1), 75-80.

Picon, A. 1996 “Towards a history of technological thought” in Fox, R. (ed.) *Technological change: methods and themes in the history of technology*, Amsterdam: Harwood Academic Publishers, 37-49.

Pillet Capdepón, F. 1989 “Los regadíos de Castilla-La Mancha: Implicaciones actuales y tipos de explotación” in *Los Paisajes del Agua*, Universitat de València and Universidad de Alicante, 133-143.

Pillet Capdepón, F. 2002 De la ficción a la percepción. Del Quijote a la Mancha literaria, *Boletín de la A.G.E.*, 34, 147-157.

Pillet Capdepón, F., and J.P. Plaza Tabasco (coord.) 2006 *El espacio geográfico del Quijote en Castilla-La Mancha*, Murcia: Ediciones de la Universidad de Castilla-La Mancha.

Pinch, T and W. Bijker. 1996 "The social construction of facts and artifacts" in Bijker, W.E., Hughes, T.P., and T. Pinch (eds.) *The social construction of technological systems*, Cambridge: MIT Press, 17-50.

Pinilla, V. 2006 The development of irrigated agriculture in twentieth-century Spain: a case study of the Ebro basin, *Agricultural History Review*, 54(1), 122-141.

Pitt-Rivers, J. 1954 *The people of the Sierra*, Weidenfeld & Nicolson, London.

Planas Maresma, J. 2003 Cooperativismo y difusión del cambio técnico en la agricultura. La contribución de las cámaras agrícolas (Cataluña, 1890-1930), *Historia Agraria*, 30, 87-117.

Ponce Herrero, G. 1992 Explotación y gestión de aguas subterráneas en las comarcas del interior Alicantino, *Revista de Estudios Agro-Sociales*, 159, 147-170.

Portes, A. 1998 Social capital: its origins and applications in modern sociology, *Annual Review of Sociology*, 24, 1-24.

Press, S.J., and S. Wilson 1978 Between logistic regression and discriminant analysis, *Journal of the American Statistical Association*, 73(364), 699-705.

Preston, P. 1995 *The Politics of Revenge: Fascism and the Military in 20th Century Spain*, London: Routledge.

Pretty, J., and H. Ward 2001 Social capital and the environment, *World Development*, 29(2), 209-227.

Pringle, T. 1988 "The privation of history: Landseer, Victoria and the Highland Myth", in Cosgrove, D E and Daniels, S (eds.) *Iconography of Landscape*, Cambridge: Cambridge University Press, 142-161.

Pulpón, A. R. 2008 El acceso al agua como factor de identificación de problemas de desarrollo agrario sostenible en el territorio del Alto Guadiana, *Estudios Geográficos*, 69(265), 665-685.

Pulpón, A. R. 2009 La Directiva Marco del Agua como referencia para la aplicación del Plan especial del Alto Guadiana, *Nimbus*, 23-24, 183-200.

Putnam, R. 1993 Making democracy work: civic transitions in modern Italy, Princeton, NJ: Princeton University Press.

Putnam, R. 1995 Bowling alone: America's declining social capital, *Journal of Democracy*, 6(1), 65-78.

Rabasco, P. 2009 La planificación en la construcción de los poblados del Instituto Nacional de Colonización, *Informes de la Construcción*, 61(515), 23-34.

Ramos Gorostiza, J.L. 2006 Gestión ambiental y política de conservación de la naturaleza en la España de Franco, *Revista de Historia Industrial*, 15(32), 99-138.

Reisner, M. 1993 *Cadillac Desert: the American West and its disappearing water*, Harmondsworth: Penguin.

Ricoeur, P. 1980 Narrative Time, *Critical Inquiry*, 7(1), 169-190.

Rico Amorós, A. M. 2004 Sequías y abastecimientos de agua potable en España, *Boletín de la A.G.E.*, 37, 137-181.

- Ringrose, D. 1996 *Spain, Europe, and the "Spanish miracle," 1700-1900*, Cambridge: Cambridge University Press.
- Ritzer, G. 2009 "Control: human and nonhuman robots" in Johnson, D.B. and J.M. Wetmore (eds.) *Technology and society: building our sociotechnical future*, Cambridge: MIT Press, 227-255.
- Robledo, R. 1996 "Introducción y estudio" in Martín, J.L. (dir.) *Documentos sobre la Reforma Agraria en los archivos del IRYDA*, Madrid: Universidad Nacional de Educación a Distancia, 7-41.
- Rogers, E.M. 2003 *Diffusion of Innovations* (5th Edition), New York: Free Press.
- Romano Serrano, M. J. 2005 *Llanos del Caudillo: memoria e historia oral de un pueblo de la colonización agraria*, Llanos del Caudillo: Ayuntamiento de Llanos del Caudillo.
- Rosell Foxà, J. 2001 "Aspectos económicos de la utilización de las aguas subterráneas en La Mancha," in Hernández-Mora, N., and M. Ramón Llamas (eds.) *La economía del agua subterránea y su gestión colectiva*, Madrid: Fundación Marcelino Botín, 181-201.
- Rosell, J., and L. Viladomiu 1997 El programa de compensación de rentas por reducción de regadíos en Mancha Occidental y Campo de Montiel, *Economía Agraria*, 179, 331-350.
- Rutledge Southworth, H. 1976 "The Falange: an analysis of Spain's fascist heritage", in Preston, P. (ed.) *Spain in crisis*, Hassocks, Sussex: The Harvester Press Limited, 1-22.
- Ryan, L. 2009 The sins of the father: The destruction of the Republican family in Franco's Spain, *The History of the Family*, 14(3), 245-252.

San Roman, E. and C. Sudria 2003 Synthetic fuels in Spain, 1942-66: the failure of Franco's autarkic dream, *Business History*, 45(4), 73-88.

Sánchez Domínguez, M.A. 2001 Fundamentos teóricos y efectos económicos del Plan Jaén de 1953, *Boletín del Instituto de Estudios Giennenses*, 179, 269-305.

Sánchez López, A.J. 1980 La colonización y el mantenimiento de la dependencia entre gran y pequeña propiedad: el caso de Viar, *Agricultura y sociedad*, 17, 69-108.

Sánchez Sánchez, I. 2001 "El asociacionismo agrario en Castilla-La Mancha", in López Villaverde, A.L., and M. Ortiz Heras (coord.) *Entre surcos y arados*, Cuenca: Ediciones de la Universidad de Castilla-La Mancha, 171-209.

Sansom, R.L. 1969 The Motor Pump: A Case Study of Innovation and Development, *Oxford Economic Papers*, 21(1), 109-121.

Sauri, D., and L. del Moral 2001 Recent developments in Spanish water policy. Alternatives and conflicts at the end of the hydraulic age, *Geoforum*, 32(3), 351-362.

Schatzki, T.R. 2003 Nature and Technology in History, *History and Theory*, 42(4), 82-93.

Schioler, T. 1973 *Roman and Islamic water-lifting wheels*, Kobenhavns: Odense University Press.

Schlager, E., and W. Blomquist 2008 *Embracing Watershed Politics*. Boulder: University Press of Colorado.

Schlebeker, J.T. 1977 Farmers and bureaucrats: reflections on technological innovation in agriculture, *Agricultural History*, 51(4), 641-655.

Serna, J., and M. Gaviria 1995 *La quimera del agua*, Madrid: Siglo Veintiuno de España Editores S.A.

Sevilla Jiménez, M., Torregrosa, T., and L. Moreno 2010 Las aguas subterráneas y la “tragedia de los comunes en el Vinalopó” (Alicante, España), *Estudios de Economía Aplicada*, 28(2), 305-332.

Shah, T. 2009 *Taming the anarchy: groundwater governance in South Asia*, Washington: RFF Press.

Shah, T., Singh, O.P., and A. Mukherji 2006 Some aspects of South Asia's groundwater irrigation economy: analyses from a survey in India, Pakistan, Nepal Terai and Bangladesh, *Hydrogeology Journal*, 14(3), 286-309.

Singh, H. and M.S. Dhooria 1971 Bionomics of the Pea pod borer, *etiella zinckenella* (Treitschke), *Indian Journal of Entomology*, 33(2), 123-130.

Skocpol, T. 1985 “Bringing the State Back In: Strategies of Analysis in Current Research” in Evans, P. B. et al (eds.) *Bringing the State Back In*, Cambridge: Cambridge University Press, 3-37.

Smith A. D. 1993 “The Nation: invented, imagined, reconstructed?” in Ringrose, M. and A.J. Lerner (eds.) *Reimagining the nation*, Buckingham: Open University Press, 9-28.

Smith, D.E. 1974 The social construction of documentary reality, *Sociological Inquiry*, 44(4), 257-268.

Smith, D.E. 2001 Texts and the ontology of organizations and institutions, *Studies in Cultures, Organizations and Societies*, 7(2), 159-198.

Smith, H.N. 1950 *Virgin land: the American West as symbol and myth*, Cambridge, Mass: Harvard University Press.

Smith, N. 1996 “The production of nature” in Robertson, G. et al. (eds.) *FutureNatural*, London: Routledge, 35-54.

Smith, N. 2008 *Uneven development: nature, capital and the production of space*, Athens: University of Georgia Press.

Solway, J. S. 1994 “Drought as a “revelatory crisis”: An exploration of the shifting entitlements and hierarchies in the Kalahari, Bostwana, *Development and Change*, 25(3), 471-495.

Sundaram, D. 2003 *Water, Technology and Commoditization and Poor – An Indian Case Study*, South Asia Conference on Technology for Poverty Reduction, New Delhi, 10-11 October 2003,
http://practicalaction.org/docs/region_south_asia/water_technology_commoditisation_india.pdf (last accessed 31st of October 2011).

Sunding, D. and D. Zilberman 2001 “The agricultural innovation process: research and technology adoption in a changing agricultural sector” in Gardner, B. and G. Rausser (eds.) *Handbook of Agricultural Economics*, Vol.1, 207-261.

Swyngedouw, E. 1996 The city as a hybrid: on nature, society and cyborg urbanization, *Capitalism, Nature, Socialism*, 7(2), 65-80.

Swyngedouw, E. 1999 Modernity and Hybridity: Nature, Regeneracionismo, and the Production of the Spanish Waterscape, 1890-1930, *Annals of the Association of American Geographers*, 89(3), 443-465.

Swyngedouw, E. 2007 Technonatural revolutions: the scalar politics of Franco’s hydro-social dream for Spain, 1939-1975, *Transactions of the Institute of British Geographers*, 32(1), 9-28.

Swyngedouw, E. 2013 Into the sea: desalination as hydro-social fix in Spain, *Annals of the Association of American Geographers*, 103(2), 261-270.

Taher, T., Bruns, B., Bamaga, O., Al-Weshali, A., and F. van Steenbergen 2012 Local groundwater governance in Yemen: building on traditions and enabling communities to craft new rules, *Hydrogeology Journal*, 20(6), 1177-1188.

The Guardian 2009 “Spanish wetlands shrouded smoke as overfarming dries out peat”, 19th October 2009, <http://www.guardian.co.uk/environment/2009/oct/19/las-tablas-water-wetlands-burn>, (last accessed 26th of March 2013).

Ton, K. and K. De Jong 1991 Irrigation technology and social change: an analysis of the social variables of technology, *The Journal of Developing Areas*, 25(2), 197-206.

Tortella, G. 2000 *The development of modern Spain: an economic history of the nineteenth and twentieth century*, Cambridge: Harvard University Press.

Tournikiotis, P. 1999 *The historiography of modern architecture*, Cambridge: MIT Press.

Varela-Ortega, J. 1975 *Politics and Elections in Early Restoration Spain with special reference to Castile 1875-1903*, Unpublished Dphil Thesis, University of Oxford.

Velasco Lizano, M. 2002 “La Reserva de la Biosfera de la Mancha Húmeda. Estado de conservación de los humedales en relación con el uso de las aguas subterráneas” in Coletto, C. et al. (eds.) *Conflictos entre el desarrollo de las aguas subterráneas y la conservación de los humedales: la cuenca alta del Guadiana*, Madrid: Fundación Marcelino Botín, Ediciones Mundi-Prensa, 197-231.

Villanueva Paredes, A. and J. Leal Maldonado 1990 *Historia y Evolución de la Colonización agraria en España, Vol.3 La planificación del regadío y los pueblos de colonización*, Madrid: Ministerio de Agricultura, Pesca y Alimentación, Ministerio para las Administraciones Públicas, Ministerio de Obras Públicas y Transportes.

Vives, J. V. 1969 *An economic history of Spain*, New Jersey: Princeton University Press.

Wainwright, J. 2005 Politics of Nature: A Review of Three Recent Works by Bruno Latour, *Capitalism, Nature, Socialism*, 16(1), 115-122.

- Wang, J. et al. 2006 Privatization of tubewells in North China: Determinants and impacts on irrigated area, productivity and the water table, *Hydrogeology Journal*, 14(3), 275-285.
- West B. and P. Smith 1996. Drought, discourse, and Durkheim: a research note. *Journal of Sociology*, 32(1), 93-102.
- Wester, P., Mollard, E., Silva-Ochoa, P., and S. Vargas-Velázquez 2009 “From Half-full to Half-empty: the Hydraulic Mission and Water Overexploitation in the Lerma-Chapala Basin, Mexico” in Molle, F. and P. Wester (eds.) *River Basin Trajectories: Societies, Environment and Development*, Wallingford, Massachusetts: CABI, IWMI, 75-98.
- Whatmore, S. 2002 *Hybrid geographies: natures, cultures, spaces*, London: SAGE Publications Ltd.
- White, H. 1980 The Value of Narrativity on the Representation of Reality, *Critical Inquiry*, 7(1), 5-27.
- Whittle, A. and A. Spicer 2008 Is Actor Network Theory Critique?, *Organization Studies*, 29(4), 611-629.
- Wijnen, M., Augeard, B., Hiller, B., Ward, C., and P. Huntjens 2012 *Managing the Invisible: understanding and improving groundwater governance*, Water Papers, The World Bank.
- Williams, T. (ed.) 1978 *A history of technology*, 6 Volumes, Oxford: Oxford University Press.
- Wittfogel, K. 1957 *Oriental despotism: a comparative study of total power*, New Haven: Yale University Press.
- Worster, D. 1992 *Rivers of Empire: water, aridity, and the growth of the American West*, Oxford: Oxford University Press.

Worster, D. 1994 Nature and the disorder of History, *Environmental History Review*, 18(2), 1-15.

Worster, D. 2004 *Dust Bowl: the southern plains in the 1930s*, Oxford: Oxford University Press.

WWF 2012 El fiasco del agua en el alto Guadiana, <http://www.wwf.es/?22540/WWF-denuncia-la-compra-pblica-de-agua-fantasma--en-el-Alto-Guadiana-por-66-millones-de-euros>, (last accessed 16th of January 2013).

Yow, V. R. 1994 *Recording oral history: a practical guide for social scientists*, Thousand Oaks: SAGE Publications.

Annex 1.

Table 1. Qualitative semi-structured in-depth interviews

<i>Interview number</i>	<i>Date of interview</i>	<i>Location of interview</i>	<i>Time of interview</i>	<i>Date of birth of interviewee</i>	<i>Place of birth of interviewee</i>
1	01/06/2011	Tomelloso	11.30 am	31/12/1949	Tomelloso
2	01/06/2011	Villarta de San Juan	5.30 pm	9/08/1920	Villarrubia de los Ojos
3	01/06/2011	Villarta de San Juan	6 pm	10/10/1940	Villarta de San Juan
4	01/06/2011	Villarta de San Juan	6.30 pm	26/08/1930	Villarta de San Juan
5	02/06/2011	Tomelloso	10.30 am	22/06/1938	Tomelloso
6	02/06/2011	Tomelloso	12 pm	1941	Tomelloso
7	02/06/2011	Tomelloso	1 pm	17/04/1938	Tomelloso
8	02/06/2011	Tomelloso	1.30 pm	03/04/1938	Tomelloso
9	02/06/2011	Alameda de Cervera	6 pm	11/07/1930	Campo de Criptana
10	02/06/2011	Alameda de Cervera	6.30 pm	18/12/1927	Alcázar de San Juan
11	02/06/2011	Alameda de Cervera	7 pm	1932	Tomelloso
12	03/06/2011	Manzanares	11 am	22/08/1931	Manzanares
13	06/06/2011	Llanos del Caudillo	8.30 pm	1940	Villarta de San Juan
14	07/06/2011	Argamasilla de Alba	4.30 pm	1942	Argamasilla de Alba
15	07/06/2011	Argamasilla de Alba	6 pm	16/06/1948	Argamasilla de Alba
16	08/06/2011	Manzanares	11.30 am	04/03/1928	Manzanares
17	13/06/2011	Alcázar de San Juan	12.30 pm	1936	Alcázar de San Juan

Table 2. Participant observation

<i>Participant observation</i>	<i>Date of participant observation</i>	<i>Location of participant observation</i>	<i>Event</i>
1	23/03/2011	Complutense University of Madrid, Madrid	Research Seminar on Common Groundwater Management, Water Observatory
2	25/03/2011	Community of Irrigators of Herencia, Herencia	Research trip with the Water Observatory
3	26/05/2011	Lagunas de Ruidera	Conference AEUAS (Spanish Association of Groundwater Users)

Table 3. Transect walks

<i>Transect walk</i>	<i>Date of transect walk</i>	<i>Location of transect walk</i>	<i>Name of the guide</i>
1	25/03/2011	Field, Alcázar de San Juan	José
2	01/06/2011	Field, Tomelloso	Justo
3	06/06/2011	Field, Llanos del Caudillo	Pedro
4	08/06/2011	Field, Manzanares	Anonymous
5	14/06/2011	Company Warehouse Riegos Lozano, Manzanares	Two technicians, anonymous