RISKING THE FLOOD

CARTOGRAPHIES OF THINGS TO COME

D.PHIL. THESIS and ABSTRACT

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Abstract

Reflecting on fieldwork carried out in the UK insurance sector, the thesis explores the role played by various types of actuarial and hydrological expertise in the performance of flooding as a matter of sustained public concern. In doing so, the question is raised: what analytical status to give the concept of *risk* when accounting for the epistemic doings involved in bringing yet unrealised future floods to bear on the present? Contrary to most other European countries the provision of flood insurance in the UK is left to the market and organised via an agreement under which insurers pledge to provide cover in areas protected by the Government to a standard of 1:75 years (the average return period between floods). What should be taken into account when mapping out this 1:75 year flood zone is subject to debates constantly revitalised by flood events with changing characteristics as well as new ways of modelling and anticipating what has yet to take place. How should we understand the knowledge claims hardwired into these debates through the involvement of actuarial and hydrological expertise? The thesis will argue that a reorientation of flood risk away from a status as the (multiple) object of these claims towards a status as an event in which a diverse variety of other things are brought into being (maps, futures, frequencies, anxieties, publics, geographies, things which are not necessarily very well understood as risk per se), will give rise to more productive and eventful questions. In the terminology of Isabelle Stengers, to risk is to create the possibility of bringing new things to life – the risking of floods seems to be constantly exciting such creativities.

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Introduction

What might it mean to be risking the flood?

> *As soon as we begin to talk indeterminism to our friends, we find a number of them shaking their heads. This notion of alternative possibility, they say, this admission that any one of several things may come to pass, is, after all, only a roundabout name for chance; and chance is something the notion of which no sane mind can for an instant tolerate in the world. What is it, they ask, but barefaced crazy unreason, the negation of intelligibility and law? And if the slightest particle of it exists anywhere, what is to prevent the whole fabric from falling together, the stars from going out, and chaos from recommencing her topsy-turvy reign? (James 1943a, p.153)*

> *The need to accurately predict both groundwater and surface water flash floods - the latter firmly linked to drainage capacity - was heightened after last summer's catastrophe. In response, mapping technology specialists have announced developments over recent months to help overcome these 'black holes' in insurers' knowledge. But whether these advances could be described as the 'Holy Grail' is doubtful. With the UK's drains in various states of repair, and no adequate data on their current condition available, insurers will always face uncertainty. In addition, there is the impact of climate change and the omission of small rivers and streams on existing Environment Agency data - despite their ability to result in nasty incidents. (Post Magazine 21.02.2008)*

> *Maps are not prescriptive but infinitely promising. (Corner 1999, p.235)*

In November 1884 the American psychologist and philosopher William James addressed students at Harvard on 'the dilemma of determinism': is 'free will' genuinely free, or is everything given in advance? Refreshingly, the answer was of little interest. James made it quite clear from the outset of his lecture that he was not going to offer any solution or provide any settlement to an ancient intellectual tussle between those professing the predetermined state of the universe and those contesting it[1]. 'Facts', he proclaimed, 'have hardly anything to do with making us either determinists or indeterminists' since it is impossible to see how 'any amount of assurance that something actually happened [can] give us the least grain of information as whether another thing might or might not have happened in its place' (p.152). To James, the existence of alternative possibilities was a matter of rational belief, not of proof, and hence his interest in determinism was of an altogether different sort than that of the usual protagonists debating its veracity. Rather than attempting to prove (or disprove) the contention 'that any one of several things may come to pass' he tried to understand how these things-to-come must, and positively can, exist beyond proof and verifiable evidence. When I now propose to explore how floods are risked, this schism between actual fact and credible possibility is fundamental: what I am after are the more-than-factual ways in which eventualities are brought to life.

I deliberately frame it as a 'more', rather than a 'less', since I am not interested in reiterating any linear conception of uncertainty as simply incomplete or second rate knowledge. On the contrary, it seems to me, at least in the context of flood risk, that the realisation of alternative possibilities involves the mobilisation of things which can be positively ascertained as facts. Crucially, of course, it is not reducible to these things, but neither is it short of them. It requires a leap of faith beyond them, something more than what they have to offer. In the empiricist style of thought championed by James, such instances of

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[1] The discussion dates back to the pre-Socratic philosopher Epicurus who tried, to no avail, to reconcile Democritus' idea of a world made from atoms falling through the void with the notion of human freedom (Prigogine, Stengers 1997).

'belief' are not construed as negatives or surrogates in the absence of more robust and justifiable ways of knowing. Rather, they are understood to be at the root of what it means to know at all. To illustrate this point James used the metaphor of 'live' and 'dead' electric wires and proposed to define a live hypothesis as 'one which appeals as a real possibility to him to whom it is proposed' ('belief') and to measure this 'liveness' by such a person's 'willingness to act' (James 1956, pp.2-3). Indeed, the evolving plethora of possible future floods circulating the public domain under the auspices of forecasts, maps and models displays a considerable degree of 'liveness' if gauged using this method[2]. It has 'practical consequences' (James 1987, p.506); it makes a difference.

Essentially, then, the question I am trying to ask relates to the 'liveness' of indeterminacy itself. How it takes place; how it eventuates. While it might be impossible to factually ground its implicit contention that things could have been otherwise than what has observably taken place, it is nonetheless a claim with a noticeable purchase on reality as we know it. In a world in which risk has become instrumental to the analysis, anticipation and management of everything from mundane accident to cosmological disaster (e.g. Adams 2001, Posner 2004, Power 2004, Bostrom, Cirkovic 2008) and is seized upon as a sign of the times, the mould in which contemporary modernity crystallizes (e.g. Beck 1992b, 1995, 1999, 2009, Giddens 1991, 1994, 2009), it seems evident that indeterminacy has made its mark – with or without the assistance of proof. But with the assistance of what, then, has such a

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[2] James dubbed the approach 'pragmatism' (James 1943b).

construction acquired its integrity? What generator sparks the current; what conductive material makes the wiring to go live?

Prompted by these curiosities, and with the risking of floods in mind, I am interested in the emergence of believable ('live') eventualities. How can things to come have real effects without actually coming to pass? How, that is, can they attain reality without confirming their premonitions (which would deprive them of their ambivalence and make them more than merely possible) and, equally important, how can they maintain their indeterminable futurity without becoming themselves indeterminable (which would fundamentally obscure their realisation)? The critical point, which James kept stressing, is that in between the two extremes of the deterministic argument rehearsed above – in between the absolutes of intelligible law and topsy-turvy chaos – the indeterminist seems able to construct an altogether orderly universe which leaves room for chance without dissolving into perplexing disarray:

> *The creator himself would not need to know all the details of actuality until they came; and at any time his own view of the world would be a view partly of facts and partly of possibilities, exactly as ours is now. Of one thing, however, he might be certain: and that is that his world was safe, and that no matter how much it might zigzag he could surely bring it home at last. (p.183)*

It is implied that indeterminacy is not simply a 'want of determinateness or definiteness' (as the Oxford English Dictionary has it); it is not just an absence of something, but a particular type of presence which effectuates, and is effectuated by, an equally particular mix of actuality and possibility. Flood risk embodies such a mix: some things are known as facts (floods have been observed; weather patterns have been recorded; terrains have been mapped; flows have been theorised; defences have been designed; vulnerabilities have been located; policies have been adopted; and regulations have been put in place), while some (other?) things are known as possibilities (future floods and weather patterns are imagined; alternative maps and theories are proposed; the effects of policies and regulations are pondered; and vulnerabilities and defence strategies are reassessed accordingly). There is a very fine line separating what might possibly come to pass from what has actually taken place here and they are frequently stirred into hybrid coexistence. At the end of the day, however, whether for the benefit of the work of political, scientific or commercial construction, flood risk is a platform to build on. Although it is concerned with potential catastrophe, and although it embodies something inherently indeterminable, it provides a distinct alternative to the paralyzing absence of certainty: it reassures us, in the words of James, that the world is 'safe'. Not safe from being flooded, of course, but from being abysmally unintelligible.

In what follows, I pursue a geographical impulse to contemplate the kind of space needed for this indeterminable, though far from intangible, futurity to take place. A space too porous and heterogeneous for facts to have the final say, a space in which things can be left to chance and possibilities kept open, and yet a space which can be reassuringly mapped out in terms of risk. What makes that type of mapping possible? By what interventions can things which have yet to come (or not to come) be charted? 'In representing the geography of Paradise,' writes Antonio Scafi, 'medieval map-makers always emphasized the *passage* to a dimension different from the time and space of ordinary human experience' (1999, p.60). To risk, it seems, compels a similar type of dimensional transit, 'a link between incommensurable worlds' (p.57), and a pragmatic leap of faith beyond the horizon of modernist cartographies 'reduced to three dimensional Euclidean space and limited to our ordinary experience of the physical world' (pp.67-68). Yet, whereas the cartographers of Eden clearly marked the placement of what cannot per se be found (paradise lost) by setting it pictorially apart from the rest of their Mappae Mundi, such distinctions quickly fade from view when risk assessments become enthralled by the cartographic 'ethic of accuracy' (Harley 2001) diffusing in force through practices like simulation modelling and remote sensed imaging. Contemporary flood maps are far from explicit about setting the cartographic placement of things to come spatiotemporally apart from what has observably taken place. When I adopt the eventful terminology of risking, rather than of risk, it is to highlight that such a distinction, albeit increasingly covert, is nonetheless being made, and that the 'liveness' of indeterminacy is, precisely, very much alive: it makes a difference to the world affected by it.

'Risking the flood' before 'the risk of flooding'

> *Hope is easily identified and its quantitative presence or absence highlighted, but the taking-place of hope, its mode of operation, remains an aporia. (Anderson 2006, p.733)*

'Flooding' and 'risking' are both verbal nouns poised between action and object. They refer to the instance of a doing (to flood, to risk) and thus impart temporality and creativity to what would otherwise be cast substantively as a noun (a flood, a risk). But whereas 'flooding' enjoys colloquial popularity as something which is unequivocally verbal, the same cannot be said for 'risking'. A flood has meaning only as an *event* – continuous change captured under a convenient heading – but it is less clear whether or not the same is true for risk: Is it, or is it not, present before the risking? A risk can be run, taken, managed or hedged; it can be bought, sold, written or insured; things can be put at risk or associated with it; it can be measured, and it can itself be a measure. Any sense of becoming is lost in statements like: ‛the Government said it could not give a figure for the number of households at a higher flooding risk than one in 75' (Birmingham Post & Mail 12.07.2008); ‛insurers believe urgent action is needed to reduce the risk from climate change if cover is to remain affordable and widely available' (Financial Times, 20.08.2007); or ‛13 major developments had been given the go-ahead despite advice from the Environment Agency that they would be at risk from flooding‛ (Coventry Evening Telegraph, 19.02.2008). This kind of standard parlance implies a pre-existence which might be represented or manipulated by otherwise extraneous actions such as those related to the practices of measurement, modelling, planning or engineering. It leaves open the question what it actually means ‛to risk'? If taken to be the action of putting at risk or associating with things which are already risky, then ‛risking' is not endowed with the same creativity as ‛flooding'. It is merely the redistribution of things which are already there; it does not bring anything new into being. The aim of this thesis is to posit it otherwise so as *to restore risk as a way of doing other things, rather than as an object of other doings*. By proxy of the Latin ‛periculum', risk traces its etymological origins to the Sanskrit word ´par', to conduct, or, in its Greek bifurcation, to pierce a way through. Eventually, this is the source of the Latin ‛portus', a doorway. Notions like change, movement and passage are in other words deeply embedded in the linguistic ancestry of risk, even though this verbal pedigree tends to fade from view when risk takes form both as measurable and as a measure in the context of insurance policies and protection standards.

To the Belgian philosopher of science Isabelle Stengers risk is inextricably linked to creative power (Stengers 1997, 2000) and what she calls ‛cosmopolitics' (2003a, 2003b, see also 2005). Any successful bringing into being, she argues, must risk the parts involved in the enterprise. Invoking new realities and making novel claims to knowledge thus necessitates experimentation; it implies a material putting at stake in which existing roles and constitutions are jeopardized and reassigned in order to invent 'the power to confer on things the power of conferring on the experimenter the power of speaking in their name' (1997, p.164). Hence, styled as a creative practice, risking reveals its commonality with an undertaking that often finds its ambiguous self at the centre of geographical attention, namely that of making maps. 'Mapping', in the words of James Corner, 'unfolds potential; it re-makes territory over and over again, each time with new and diverse consequences' (1999, p.213). He thus distinguishes, in a manner following the work of Gilles Deleuze and Félix Guattari (1987), between mere tracings of 'things which are already known' and proper maps which 'discover new worlds within past and present ones' (Corner 1999, p. 214). Such an argument about the creative and, thus, far from politically neutral capacity of maps has been a recurrent vehicle for critical engagements with cartography (e.g. Pickles 1995, Harley 2001, Mitchell 2002), but for Corner it is also a way of highlighting the enabling character of mapping; that it is a making-possible just as much as a making-subjugated or a making-powerful. In situations where the alternative would have been the crudely uncertain and profoundly dissuasive encounter with unmediated danger, risk is, in a manner similar to mapping, a way of making possible. UK insurers, for example, cover potential flood damages worth billions of pounds every year[3], an unthinkable gamble was it not for the creative devices deployed across the spectrum from hydrology to finance to enable

[3] In 2000 the Association of British Insurers estimated that a major flood could cost the industry in excess of £1bn (ABI 2000). Three weeks later that happened for the first time. After the events in the summer of 2007 the figure tripled to a total of £3 billion paid out on claims (ABI 2007).

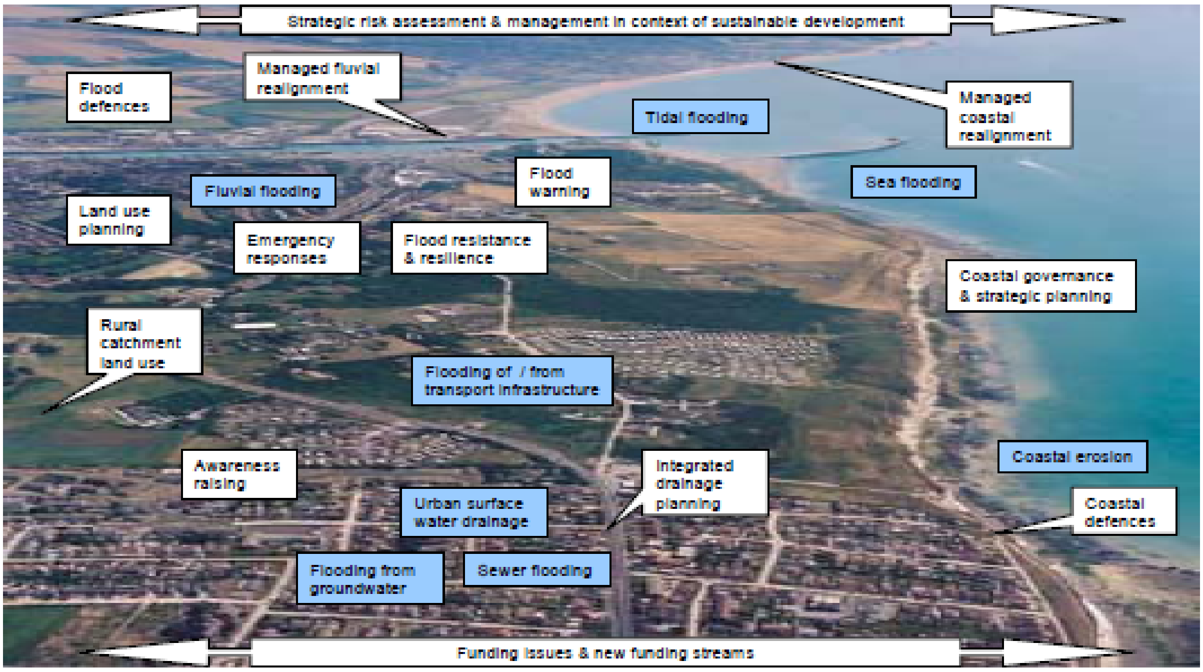
hitherto unavailable things like return periods, flood zones, premiums, policy conditions or annual exceedence probabilities to take shape. These devices are, to these ends, assisting the discovery of 'new worlds within past and present ones'.

The exploratory notions of pathway and passage lost in the etymological hinterlands of 'risk' once again transpire. In the cognate vocabulary of mapping such devices could be understood as being at work to 'reveal artificial geographies that remain unavailable to human eyes' (Corner 1999, p. 214), the outcome of their efforts being a world in which the risk of flooding can be traded. Not in the sense that it has somehow been made sufficiently profitable or manageable to be safely taken on, but simply that it has been made possible: that flood risk has emerged as an intelligible and transferable object. Risking (in the creative sense) thus paves the way for the insurance industry to take risks (in the conventional sense), while the precise character of such a pavement, as well as the intricacies of its creative procurement, remains to be uncovered. That is the aim of this thesis. Of particular interest is the distinct cocktail of well-knowns and unknowns that catalyzes creativity in the cartographic apparatuses of both mapping (the making available of otherwise unknowable geographies by analogy to the well-known surface of the earth) and risking (the making available of otherwise unknowable futures by analogy to well-known pasts and presents). How does that cocktail derive its potency? What triggers its creativity? Three points must be clarified before I move on. Firstly: why are these questions interesting? Secondly: how do I propose to go about answering them? And thirdly: what is it exactly that I am trying to accomplish by doing so?

Why?

> *Scientists say that Monday's monsoonlike downpours are the increasingly strange shape of things to come. (...) But this is not simply an act of Nature. This flooding was also a result of systematic, shortsighted failings on part of successive governments. Now questions must be answered: Why has half the new housing built since the Second World War been built on flood-prone land? Why do we keep concreting over the countryside, destroying the natural drainage process? Why are less than 50 per cent of our major flood defence systems up to the job? Why have so many of our rivers been straightened in a disastrous attempt to control their flows? Why do local authorities and ministers continue to flout official planning guidelines? (Daily Mail 27.07.2007)*

It is complicated. If anything sums up the numerous conversations I have had with informants throughout my fieldwork, this is it. The complexity of the UK flood issue is recognized across the board. Although flooding formally counts as a 'natural hazard', and although insurers label that type of perils 'acts of god' to denote an origin outside the sphere of human control and responsibility ('beyond the power of anyone to foresee, and for which no one can sensibly be blamed' (Buchanan 2000, p.104)), most flood events do not align with such straightforward causation. Not only are they influenced by a broad variety of actions which cannot be traced to a detached domain of 'nature' (or super-nature for that matter), but they themselves represent a quite diverse and highly heterogeneous set of incidents. Figure 0.1, which is taken from the Department of Environment Food and Rural Affair's 'Making Space for Water' strategy (DEFRA 2004), lists 'tidal flooding', 'fluvial flooding', 'sea flooding', 'flooding of/from transport infrastructure', 'coastal erosion', 'urban surface water drainage', 'flooding from groundwater', and 'sewer flooding' as discrete problems to be dealt with within the same 'management context' and under the same 'strategic risk assessment'. In turn, that includes considerations relating to 'flood defences', 'emergency responses', 'flood resistance & resilience', 'flood warning', 'awareness raising', 'integrated drainage planning', 'rural catchment land use', 'land use planning', 'managed fluvial realignment', 'managed coastal realignment', 'coastal defences' and 'coastal governance & strategic planning'. Not accounted for in figure 0.1 is the layer of complexity added by the various ways in which these problems are turned into information and projected in time, the various kinds of expertise involved in doing so, and the various interests taken by different groups of stakeholders in how that is done.



0.1 – It is complicated: 'Proposed scope of a new strategy for flood and coastal erosion risk management' as it appeared in the Department for Environment, Food and Rural Affair's 'Making Space for Water' strategy (DEFRA 2004, p.25).

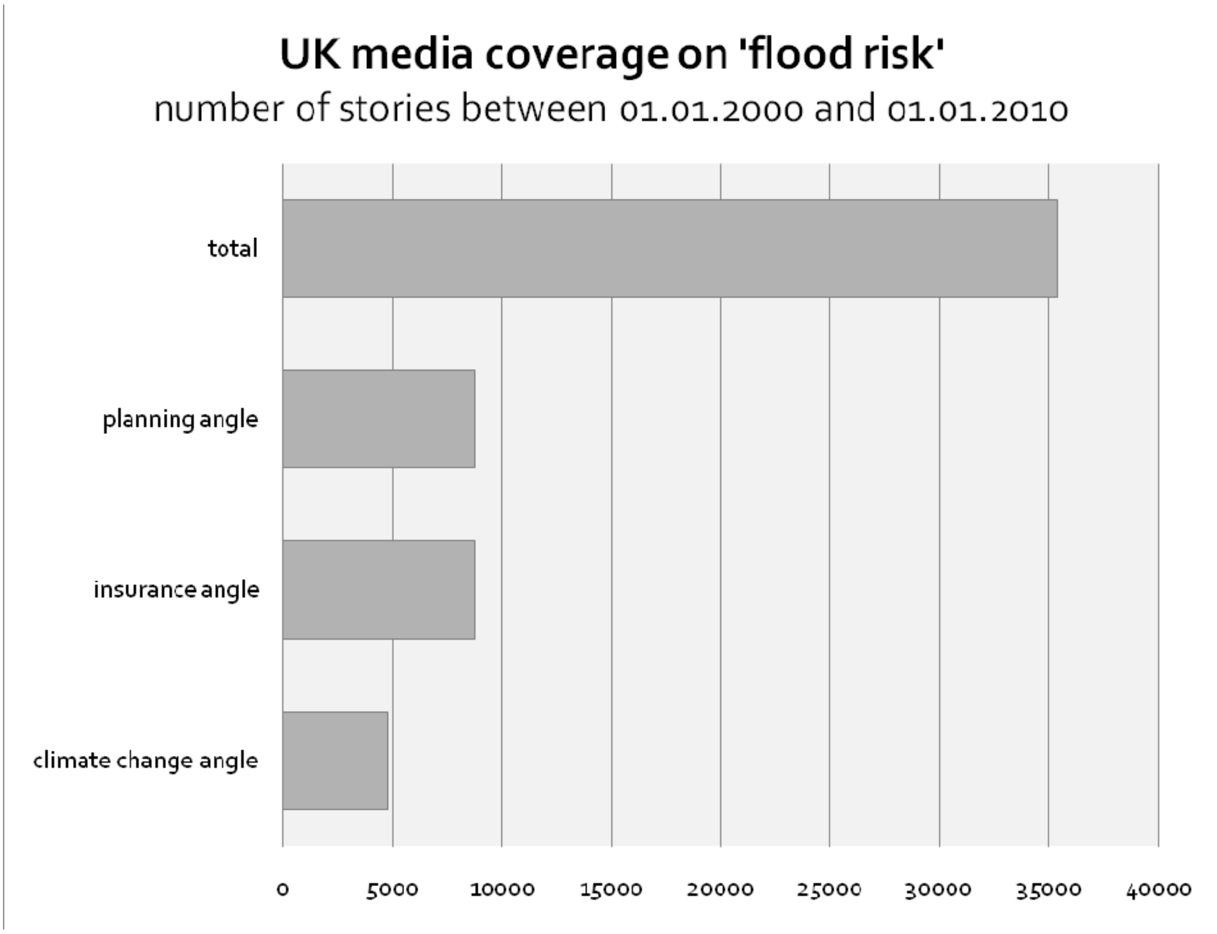
The 'Making Space for Water' strategy was a departure from a fragmented policy which treated many of these problems in relative isolation towards a more integrated approach to flood management. In other words, the issue is not only complicated, but dynamically so; it saturates divides like present/future and nature/culture, fuelled by emerging downpours and policies alike. Even as I am drafting this introduction, the British Isles are (once again) on flood alert (se figure 0.2). In November 2009 the Cumbrian town of Workington was severed down the middle by the river Derwent as it tore down a bridge and claimed the life of a local policeman. Counties in Northern England, Southern Scotland and the Republic of Ireland were particularly badly hit, leaving for instance half of the city of Cork without water supply, but the downpours caused problems as far south as Devon and Cornwall. Although equally disastrous each time they strike, and although there is absolutely nothing routine or trivial about the reek of filthy flood water drenching through properties and personal belongings, floods have become somewhat customary in the UK: they are rarely off the agenda.

0.2 – Riverine flooding in Cockermouth (Cumbria), November 2009 (DEFRA 2009).

In recapturing the situation in Cumbria, the media flagged up the complex and, to the flood stricken public, increasingly familiar range of problems, not least relating to the provision of insurance cover, which inevitably set flood disasters in a context far beyond torrential rains and swollen rivers; a context which sustains the presence of flooding in the public imagination even when the skies have cleared and the water has receded. The Sunday Telegraph wrote:

> *Flood risks mean 485,000 homes in England are potentially uninsurable and as a result unmortgageable, according to official figures. The Environment Agency has told The Sunday Telegraph that nearly two and a half times more properties are thought to be at risk than estimates just seven years ago. Officials say climate change is to blame for catastrophic flooding, as suffered in Cockermouth and Workington, in Cumbria. Worse still, the figure is forecast to rise to about 850,000 by 2035. These are the homes expected to flood at least once in every 75 years, and under an existing agreement between the Government and insurers, anyone who has insurance on one of these properties will continue to be offered cover until 2013. (...) Unfortunately, it appears that even though these "rules" have been agreed upon, they are not always being applied, so those who should continue to receive cover in their new properties are finding they are unable to. Mary Dhonau, chief executive of the charity National Flood Forum, said she was aware of several cases where existing customers have not been able to continue with their existing insurer at renewal, in defiance of the ABI's rules. (...) "Many people are having insurance cover removed when it comes to renewal. Go elsewhere? Well, you'd need to think how to answer 'Have you ever been refused insurance cover?'" (...) "Significant investment to flood-proof properties is also having little effect on annual premiums and excess charges. One woman spent pounds 47,000 flood-proofing a block of five flats, and naturally thought this would ease premiums and excess charges. Yet she is still facing a pounds 20,000 excess. Another woman spent pounds 30,000, and then tried to sell her house. The buyer pulled out when they couldn't get insurance." (The Sunday Telegraph 29.11.2009)*

The angle in this piece of commentary is typical. Besides the immediacies of warning and alleviation, the public discourse on flooding in the UK feeds on issues like planning and protection (the responsibility of which falls to the Government, its agencies, and to some extent the individual homeowner) and the provision of insurance cover (the responsibility of which falls to the insurance market). As shown in figure 0.3, out of more than 35,000 stories published on flood risk in the UK media for the past ten years, one in four has had an insurance angle while about the same number has covered planning. Considering the potential effects of being uninsured fleshed out above, it is hardly surprising that the provision of flood insurance is a matter of persistent public concern. Flood cover has been broadly available in a comprehensive format bundled with other risks (e.g. storm, fire or theft) since 1961 when the Labour opposition threatened to nationalise it, should they come to power, and the industry committed to a policy of quoting by default and at affordable rates (Crichton 2005).



0.3 – Number of stories in the UK media containing the search term 'flood risk' between January 1st 2000 and January 1st 2010 (35,410 in total). The diagram also shows the proportion of these stories which had a climate change (4,765), an insurance (8,753), and a planning (8,774) angle respectively. For climate change the search term 'climate change' was used in addition to 'flood risk'; for insurance search terms like 'insurance', 'insurer' or 'ABI' were used; for planning search terms like 'planning', 'ppg25' or 'pps25' (planning and policy statement and guidance) were used. The angles sometimes overlap. Not represented in the diagram is the proportion of stories covering both climate change and insurance (1,583) or insurance and planning (1,973) simultaneously. The search was conducted using the Dow Jones Factiva database.

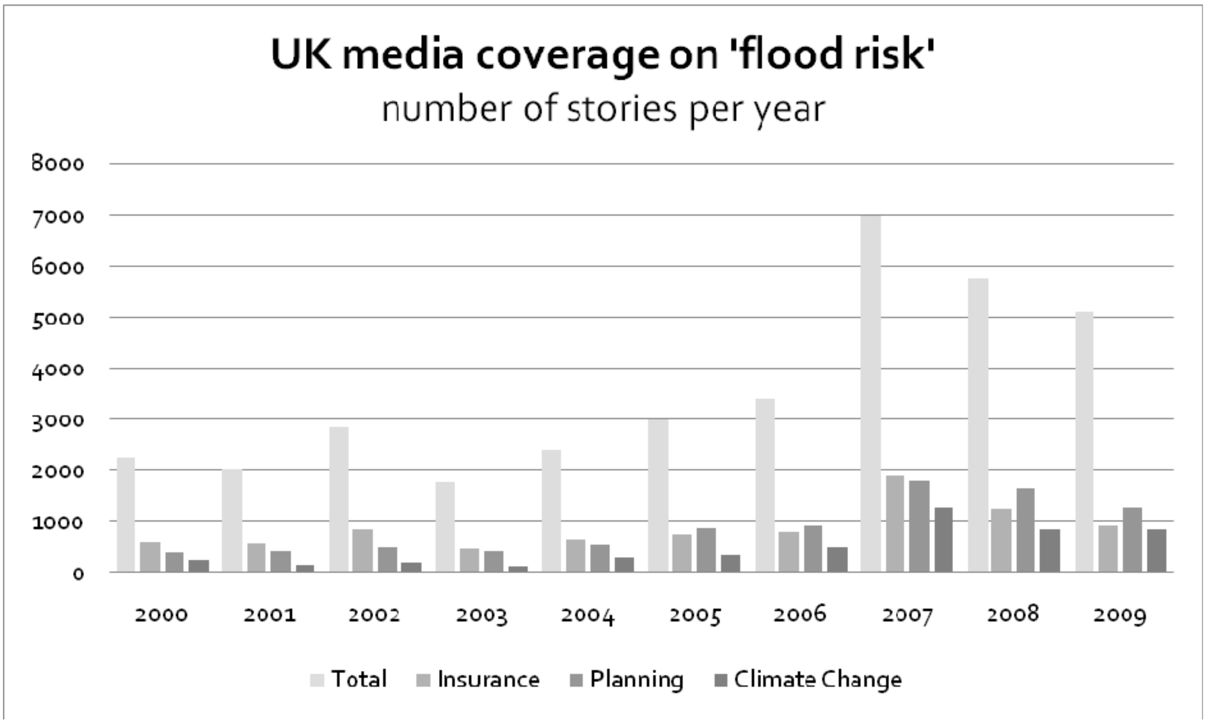
The bundle system comes with the benefit of high market penetration (most people need household insurance for one reason or another[4]), but it also complicates the problem of not being able to get flood cover by suspending it in a broader entanglement of causes and effects. It is no longer a concern isolated to the financial mitigation needed to reinstate flood damaged properties, but a far more diverse issue of general uninsurability with its ensuing prospects of unmortgageable, devaluated and potentially unsellable properties. Similarly, the bundle system exacts an aggregate consideration of many hazards at once, meaning that moderate flood risk could become a problem in conjunction with other perils. Whereas taken alone the refusal of flood cover is a problem which materialises only if flooding actually occurs, the wider implications concerning the equity and mortgageability of a property become problematic without regard to the actual course of future events the minute cover is dropped. Thus, risk assessments might be dealing with yet unrealised potentials, 'events-in-becoming', as Joost van Loon succinctly puts it, a sort of existence which 'never take[s] place (as disasters do)' (2002, p.29), but they are themselves anything but unrealised. Despite all their futurity they have very real effects on their present, and to those affected by the possibilities they bring to life (be they home owners, mortgage lenders or insurers) risks take no less place than the disasters towards which they conjecture. Future floods, eventualities which are still but imaginary potentials of things to come, can in this way have both very material and disastrous consequences without ever closing down a single road, soaking through one inch of flooring or short circuiting even the most limited part of the electrical grid. They operate from different

[4] 95% in the UK(Crichton 2002) although a number of policy holders (25% in 2001 figures) do not take out contents insurance (ABI 2001b) and informal inquiries suggest that some policy holders are underinsured by up to £20,000 (ABI 2001a).

premises and exert their influence through the persuasively 'real' visual outputs of forecasts and simulation models (Yearley, Cinderby et al. 2003). These operations, I contend, can be understood as key moments in the risking of floods. As the piece from the Sunday Telegraph suggests, and as shown in figure 0.3, they are often advanced under the banner of 'climate change', but the manoeuvre they perform is generic: that is to concoct the potent mixture of determinable fact and indeterminable possibility that grants them the creative power to invent a set of hitherto unavailable futures and bring them to bear on the present. In the UK, this concoction is firmly rooted in the transitive domain between science, politics and the market (adding further complexity to the issue) through a unique arrangement which orchestrates the provision of flood insurance.

A Statement of Principles

In October 2000 the Association of British Insurers (ABI) asserted that flood risk assessments were improving as new modelling software was becoming available. Concerned about climate change prospects and increased building development on floodplains, the ABI published a report in which they considered two hypothetical extreme flood scenarios driven respectively by a storm in the Severn and Trent catchment, and a heavy rainfall event over the Thames and outer London area (ABI 2000). The insured losses, which were estimated somewhere in between £1bn and £2bn, by far exceeded the costs of any previous flood disaster and prompted the ABI to raise questions about the adequacy of the Government's flood management strategy, not least the budget behind it and the knowledge available to support a realistic appreciation of the problem. When the UK was hit by the worst rains for 270 years only weeks later, with the ensuing floods producing £1.3bn worth of insurance claims, the consensus which had existed since the 1960s between the Government and the industry broke down. The scene was set for an ongoing debate about the division of responsibilities and the extent to which the insurance industry should be obliged to serve the interests of the general public when they are not necessarily concurrent with those of the financial markets. In the immediate aftermath of the 2000 floods a two year truce was agreed under which insurers would continue to provide cover as normal (ABI 2001a), but from January 1st 2003 the so called 'Statement of Principles on the Provision of Flood Insurance' (ABI 2002), in which the Government's own minimum protection standards were adopted as the condition for cover on normal terms, was put in place following negotiations between the ABI and the Department for Environment, Food and Rural Affairs (DEFRA). From then on, properties which were deemed at risk of being flooded more than once in every 75 years could not be guaranteed a quote, an arrangement which effectively meant that DEFRA's ability to live up to its own protection standards, either by enforcing the relevant restrictions on planning or by allocating the necessary funds to the flood defence budget, became interlocked with disputes over the provision of flood cover. As shown in figure 0.4, planning and insurance issues have constituted a steady ingredient in the public discourse on flood risk since 2000, rising and falling in tandem with the general surges in media coverage, such as the one following the worst floods ever recorded in the UK in the summer of 2007.



0.4 – Number of stories per year in the UK media containing the search term 'flood risk' (columns labelled 'total'). The diagram also shows the proportion of stories for each year with an insurance, planning and climate change angle respectively. The same terms apply as in figure 0.3.

In the course of the past decade the statement of principles has been negotiated and revised thrice (ABI 2002, 2005, 2008a), each time articulating new concerns about the availability of cover on the one hand, and the efforts made to manage the risk of flooding on the other. These concerns implicate an ambiguous diversity of practices, responsibilities, scales and materials which complicates the attempt to strike a balance around the 1 in 75 year return period. The official tri-annual negotiations are by no means the only forum in which the arrangement has been scrutinized, a fact which became clear immediately after the first statement came into effect on the 1st of January 2003. DEFRA and the ABI had officially agreed that:

> *In a number of locations the risk of flooding is unacceptably high. Existing flood defences provide less protection than the Department of Environment, Food and Rural Affairs' indicative minimum standard of 1 in 75 years for urban areas. Where improvements in flood defences sufficient to meet these standards are scheduled for completion within the next 5 years, insurers will maintain flood cover for domestic properties and small businesses which they already insure. The premiums charged and other policy terms - such as excesses - will reflect the risk. (ABI 2002)*

But what exactly constituted 'flood defences'? When were they considered to be 'sufficient'? How was the 1 in 75 year flood zone going to be mapped out? What did it mean that premiums and excesses would 'reflect the risk'? And who/what defined 'the risk' in the first place?

An example: In February 2003 the local flood action group in the town of Lewes, East Sussex, issued an online survey on the availability of insurance cover following the 2000 floods[5]. The first Statement of Principles had come into effect a month earlier, preceded by a two year period in which the industry had officially committed to continuing cover as usual. Out of 254 respondents, 114 (45%) experienced substantial changes to their policies, with 45 of them (18%) reporting a refusal of cover altogether. The problem was temporarily resolved when the Environment Agency announced a comprehensive flood defence scheme for the town, but it quickly became clear that the plan would be jeopardized by a tight budget and a pressing need to prioritise, on a national scale, the ways in which public money was being spent. Nine months later (November 10th) the local MP, Norman Baker, took up the issue in a parliamentary debate with the then Minister for the Environment, Elliot Morley. From the perspective of the Lewes representative the problem was this:

[5] http://www.lewes-flood-action.org.uk/insurance/surveyresults.html (16.09.2008).

There will almost certainly be flood defences in Malling and probably in the Cliffe cell, but from the information that I have been given it seems unlikely, or at least highly debatable, that flood defence schemes will be produced for the other cells: town centre, west, the Talbot terrace area, North street, and so on. That is very serious. People would once again have the spectre of flooding hanging over them, with no relief in sight. People deserve better than that, after the horrors they went through and the promises that they thought the Government had given.

Insurance companies have, with the Government's help, been quite supportive. The insurance problem has, by and large, gone away because of the schemes; people are being asked to pay a lot more, but can mostly get insurance. However, that problem will recur, because if the insurance companies think that the schemes are off the agenda, they will simply pull the plug. We must not let that happen.

Of course, what could not be allowed to happen was not an event-in-becoming but something acutely present and consequential, namely the loss of cover. In his response, the Minister for the Environment drummed up parts of the heterogeneous 'assembly' (in the sense of Latour 2005a) which was, by way of the Statement of Principles, presiding over the provision of flood insurance:

I concede that the way in which cells are approached is not ideal. For engineering purposes, it is normal to look at a flood defence scheme in terms of self-contained cells. That is part of the engineering assessment. I will be quite honest and say that it is also the case that an assessment must be made of the cost-benefit ratio. It would not make sense to spend millions of pounds on a cell if that is far greater than the value of the property within it. We have 1.7 millions properties at flood risk, and we face demand for schemes all over the country, including in the Uck catchment [which includes Lewes]. We have to use resources in the most effective way.

To illustrate that point, I can give the hon. Gentleman an indication of the calculations that are made. He is quite right about the Malling Brooks and Cliffe areas. If we take a one in 100-year flood event, which is the kind of protection level that I want to see, there are about 218 residential properties at risk in Malling Brooks and 166 in Cliffe. There are also commercial properties. Town centre, west has a score, but one that is low priority. We have two residential properties at risk there in a one in 100-year event. In North street there are no residential properties at risk in a one in 100-year event. In Talbot terrace there are six. Some schemes may cost millions to defend a tiny number of properties.

> *I know that that is not much consolation to the people who live in those areas, or to the school in Talbot terrace that the hon. Gentleman mentioned, and I sympathise with their situation, but they cannot expect millions of pounds of taxpayers' money for a very poor return on those cells, when that money could go to other schemes, including in Lewes and other parts of the Uck area, where many more people can be defended.*

This diversity of electorates, calculative practices, protection standards, economic grading systems, defence strategies and geo-physical features forms part of the material grain peculiar to the provision of flood insurance, its 'more-than-human' geography (Whatmore 2006), and its 'political chemistry' (Barry 2001). But an important ingredient temporarily fades from view. In a letter to the local MP dated a week earlier (November 4^{th}) the Head of Household and Property at the ABI rearticulated the crucial role of information and expertise in bringing this more-than-human assemblage together:

> *The dataset identifies full postcodes such as BN7 where EA has assessed that some or all of the properties face a probability of flooding of greater than 1.3% p.a. It is of course possible that even within such a postcode, which typically covers 15-30 properties, there may be individual properties that face a risk lower than the 1.3% p.a. threshold, due to topography, design features etc. Any customer who considers that this applies to their situation should provide their insurer with evidence that supports this assessment. Insurers need to manually override their systems to accommodate individual customers in such circumstances, and this "exceptional" treatment can give rise to operational difficulties.*
>
> *(…)*
>
> *ABI has also secured data from EA on the areas which will be protected by planned defences for which there is a firm commitment of funding. This information enables insurers to commit to continuing cover for existing customers in these areas, as described in the second category under the Statement of Principles. (…) As you know it is very unfortunate that the proposed schemes for Lewes have not yet secured full funding and that therefore most properties in the town therefore fall into the third category under the Statement of Principles, where insurers have undertaken to use best efforts to remain on cover for existing customers only. I know that you continue to press for early resolution of this and we fully support you in these efforts as insurers are equally concerned to achieve better management of risks for their customers.*

Thus, a host of knowledge claims pervade the provision of flood insurance; information about 'the risk', here in the substantive form of both a measurable and a measure. It is these mappings, so inextricable to the way in which DEFRA's budget is brought into conversation with the topography of the Uck catchment, the way in which engineering practices acquire importance to the citizens of Lewes, the way in which different scales and priorities are brought to bear on each other, and the way in which the profitability of the insurance industry becomes an ally, or an enemy, of the public good, which I propose to explore. The Statement of Principles sets a scene in which the risking of floods becomes explicit and acquires form(s) as it is adopted into purposive 'communities of practice' (Bowker, Star 2000) and enters into concrete dialogue with the stuff that suffuses these communities with their more-than-humanity. It is, in a sense, a case of what Timothy Mitchell calls 'techno-politics': 'an alloy that must emerge from a process of manufacture whose ingredients are both human and nonhuman' (Mitchell 2002, p.42). Except not quite: such an alloy would supposedly, and ironically, enable 'a certain way of organizing the amalgam of human and nonhuman, things and ideas, so that the human, the intellectual, the realm of intentions and ideas seems to come first and to control and organize the nonhuman' (p.43). That level of organization is not evident in the Statement of Principles; the alloy has not been cast to a standard that supports the illusion of humans being entirely in control when it comes to directing their nonhuman co-constituents. In fact, part of the reason why the provision of flood insurance has been a sustained target for criticism and debate is that the Statement of Principles never really managed to become that simple case of an agreement settled around a 1 in 75 year benchmark. On the contrary, the continuous disputes around that number and its copious implications have left the provision of flood insurance wide open for scrutiny.

Again, it is complicated. Floods come in a variety of forms ranging from sewage backing up through toilets, over rivers swollen by torrential downpours, to storm surges wreaking havoc across coastal regions. They can be attributed to anything from weather patterns to urban planning or rural land use, and they concern a range of academic fields, technological specialties and areas of expertise. What is allowed to have a voice, and what is not, when the 1 in 75 year flood zone is mapped out is ample cause for debate. In 2007 the EA jointly released a 'fact sheet' with the ABI in which they tried to settle some of the frequently voiced concerns regarding the provision of flood insurance. The first question immediately brought the lack of techno-political control into view:

> *Q1. How can I find out the flood risk affecting my property?*
>
> *The Environment Agency's Flood Map for England and Wales is published on the internet. (…) It shows the probability that land, not individual properties, will flood. We do not hold information on floor levels, construction characteristics and designs of properties. We would need this and other detailed information to be able to say whether flooding of a certain depth would enter into a property and cause damage. (…) The Flood Map does not provide information on flood depth, speed or volume of water. It also doesn't show flooding from other sources, such as groundwater, direct runoff from fields, or overflowing sewers.(EA 2007)*

The point here is that insurers are still liable to pay out claims regardless of the source of flooding, in the same way as homeowners take out policies for individual properties which do precisely have particular design features and construction characteristics. The risking of floods does not wait for the emergence of clear and authoritative guidelines by which to proceed. Hence, my intention here is not to disassemble an otherwise smoothly functioning techno-political machine to reveal how it hides from view its heterogeneous constituency. That is quite unnecessary considering that the assembly was never really successful in the first place.

So, what is my intention?

Clearly, there is no denying that a range of 'black boxed' (Latour 1987) statements circulate the issue of flood insurance, especially those claiming to convey information about risk. Maps have been made; probabilities have been calculated; to say that the risking of floods proceeds beyond what has been established as fact is neither very surprising (anything else would render the concept of risk nonsensical), nor is it denying that facts have indeed been established. All sorts of claims to knowledge are forged from the more-than-human alloy, but rather than settling anything, rather than engendering techno-political control, they often seem poised for the opposite. As Andrew Barry puts it:

> *To render an object in the specific form of information is likely to involve a multitude of different scientific procedures and innovations, political negotiations and compromises, regulatory arrangements, technical standardisations, financial investments and institutional resources. In doing so (...) the production of information may precipitate new forms of political conflict (what forms of information should be produced, for what reasons, and with what instruments?) while displacing or silencing others. (2001, p.153-154)*

It can easily be asserted that flooding is complicated, but the interesting question is really what to make of that assertion? Barry observes that complexity is not only present in the rendering of information itself, but also in the political reality of which that information becomes part once produced. Whereas successful techno-politics in Mitchell's construal has the ironic side effect of covering its own tracks and concealing its more-than-human entanglements, Barry adds the possibility of an alternative feedback loop which produces less control and more entanglement. Risk issues are notorious for precisely that kind of perpetual self-complication, a feature which is frequently brought to the fore in sociological accounts of the present state of 'reflexive' (Beck, Giddens et al. 1994), 'liquid' (Bauman 2000) or 'late' (Giddens 1991) modernity. Thus, to the German sociologist Ulrich Beck, risk issues have fundamentally altered modern society:

> *Key institutions of modernity, such as science, business and politics, which are supposed to guarantee rationality and security, are confronted with situations in which their apparatus no longer has any purchase and the basic principles of modernity no longer hold automatically. As a result, these institutions are being judged completely differently – no longer as trustees but as suspects. They are no longer seen as managers of risk, but as sources of risk. (2009, p.54)*

The assertion that flooding is complicated could definitely, and productively, be brought into conversation with this type of social critique – indeed, institutions like the insurance industry or the Environment Agency are frequently caught up in the paradox of being both trusted managers and suspected sources of the problems associated with flooding – but this is not quite what I want to make of it. It is widely argued that the emergence of risk as something calculable and manageable is a thoroughly modern contraption (see for example Short 1984, Beck 1992a, Reddy 1996), and as such it makes sense to view the inadequacies of risk management as a failure of modernity. However, the question is to what extent risk was ever compatible with that kind of managerial ambition? Reddy calls it a 'myth' (1996) while Castel depicts 'an absolute reign of calculative reason and a no less absolute prerogative of its agents, planners and technocrats, administrators of happiness for a life to which nothing happens' (Castel 1991, p.289). Coming to this realisation can either be construed as a failure, a break down, as when Bauman portrays 'a sense-numbing and mind-chafing grey zone, as yet unnamed, from which ever more sinister fears seep, threatening to destroy our homes, workplaces and bodies through disasters – natural but not quite, human but not completely, natural and human at the same time though unlike either of them' (2006, p.5). Or it could be construed as a way of acknowledging that we have, in the words of Latour, 'never been modern' (1991). I have no intention to construe risk as a failed concept. What I am after is a new way of asking questions about flood risk without getting caught in existing critique and focus instead on risk as something which takes place. The problem seems to be that no matter how harsh or sinister these critiques become, they always seem to invest risk with a specific ontology of the object (even though it might be a mythical or elusive one – hence the criticism). I want to invest it instead with the ontology of the event; I want to understand how it hardwires things into politics, or how it makes them useful to a market; I want to explore what makes it tick and what assemblages it enable. A little background is needed to further substantiate this motivation.

Understanding Environmental Knowledge Controversies

My project grew from a pre-existing set of ideas and trajectories and was in a sense well underway when I began working on it. Funding was secured prior to my involvement through the Economic and Social Research Council (ESRC) for a doctoral studentship labelled 'Environmental Knowledge Controversies: Flood Risk Mapping, Insurance Zoning and the Politics of Rural Property'. Hence, my initial task was not to flesh out a research strategy for a question that I already knew how to ask, but to work out what questions this unfamiliar heading seemed to be suggesting in the first place. Since the studentship was the brainchild of a larger interdisciplinary research cooperation addressing the public controversies arising from flood risk forecasting and management strategies[6], this task was, in some respects, relatively straightforward. At least it was not a tabula rasa which had to be filled in from scratch; there were common understandings and agreed agendas, sympathies and aversions, and there was a literature to build on. A key impulse of the mother project was to follow a francophone drive in the sociology and philosophy of science to reconceptualise public knowledge controversies as 'generative events' (Whatmore 2009, p.588, following Callon 1998, Latour 2003, Stengers 2005) rather than impeding obstructions to the proper conduct of politics and science, and thus cultivate the idea that 'controversies enrich democracy' (Callon, Lascoumes et al. 2009, p.28).

In the early 2000s England was already more than familiar with the ways in which knowledge and expertise could become contested in the public domain, not least in connection with a series of GM and BSE related food scares (see Stassart, Whatmore 2003), and the management of inland flood risk was fast providing another prime arena for dispute. In conjunction with the ominous anticipations of climate change and a series of severe flood disasters, the debates springing from issues like rural land use, sustainable protection measures, and sprawling floodplain developments (not least in the densely populated South East) were soon calling both the legislative/institutional framework and the knowledge claims pervading it into question (see for example Brown, Damery 2002). The deployed expertise did not always display the 'social robustness' (Nowotny, Scott et al. 2001) needed to command the trust of the broader public, a deficit which materialised (and still do) in questions like 'why is

[6] The broader 'Understanding Environmental Knowledge Controversies' project, which involves research teams at the Universities of Oxford, Durham, Newcastle and East Anglia, is jointly funded by the Economic and Social Research Council (ESRC), the Biotechnology and Biological Sciences Research Council (BBSRC) and the Natural Environment Research Council (NERC) under the Rural Economy and Land Use (RELU) programme.

my property uninsurable when the Environment Agency tells me I am not at risk?', 'why did they allow my house to be built on the flood plain when they are not willing to provide the necessary protection?' or 'how come I cannot get my policy reinstated when there is supposed to be 100 years between the kind of floods that hit us'. The point of the interdisciplinary undertaking of which I had become part, including the reason for its adoption of a generative approach to controversies, was to constructively address this lack of robustness. For the other members of the team that meant developing 'an integrated model for forecasting the in-river and floodplain effects of rural land management practices' as well as experimenting with 'a new approach to public engagement in the production of interdisciplinary environmental science' (quoted from the project website[7]). 'Competency groups' comprising affected members of the public as well as social and natural scientists were set up in two flood stricken local communities to provide a 'civic apparatus' designed to 'collectively interrogate explanations for, and solutions to, flooding in the locality' (Whatmore 2009, p.595). Under the right conditions, so was the proposition, both the political empowerment of the community and the social robustness of the relevant science could stand to benefit from taking controversies seriously as a driver of public engagement, not least in cases involving multiple forms of expertise in the planning for, and anticipation of, future contingencies. Controversies and their 'hybrid forums', as Michel Callon puts it, were envisaged as potentially 'powerful apparatuses for exploring and learning about possible worlds' (2009, p.28).

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[7] http://knowledge-controversies.ouce.ox.ac.uk/project/ (20.11.09)

Such was the ethos of the intellectual environment in which I found myself trying to make sense of 'Flood Risk Mapping, Insurance Zoning, And the Politics of Rural Property', and such was the extent to which that sense-making presented itself as somewhat straightforward. As the holder of an independent studentship, the fulfilment of which would have been severely hampered by simply adopting the already formulated questions and strategies emanating from another project, it was not in my job description to take active part in the experimental work carried out in the competency groups. Whereas this work, and the rationale behind it, unavoidably came to serve as a welcome sounding board for my own coming to terms with what I was trying to do, it was not going to spell out that understanding for me. Nevertheless: it was the linchpin without which I would never have become interested, and indeed implicated, in the questions I have ended up asking.

Coming from a country (Denmark) where flooding is something you get from a storm surge in the rare event of a sea wall being either too low or too weak, I was completely ignorant of the complexity and scale of the inland flood problem in the UK when I arrived. Arbitrary members of the public who I happened to converse with about my research were invariably a lot better informed than I was and immediately saw the need while I was still asking myself why. In a sense, the whole enterprise had a distinctly ethnographic flavour to it early on and put me face to face with the 'exotic' a long time before I started doing anything formally classifiable as fieldwork. And the things that more than anything else appeared strange and outlandish to me were the things I was supposed to be working on: knowledge controversies. Although it was unclear to me what these actually were, it was quite clear that they were manifestly there. In fact, there was a major cooperative research effort going on around me dedicated entirely to their understanding. At the same time the media was teeming with flood related stories and within the first month of my arrival in the UK I was introduced to a plethora of possible controversies simply by rummaging through the pages of the press. On January 22nd 2007, for example, the Northampton Evening Telegraph pondered why the Environment Agency endorsed the urbanisation of the local flood plain while simultaneously stressing its crucial importance as natural water storage. On January 30th a reader of the Western Morning News had no sympathy for wealthy Londoners coming down to snatch a piece of low lying Devon seaside with no regard to the flood risk:

> *Good tidings, ha-ha, from the highlands of Dartmoor, where we have learnt where to build and where not to build, and we have mastered the art of living with the wet on the right side of the door.*

On February 1st Reuters reported that 160,000 new homes would be built on flood prone former brown field as part of the Thames Gateway redevelopment project, and that the insurability of these properties could be put into question by new climate change predictions. A spokesperson from the Association of British Insurers was quoted as saying that 'more properties vulnerable to extreme weather' would 'put the issue of flood risk into sharp focus' (once again, as it later became clear to me). It was also noted that lack of insurance cover would be likely to preclude mortgage loans on the properties. On February 12th The Times ran a story about a man in Yorkshire who, despite living on the top of a hill over 40 miles from the North Sea, had his home insurance premium doubled following an unfavourable flood risk assessment from the Environment Agency. One had to ask, I thought, in all these cases: what is merely a conflict of interests? What is truly controversial? And what is simply a question of misunderstanding or poor communication? Surely the EA must have been mistaken when they made that assessment? And just because some authority is forced to weigh a range of difficult priorities against each other in order to solve the housing crisis in the Greater London area, does that justify calling it a 'knowledge controversy'? I seemed to be missing the point. The questions which now motivate this thesis started out as very practical and preliminary attempts to open up this conundrum: What is a knowledge controversy? And why/how does a thing like flood risk become part of one?

The first thing to understand about these difficulties is that 'risk' (noun), which is undeniably a claim to knowledge and thus a seemingly suitable starting point when looking for knowledge controversies, takes on a veritable plethora of roles in debates over the provision of flood insurance in the UK. In figure 0.5 I have tried to sketch out some of the key events in the development of the issue over the past ten years. It is quite incomplete and might for example just as well have started ten years earlier and included some of the significant developments in hydraulic modelling which kick-started the debate in 2000. Nevertheless, it hopefully brings home a point: scanning through it for the play of 'flood risk', reveals an ambiguous entity which might be associated with a contested type of expertise (particularly clear in the debates over floodplain mapping unfolding between 2002 and 2004); a vehicle for contemplating possible futures (e.g. the first ABI report on flood risk in 2000 or Lord Stern's report on the economic impacts of climate change in 2006); a way of reflecting on actual flood disasters and their sometimes surprising implications (especially following the Boscastle floods in 2004 and the summer floods in 2007); a political leverage (all three negotiations of the Statement of Principles are prime examples, but notice also the 2009 ABI report on the financial impacts of climate change with its 92 suggestions for Government action); a priced object of exchange (the underlying premise of most contributions by the ABI and their individual members); or a way of framing the standard to which things should be built and areas planned (most notably in the saga of the PPS/PPG25 and its amended practice guidelines).

Flood risk and insurance in the UK between 2000 and 2009 (two pages)

2000

ABI issues warning that insurance claims from future flood events could exceed £1bn (ABI 2000)

10,000 homes and businesses flood in autumn after heaviest rains on record, confirming ABI fears within weeks of publication (£1.3bn loss)

EA makes public first indicative floodplain maps on its website

Following concerns in Parliament ABI members agree to continue flood cover as usual for a two year period ending December 31st 2002

2001

Responding to an official flood risk appraisal (DEFRA 2001) the ABI calls for a 'partnership approach' conditioning continued availability of cover on increased Government flood defense spending (ABI 2001a)

Planning Policy Guidance 25 issued in an attempt to control flood plain development (Communities and Local Government 2001)

2002

After grading properties using the EA online flood map, eSure announces that it does not feel obliged to continue quoting in high risk areas, provoking sharp reactions from Parliament as well as from the EA

Royal and Sun Alliance launches its Geographical Risk Analysis tool which allows underwriters to access flood risk information by post code and grade properties on a red/amber/green scale

ABI announces that the temporary agreement to continue cover will not be renewed. Instead a 'Statement of Principles' will replace the deal from January 2003. DEFRA's indicative minimum protection standard for urban areas, 1 in 75 years, is adopted as a baseline for offering cover

Norwich Union commissions its own high resolution aerial survey of the UK in order to launch an address level flood map, Next Map, directly challenging the lower resolution post code level EA alternative and causing widespread public concern that more risks will be refused

2004

After 8 hours of extremely heavy localized rain a 3m flood wave sweeps down the high street of the Cornish village of Boscastle familiarizing the public with the concept of 'flash flooding' and prompting questions about the adequacy of available flood maps, which do not take this type of flooding into account

EA upgrades its online flood map to become, in its own words, 'the most detailed and up-to-date picture of flood risk encompassing the whole of England and Wales ever produced' (EA 2006, p.3)

...continued from previous page

2005

The Statement of Principles undergoes its first tri-annual review and becomes the Updated Statement of Principles (ABI 2005)

ABI criticizes the implementation of PPG25 noting that 1 in 4 planning applications objected to by the EA still go through

2006

The report from the Stern Review once again puts climate change on top of the agenda as the implications of rising temperatures for the provision of insurance cover, and the role of the industry in mitigating the effects, are spelled out (Stern 2007)

After sustained critique of the Government's lack of resolve in the issue of floodplain development the PPG25 is replaced by the Planning and Policy *Statement* 25 (Communities and Local Government 2006) introducing maximum flood risk tolerances for different types of development

2007

In June and July the UK is hit by the worst floods on record. The cost to the insurance industry exceeds £3bn. Rainfall of this magnitude in the summer months is unprecedented and the Government commissions a review of the events headed by Sir Michael Pitt

Even though the Statement of Principles is only up for review in late 2008 the ABI insists on reopening the deal a year early after their own reports on the flood events of the summer concludes that not all sources of flooding, and in particular surface water, are integrated into the Government's flood management strategy (ABI 2007)

2008

The Pitt review blame the 2007 floods on a changing climate and a meandering jet stream, and calls for 'urgent and fundamental changes in the way the country is adapting to the likelihood of more frequent and intense periods of heavy rainfall' (Pitt Review 2008, p.vii)

After prolonged negotiations a Revised Statement of Principles comes into effect in July. It demands concrete responses to the Pitt review and aims to be the last of its kind with a due date in July 2013 (ABI 2008a)

2009

Leading up to the IPCC summit in Copenhagen the ABI publishes research on the financial impacts of climate change suggesting that a 2°c temperature rise could mean a 16% increase in the average price of flood insurance. The report contains no fewer than 92 recommendations for Government action (ABI 2009b)

The practice guide accompanying PPS25 is updated with several additions to assessment of flood risk and management of surface water and drainage problems (Communities and Local Government 2009)

0.5 – Timeline showing key events in the provision of flood insurance issue as they have played out between 2000 and 2009.

In England the Environment Agency (EA) is the managing authority for the main rivers. It receives funding from the Department for Environment, Food and Rural Affairs (DEFRA), who has the policy responsibility for flood and coastal erosion risk management, and it supervises the construction, upgrade and maintenance of flood defence schemes on main rivers[8] as well as overseeing planning applications for permissions to build on flood prone land[9]. As part of its obligation to forecast and raise awareness the EA also issues flood warnings for all main rivers, holds and updates data from the National Flood Risk Assessment (NaFRA), and maintains its online flood map service. In relation to the provision of flood insurance the EA has been particularly contested when it comes to the availability of data, the quality of maps and planning permissions. Throughout my fieldwork, not least when I have interviewed insurers involved with the negotiation of the Statement of Principles, both access to (presumably public) data and the quality of the policy instruments available to control floodplain development has been articulated as major concerns, both of which can be seen as drivers for various initiatives across the insurance industry to invest in non-EA maps and models. This is perhaps best exemplified in Norwich Union's 2004 decision to not only launch its own rivalling flood map, NextMap, but to commission its own high-resolution aerial survey of the UK as the basis for it. This enabled Norwich Union to assess flood risk on address rather than postcode level and thus challenge the official perception of the 1 in 75 year flood zone (i.e. who should, and who should not, be offered cover). However, the EA is not the only public body tasked with

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[8] The EA took over this role from its predecessor, the National Rivers Authority (NRA) in 1995, and carries it out under the Water Resources Act 1991.

[9] This role was first set out in the Planning and Policy Guidance 25 (Communities and Local Government 2001) and strengthened in the Planning and Policy Statement 25 (Communities and Local Government 2006).

the management of inland flood risk, a fact which has come into sharper focus in recent years as surface water flooding from heavy rainfall *outside the main rivers* has gained prominence as a composite part of the flood problem. Under the Land Drainage Act 1991 the responsibility for land drainage and the maintenance of non-main watercourses falls to either local authorities or designated Internal Drainage Boards (IDBs). In England more than 1.2m hectares of lowland are assigned to IDBs as areas in need of special drainage measures such as pumping stations, river improvements or drainage channels. If no IDB is in place, these tasks are taken on by either city or county councils, who are also responsible for the emergency services (as the highway authority, the county council is specifically responsible for drainage and culverts in connection with the main roads)[10]. Maintenance of the public sewerage system falls to the water companies while it is the responsibility of the individual homeowner to make sure he or she is properly connected to the system. Private landowners are obliged to allow flood water to pass without diverting it, and if they are riparian owners this obligation extends to keeping the river bed and the banks clear of obstructions. In the wake of the 2007 floods a thorough review of responsibilities relating to drainage and surface water issues was called for both by the insurance industry (ABI 2007) and the Government's own commission tasked with investigating the events (Pitt Review 2008). On June 25th 2008 the Secretary of State for Environment Food and Rural Affairs thus announced that local authorities were to take responsibility for surface water management and in December that year the official response to the Pitt Review asserted that Local Authorities were to be allocated £27m to deliver

[10] Detailed information on flood management responsibilities in the UK is available from the DEFRA website at http://www.defra.gov.uk/environment/flooding/who/index.htm (07.02.2010).

'leadership on flood risk management in the 50 highest priority areas; including surface water management plans, tackling of surface water problems, mapping of drainage assets, and oversight and maintenance of sustainable drainage systems (SUDs) for new housing, etc.' (DEFRA 2008, p.25).

True to the principal of symmetry, controversies are, in Latourian terms, something which the Actor-Network scholar should 'let the actors deploy' – the full range of them – so as to 'allow the actors to unfold their own differing cosmos, no matter how counter-intuitive they appear,' always keeping in mind that 'the best solution is to trace connections *between* controversies rather than decide how to settle any given controversy' (Latour 2005b, p.23). That definition (if definition is the correct word) is arguably inclusive beyond reason and does not provide any type of meaningful distinction. Nevertheless, that was the version which seemed to make sense to me. Indeed, it could be argued that Latour's usage of the term controversy corresponds rather well to the way Stengers summons the language of risk, jeopardy and experimentation to bring in to view the necessary putting at stake involved in any type of creative becoming. To ask how floods are risked, how they become measurable as risk, or what it means to risk them, are thus all questions which implicitly denote tracing the controversies of which flood risk must necessarily become part. Or to put it differently: to explore what makes flood risk controversial is essentially synonymous with exploring how flood risk is made, or more precisely, in the terminology adopted in this thesis, how floods are risked. One implies the other.

How?

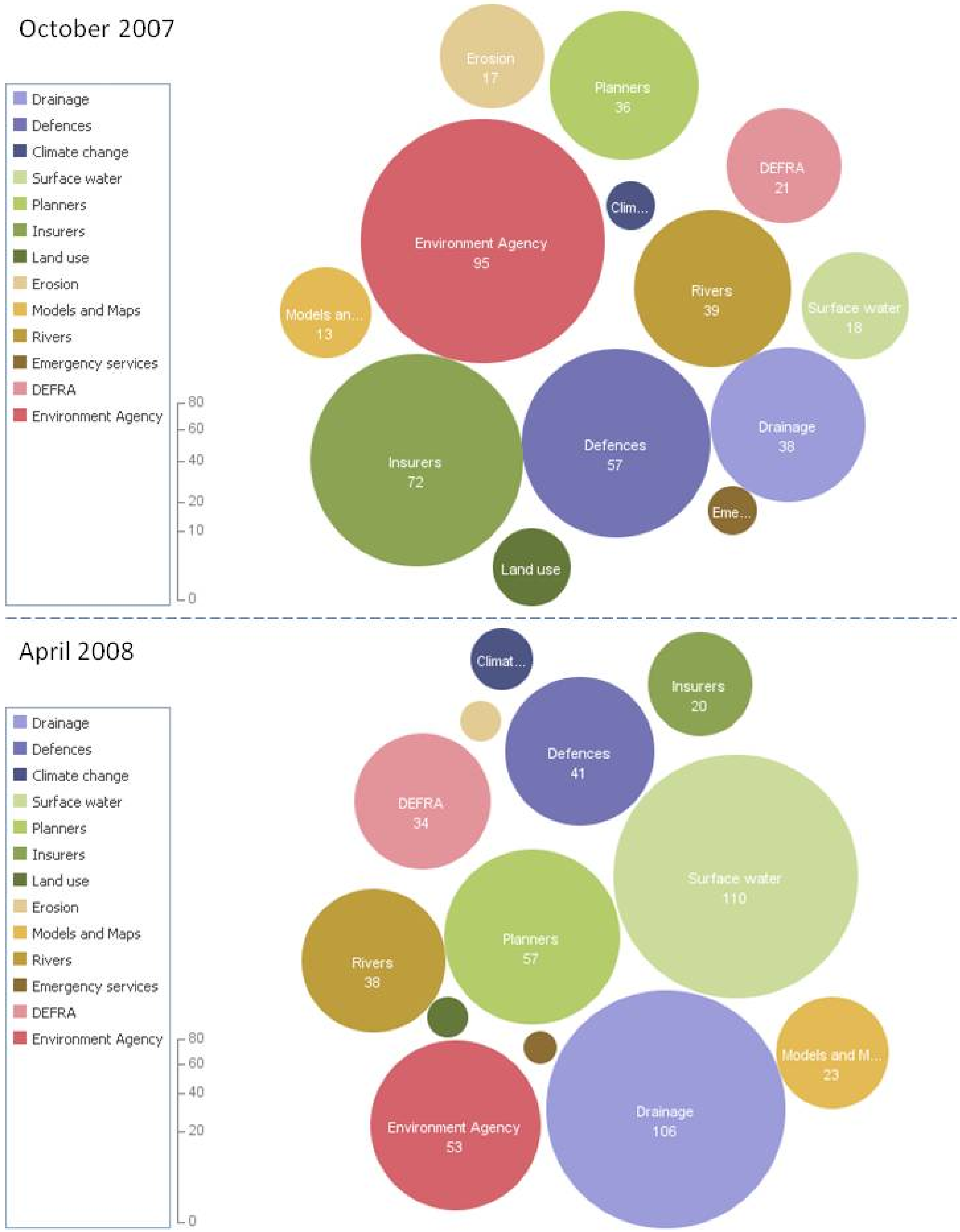
> *To bring these sites into the same frame of study and to posit their relationships on the basis of firsthand ethnographic research in both is the important contribution of this kind of ethnography, regardless of the variability of the quality and accessibility of that research at different sites. (Marcus 1998, p.94)*
>
> *I call ethnography a meditative vehicle because we come to it neither as to a map of knowledge nor as a guide to action, nor even for entertainment. We come to it as the start of a different kind of journey. (Tyler 1986, p.140)*
>
> *Knowing proceeds in parallel with the body's physical encounters. (Thrift 2003, p.111)*

Stephen Crook has argued that risk can be seen as a constantly failing attempt at creating order (1999). My own attempt to write a thesis about flood risk started in a Black's outdoors store on the High Street in Oxford where I was planning ahead and buying a pair of waterproof hiking boots. I imagined that I would be following experts into the floodplain, inspecting defences and surveying features of the landscape; I thought that I would be working in a field which was quite a bit wetter than the offices of underwriters and modellers that I ended up visiting. However, the researcher who was supposed to have been the socio-material extension of these boots has long since failed along with his project. As I will try to make clear below, they were not the last of their kind to do so. Interestingly, these failures seem the obvious vantage point for launching a methodological reflection over how this Thesis has been brought about: if risk is a constantly failing attempt at creating order – and if risk is vital to creation – then I hope to have failed.

In my report for the transfer of status, which was one of the last things I did before I started booking interviews and making arrangements with informants, I announced that I would be following the enactment of flood risk in a manner similar to that suggested by Bruno Latour in a play of words with the acronym ANT (Actor-Network Theory) and the strident ground-level gait of the ant; an attritional pace at which every obstacle must be reckoned with and every bifurcation accounted for: 'the ANT scholar has to trudge like an ant, carrying the heavy gear to generate even the tiniest connection' (2005b, p.25). I was convinced that I was hence on track to do something thoroughly ethnographic: in-detph, meticulous, symmetrical. Little did I realise that I would also be carrying this gear around while some not so tiny connections were being generated in complete ignorance of my heavy carryon. Although I will argue that this thesis has taught me how to ask new and more eventful questions about flood risk, it should be clear from the outset that this process has itself been 'hostage to events' (Clark 2003). It rarely seemed so at the time, but being repeatedly foiled and disempowered has actually been quite productive and is, I think, in the end, the main reason why the work I have done might actually be called 'ethnographic'. It has got less to do with in-depth diligence, and more to do with sharpened attentiveness and surprises taken seriously (which are arguably, and to be fair, also virtues of the ant). If this thesis has an ethnographic flavour it is not because it has been 'drawing up all the rules and regularities of tribal life; all that is permanent and fixed' (Malinowski 1972, p.11), but rather because it has attempted 'for a very short span of time, to produce a different sense of how things might be, using the resources at hand' (Thrift 2003, p.119). This is not a 'document of the occult'; but it might be somewhat of an 'occult document' (Tyler 1986).

After I gave up on the waterproof hiking boots, I took my ant-like trudge to the City of London and the Statement of Principles which I early on considered to be a natural focal point for my research. It is important to remember that I was working on a somewhat bounded assignment. I might have been looking for practical (and feasible) ways of following through how indeterminacy takes place, but that search was always confined by two non-negotiable conditions: I had to work with flood insurance, and I had to do it in England. In principle, that does not narrow down the field too much. In 2009 there were 799 companies authorised by the Financial Services Authority (FSA) to carry out general insurance business in the UK (as opposed to long term business like life cover or pensions), and with notable exceptions, such as the Norwich based Aviva group, these primary insurers tended to concentrate in the London area. The same goes for some of the wider infrastructure implicated both in the trade and assessment of risk. Direct transactions between insurers and their clients account for only 32% of the policies sold; 35% goes through brokers (e.g. AXA or Endsleigh), 17% through a bank or a building society (e.g. Barclay's or NatWest), and 15% through retailers (e.g. Tesco or Debenhams), utility groups (e.g. British Gas) or another company agent (ABI 2009). Likewise, flood risk assessments are increasingly outsourced to specialist consultancies. These include hydraulic modellers which produce flood maps or flood risk assessment tools for primary insurers (typical actors include HR Wallingford, Halcrow and JBA), as well as credit rating agencies, who model potential losses (this could be Guy Carpenter, Moody's or Standard & Poor), and catastrophe modellers who supply scenario based software packages to assess aggregate probabilities mainly for reinsurance purposes (this market is more or less dominated by a triumvirate consisting of EQUECAT, RMS and AIR). However, in this complex web of corporate interests and competitive tactics access quite often became a problem. As it became increasingly clear that what I was going to engage in an intimately ethnographic manner was some very sensitive information indeed, keenly protected by the companies that owned them, I felt the need to think on my feet and make adjustments in order to keep generating materials. I found myself interviewing insurance professionals in pubs, well away from their corporate headquarters, and it became standard practice to offer all informants anonymity (which is why they appear in this thesis only by the letter 'i' followed by a number). Furthermore, the people I interviewed were all intimately familiar with what it meant to be doing post graduate research (most of them had a PhD or similar) and took a keen interest in telling me what my project was about, what it should be about, what was of interest, and what was certainly not of interest. These conversations ranged from the immensely fruitful to the deliberately obstructive where I left the interview with a clear sense of having been steered safely around the things which would in fact have been interesting. When I stated that the complexity of the flood issue was recognized across the board by everybody I talked to, it must also be noted that they did not fail, and rightly so, to recognize my work as part of that complexity.

The renegotiations of the Statement of Principles were one of the few examples of a process that both I and my informants in the ABI considered to be of interest to my project, and within the first year of my research I had been lined up to follow the meetings to secure a new deal. I met the negotiating team for the first time in June 2007, the first meetings with DEFRA were going to take place in January 2008, and as Christmas approached everything seemed to be on track. The fact that my first summer in England had also seen the worst floods on record take place did only make the process more interesting, I thought. Increasingly, however, so did ABI and DEFRA, which would eventually cause major interruptions to my fieldwork plans. In figure 0.6 I have visualised the content of the debates in parliament over the issue of flooding in October 2007 and April 2008 respectively. They show a distinct change in the matters of public concern: three months after the floods the 'Environment Agency', 'insurers' and 'defences' are the high rankers, whereas six months later they have been supplanted by 'surface water', 'drainage' and 'planners'. I am going to return to these changes in chapter 2, but now they should simply serve to demonstrate how the changing anatomy of the flood issue was a major factor to be reckoned with during my fieldwork. The summer floods might have rearticulated the need for a viable Statement of Principles, but they did not right away render it controversial. It was only when reports started to come out stating that the government had been completely unprepared for the events (e.g. Pitt 2008), that things became complicated. As issues of drainage and surface water were brought to the fore, and as it became clear that there were neither adequate knowledge nor policies in place to deal with them, I was shut out of the negotiations. Ironically, and this is the productive part, figure 0.6 is the result of a new digital mapping strategy that I adopted in desperation after being shut out. The materials generated in this way have become the backbone of chapter 2 and are in many ways integral to my ambition of reinvesting flood risk with an ontology of the event.



0.6 - Comparing parliamentary debates on flooding (October 2007 vs. April 2008). Full text transcripts (Hansard) have been searched for occurrences of different actors. Each actor represents multiple, but related, search terms so that 'Insurers' for example stands for instances of 'ABI', 'Insurance', and 'Insurer'.

For the past three years I have generated a diversity of materials by asking my question in libraries, archives, training sessions and interview rooms, indoors and outdoors, online and on paper; I have visited insurance professionals, engineering consultants, policy makers and academics; I have recorded and transcribed audio files; I have set up web crawls and launched bibliometric surveys; I have trawled through literature, media clips and Government records; I have seen flooding first hand, and I have encountered the issue as a concerned member of the public. In what follows I have tried to organise these experiences into seven explorations of what it might mean to be risking the flood. Effectively, I would like to think that they are, in their own right, putting something at risk. As Sarah Whatmore points out, a Stengerian approach offers not only the opportunity to envisage what is being researched under the creative sign of cosmopolitics, but bids the inclusion of the relationship between researcher and researched into this creative and thus jeopardizing coming-together. It offers, in other words, a way of keeping 'questions open through the research process by allying them to an insistence on the producedness of 'data' and the creative and sometimes contrary possibilities generated in and by exchanges between researcher and researched' (Whatmore 2003, p.103). This goes, not least, for the work of weaving materials together in the process of writing and I am not going to pretend that fieldwork stopped when I pulled out of London and Yorkshire (the sites where most of my interviews took place) and retreated to the libraries of Oxford to 'write up'. Indeed, very few things appeared to have a clear point when I began writing this, and when some of them did it turned out to be deceptively so. Thus, writing has been a fairly extended and abrupt process consisting mostly of unwritings and rewritings, a process which has profoundly impacted the core questions asked. That, I am afraid, is likely to show in the sometimes chaotic lack of line through the text, but I would like to think that I have followed Mike Crang in making active use of this process:

> *Analysis is not simply an issue of developing an idea and writing it up. Rather, it is **thinking by writing** that tends to reveal the flaws, the contradictions in our ideas forcing us to look, to analyse in different ways and to rethink. (Crang 2003, p.139, my emphasis)*

Each chapter can be seen as an experimental setup in which some of the materials generated in my interaction with the field are put to work, jeopardized that is, to engender new ways of thinking about what it might mean to be risking the flood. Given the ongoing nature of the project, these materials have often been gathered for different purposes than the ends to which they are now being put, but I have prioritised not to muster an army of gagged 'evidence' which could bear witness to my conclusions at the expense of being able to have a continuous and constantly doubt-provoking dialogue with my field. In effect, that has left me with four chapters (2, 3, 4 and 5) which supposedly do the core work of weaving things together. They all represent different stages along the failure/development of my research question. In particular 3, 4 and 5, which are all dealing with different types of modelling techniques (hydraulic computer models in chapter 3, physical flood models in chapter 4, and probabilistic catastrophe models in chapter 5), seem to belong to a now somewhat obsolete way of asking questions. They are never the less integral to the process of making those questions obsolete and are thus simultaneously failing and productive. I try to make use of them in the latter respect, and eventually that means that the two chapters which were originally thought of as 'methodology' (chapter 1) and 'conclusion' (chapter 6) have had to do a lot of analytical work in terms of making that process explicit. They have thus become core parts of the argument rather than auxiliary framings around it.

There are of course formal ways of accounting for the outcome of my work: 26 recorded and transcribed in-depth interviews (see appendix) have emerged from numerous conversations with 41 informants (mainly underwriters, policy people and technical experts in the insurance sector); an extensive set of field notes has been produced while participating in two introductory training courses trying to become a qualified amateur in the use of hydraulic modelling software; a similar set of notes came out of work shadowing a team of consultant flood modellers and participating in conference sessions on catastrophe modelling; I have used the online archives of DEFRA, the EA, the ABI, the National Flood Forum and various local Flood Action Groups to collect relevant publications and piece together a context for the Statement of Principles and its various renegotiations; I have compiled a dataset comprising all parliamentary debates, questions and statements relating to floods between July 1st 2007 and July 1st 2008, and I have subjected that dataset to a range of online visualisation tools to produce word clouds, phrase nets and tease out the changing make up of the flood issue month by month; I have launched more than 90 web crawls over a 6 month period using the online tool IssueCrawler to explore the network of interlinked websites starting from the flood related web pages of the ABI, the EA/DEFRA and the National Flood Forum respectively; I have made frequent use of the Times Digital Archive and the Dow Jones Factiva database to track the news stream on flood issues for the past 100 years (in detail for the past 15 years); I have explored archival material such as 17th century marine insurance publications and early 20th century reports on physical scale model experiments; and I have followed the experimental work of my host project as it sat up competency groups in flood stricken local communities. However, even when I was back at my desk 'writing up' these materials have been shuffled around in new ways, entered into surprising conversations with each other or the things populating the 'theory' or 'methodology' domains of my desktop. It was, for example, on a bench halfway between the School of Geography and the Bodleian library that a fellow student, who was working on the geography of a mummified child, introduced me to Henri Bergson's concept of radical unforeseeability (1944) and provoked a whole new way of thinking about the last three chapters of this thesis. How do you account for that kind of experience, firmly situated in the middle of 'writing up', if not as something similar to fieldwork? Indeed, I find it hard to make a meaningful distinction between the theoretical, empirical, analytical and methodological aspects of this kind of research, which is why the chapters are precisely laid out so as to bring these aspects into constructive dialogue.

Chapter 1 revisits my own process of framing questions and thus 'imagining the field' (Massey 2003). It does so from a perspective in the middle of things: a flood risk assessment exercise at Lloyd's of London, with its ensuing flood modelling and mapping components. What is put at stake here is my presumptions about the object of study and the possibilities for devising a research design around it. It generates questions which might be framed as being 'methodological', but I deliberately approach them under the headline 'Plunging In' to stress how these were in no way settled prior to my immersion into 'the field' and indeed produced some of the most important outcomes of the thesis: the realisation that flood risk is inadequately thought of as something which becomes an object of controversy. Chapter 2 contemplates what a political ecology of flood risk might look like. It does so through the trope of being out of place and tries harness the inherent creativity of flooding itself by mapping out the issue-driven formation of a flood-stricken public (Marres 2005). It does so using a combination of first hand observations, issue crawls and bibliometrically generated material. Chapters 3 and 4 both deal with determinability and ways in which floods become known as facts. But they do so with a twist. By following the process of hydraulic modelling, both through a participatory and an historical account, they explore the fictitious capacities of simulation models: their ability to bring possible futures into being by replicating pasts. To stay in the metaphor of mapmaking, the power to invoke the unknown is invented by way of analogy to well known pasts and presents. Chapter 5, on the other hand, deals with the creation of indeterminability. It uses interview material to explore the process of catastrophe modelling and the crucial role played by probability theory in making a multiplicity of hydraulically modelled, and thus deterministically constructed, scenarios populate an indeterminable, chance dependant, but explorable future. Chapter 6 tries to provide some conclusion, while chapter 7 is a postscript adapted after this thesis got stuck with its author underneath the Icelandic ash cloud that shut down European airspace in late April 2010.

The most important point to make, however, has to do with the different paces at which this thesis has been written. Mike Crang encourages us 'to think about philosophical materials as part of an activity – as a doing among our research, not as reflections standing over and above it. The process of analysis (...) is thus an active and material one, one that involves making connections – and divisions – and where material is combined, recombined, decontextualized and recontextualized' (Crang 2003, p.143). Crucially, since the chapters have been conceived and assembled in conversation with a changing set of questions (I return to these changes in chapter 1), they are at times reminiscent of an agenda which is long since transformed. This is particularly clear in chapters 3, 4 and 5, but I try to use it constructively to claim that a main contribution of my work is to discover new ways of asking questions about risk and controversy. So, let me just sum up what I am trying to achieve before I proceed to 'plunging in' (chapter 1).

What?

> *When the event is the situation of a well-marked object, we have no language to distinguish the event from the object. (Whitehead 2004, p.77)*

The provision of flood insurance is an issue which sits at the junction between several strands of productive activity and provides a crosscutting theme for the development of constructivist thinking. It not only implicates the production of scientific facts (Latour 1987, Latour, Woolgar 1986, 1988, 1999), but the enactment of markets (Callon 1998, MacKenzie, Muniesa et al. 2007, MacKenzie 2008, 2009), and the becoming of publics (Marres 2005, Marres 2007). The truly interesting question cannot be limited to how flood risk (noun), as a claim to knowledge, is brought about, but must extend to how the risking of floods brings all sorts of other things into being. That is what I want to explore here and for that purpose I need to open up a 'space of thoughtfulness' (Thrift 2003, p.115) broad enough to accommodate the cross-cutting variety of such an enquiry. Substantive risk – the object, the noun, that which becomes the focus of both modernist managerial ambitions and its critics – can be understood as an abstraction. In the language of Alfred North Whitehead, it is the event, the ongoing 'dance of molecules', which is the real element, not the static entities which refer to it (Whitehead 2004). Throughout the flood issue, risk appears in all sorts and manners as abstractions. But it does so by dint of an underlying dance of molecules, an ongoing creative ooze ripe with its potential for controversy, and it is from a starting point within this dance, known here as ‘risking the flood’, that I commence my hunt for what might possibly be called *cartographies of things to come*.

1. Plunging In

Methodological reflections on how to imagine the field

> *The middle is by no means an average; on the contrary, it is where things pick up speed. (Deleuze, Guattari 1987, p.28)*
>
> *How can being 'moved' by happenings, goings-on or encounters generate a research project? (Clark 2003, p.34)*

Lime Street, October 2007: What does it mean for something to be risked? The question starts here, in the City of London, not because it is in any way an obvious point of departure, but because it is a way of beginning thoroughly in the middle of things: in the middle of the question itself, in the middle of the issue from which it springs, and in the middle of the field through which it travels. It is also a way of beginning in a place which is designed to be a middle ground. The imposing high-rise on the corner of Leadenhall and Lime Street is the home of the Lloyd's marketplace and the conspicuous traffic through its doors attest to the osmotic relationship which exists between this building and its neighbouring financial district. A corps of licensed brokers flock here every day on behalf of their clients (who might be anything from a corporation with an air fleet to an individual with an arts collection) to negotiate insurance contracts with the resident underwriters. The trading floor, also known as 'the Room', appears more like a street market than a corporate headquarters, and that is perhaps a more accurate way of portraying its function: it is laid out as a vast array of tables, which are essentially the retail stalls of the underwriting syndicates. Each syndicate consists of a number of 'names' or capital providers (these could be private investors or companies alike) who specialise in supplying particular types of cover (this could be against a natural hazard, a financial liability or any other kind of peril). These 'names' have representation at a table in the Room through a managing agent and the brokers approach the tables where they believe there might be an appetite for the kind of business they bring in and haggle face to face with the agents to secure a policy.

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1.1 A view down towards the Lloyd's underwriting floor, better known as 'the Room' (from the Lloyd's website[11]).

Besides providing a microcosmic introduction to the process of insurance and some of its key players (clients, assets, hazards, intermediaries, underwriters, capital) 'the Room' is a good vantage point for making some initial observations about the topic of this thesis, which

[11] http://www.lloyds.com/About_Us/The_Lloyds_building/ (23.04.2010)

appears, in here, tangibly as an object. In the hands of brokers and underwriters flood risk becomes capable of placement. It can be brought up the stairs and through the main entrance; it can be traded and transferred; graded, written or refused; it can be priced, and it can be taken. It is not the air fleets or the arts collections per se which are placed on the tables, neither is it the earthquakes or the hurricanes threatening to inflict damage upon them, it is some*thing* distinctly different, something which has presence in its own right: *it* is risk. And as I enter the Lloyd's building a couple of months into my fieldwork, this is a comforting thought. Heading my scribbled strategy notes for the upcoming interviews is a research question which might have been designed to merely suggest the general direction of a conversation, but nevertheless forces a very specific restriction on its topic: 'what is flood risk?' – such an enquiry is best made if there is indeed a 'what' to be discussed. The answers can be unreservedly manifold as long as they pertain to the quality and composition of a substantive entity called flood risk. At first glance, that premise seems relatively unproblematic in places like 'the Room' where risk, including that of flooding, is an object of exchange. Yet, the question did not survive being asked in here. This thesis first of all explores how floods are risked, and not necessarily what flood risk is. Why is that; and what is the difference? In this chapter I put my research question at stake and become attentive to its highly provisional character. The implications are not only methodological, relating to the way I've been 'imagining the field' (Massey 2003), but defining in terms of setting up a format and a pace for this thesis. Whereas I started out fieldwork in search of an answer to a question (what is flood risk?) I have increasingly been writing in search for ways in which to ask that question differently (how are floods risked?). In the end, this is what I hope to have produced: a new question. All the chapters are in some way or another part of that search, and this is where it starts.

In the middle of the question

When I initially focussed my enquiry on the 'what' of flood risk, it was not because I was hoping to extract a homogenous answer. On the contrary, the question was directly derived from the knowledge controversy conundrum: what does it actually involve, in quite material terms, for something to become controversial? Surely, there must be ambiguity as to the character of such a thing? I worked from the assumption that flood risk could only truly become an object of controversy if it was somehow sufficiently multiplex to not simply allow disputes over its essence to be settled by facts. That kind of multiplicity could for example be captured in the figure of the 'boundary object' (as introduced by Star, Griesmer 1989) with its loosely defined common identity necessitating/enabling different situated concretizations into what would thus become a diverse variety of fully-fledged forms (see also Laet, Mol 2000). Or, in a related sense taken from Annemarie Mol's work on atherosclerosis, it could be imagined as a 'coexistence of multiple entities that go by the same name' (Mol 2002, p.151). These notions of multiplicity endow the concept of a controversy with potency and set it firmly apart from mere disagreement. To agree or disagree on something still presupposes an accord about the thing at stake. The scene is one of misunderstanding and rectification, a situation in which the problem becomes one of communication: ultimately, when the facts are known, there will be settlement. In the case of boundary objects, however, such an accord only just suffices to focus the controversy (on flood risk for example), but it will not be able support a solution by dint of clarification and enlightenment. There is no immediate settlement in sight because the object, through diverging practices, has become multiple. The implicated parts are simply no longer concerned with the same thing[12].

For example: if you live in the UK, the Environment Agency's online information service is one of the key ways to learn about flood risk. Based on a postcode input it toggles a local area map with two transparent overlays showing the estimated outline of floods occurring on average every 100th year and every 1,000th year (see figure 1.2). Risk, in this format, is purely a matter of probability. If you happen to find your house located in one of the flood zones, you will both *know* that there is a certain likelihood of being flooded each year (0,01% or 0,001%), but also *un-know* a whole range of other things which might have staged other narratives, played to different sensibilities and thus constituted other kinds of flood risk.

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[12] To Stengers, the protagonists of a scientific controversy never 'seek an agreement on the basis of what they might have in common', rather they 'turn back toward things to try to invent the means of making them plead ever more decisively in their favour' (1997, p.141). A scientific controversy is admittedly a much narrower concept than a knowledge controversy, but the notion that the dispute is not *over* a pre-existing, thing but rather *in* the things themselves, is instructive here.

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1.2 - Return periods on the Environment Agency's online flood map for central Oxford (as returned on the postcode OX1 3JA). The dark blue overlay represents a 1 in 100 year return period (1% or greater chance each year) whereas the lighter blue overlay represents a 1 in 1,000 year return period (up to 0.1% chance each year). The opaque dark blue lines are the main rivers (the Isis (Thames) to the west and the Cherwell on the east).

Indeed, knowing that you might be flooded can happen in far less pleasant ways than through this rather sterile prognosis – and with other gravities and intensities than those expanded in its graphic statement of probability. After a series of flood events in 2007 a householder who was still in alternative accommodation after having her home swamped by the deluge gave the following testimony to the Government commission investigating the disaster (Pitt Review 2008, p.362):

> *My 2 year old daughter's facial eczema has got worse and flares up a lot, my two sons (aged 6 & 10) have had colds constantly, we have all had bad chests, sickness and diarrhoea lots of times, coughs, sleepless nights. I have mild IBS but it has been worse recently. I have also come out in a rash all over my hands. We are at the doctor's a lot*

> *more than normal and my daughter has also had to visit the hospital due to a very bad bout of sickness & diarrhoea. It is all extremely worrying.*

Another victim, who had been forced to move temporarily into a caravan in her driveway, stated that:

> *I have had to take sick leave due to stress and insurance problems. The children's behaviour has deteriorated as their friends have left the area and there has been a lack of space for a long period of time – we have not returned to normal as yet.*

In Sheffield, a mother complained that she could no longer take her son swimming because he was too scared of getting flooded again (Pitt Review 2008, p. xxxvi). Clearly, figure 1.2 exemplifies a very different realisation of flood risk than these corporeal apprehensions amid clammy floorboards and disrupted routines. All of them are, nonetheless, realisations of flood risk. And realisation can here be understood in the literal sense of a making real: flood risk is not simply *perceived* in a different way; it is brought about differently and thus *brought into different beings*. One version is made from things like digital terrain models, precipitation data, flow simulations and maps (more on this in chapters 3 and 4), another from fear, dampness, insurance claims and diarrhoea. While both embody the notion that flooding might happen, one details its likelihood whereas the other fleshes out its consequence. Conversely, the flood map has little room for eczema and anxiety, while the householders do not tend to articulate their situation in terms of mathematical probability. These realisations are of course juxtaposed extremities chosen for the purpose of demonstration, but they mark out points along a continuum of forms, the differences between which can be more or less subtle. Many insurance companies, for example, realise flood risk by probabilistically zoning out areas in ways which bear much resemblance to figure 1.2, but with the important difference that the stories told here are always those of profitable gambles and potential financial losses. These versions of the flood risk fabric come interwoven with things like the value and vulnerability of properties, the terms and conditions of policies, and the composition and spread of portfolios (more on this in chapters 5 and 6). Even though they tap in to the same vernacular as figure 1.2, even though they share its resonance in the same 'cartographic literacy' (Matless 1999), they are distinctly different and bring different geographies into being. The important thing is that issues which make flood risk controversial (be they disputes about when insurance cover should be available, or rows over how planning permissions should be granted) seem to be inseparably caught up in this multiplicity. Consequently, at the outset of my fieldwork it appeared that any understanding as to how flood risk becomes an object of controversy would have to involve mapping out how flood risk becomes an object in the first place. Or rather: how it becomes multiple objects. Such realisations, as well as the constructivist tradition from which they draw their conceptual stamina (constructivist in the sense that things, however factual, could have been assembled differently (Latour, Woolgar 1986, Latour 1988, e.g. Pickering 1984) or indeed composed into hybrid form (e.g. Law 2002, Whatmore 2002)), imply a firm anchorage in practice. They suggest that the act of knowing is inseparable from what is being known and thus never leaves it unchanged. This is fundamental: to adopt the view that knowledge does not amount to having ideas about things that are already there, but rather constitutes processes by which these things come into being, is not necessarily about questioning their reality (Latour 1999, ch.1). On the contrary, it can be about opening up a space for thinking about how ambiguously multiplex, and thus poised for controversy, that reality really is.

Some key points must be made here, not only about the development of my research question, but about the way I have chosen to write this thesis. It is perhaps an understatement to say that constructivist concepts like 'boundary objects' or 'communities of practice' provided merely a different way of thinking about the project I was embarking on. Of course they did, but when I walked in to the Lloyd's building with my interview guide, my audio recorder and my diary ready to take notes, they were what I actually expected to find there. I did not frame the question 'what is flood risk?' because I wanted an answer as to whether or not it was in fact a boundary object worked into a multiplicity. I framed it on the prior assumption that this would indeed be the case, and that I would be able to take on the task of mapping out, in more practical terms, how that came to be so. Again: to understand how flood risk becomes an object of controversy could in my reasoning be equated with understanding how it becomes multiple. But this way of doing things turned out to be increasingly impracticable. As fieldwork progressed, the sturdiness of my assumptions became corrupted by a disquieting noncompliance. It was less and less clear in what way, if at all, it would make sense to understand flood risk as an object (boundary or not), and as the formulation of a research question thus proved more and more provisional and ongoing, the conceptual framing became more and more central to the reflections provoked by my interactions with the field.

For example: when you enter the Lloyd's building it is immediately apparent that there is more to this marketplace than the traffic of brokers and underwriters passing through it. As you stand in the Room and observe how risk is being brought back and forth between the tables, you need only look up through the 197ft tall atrium towering above the trading floor to realise the scale of the operation that makes this tangibility possible. The Lloyd's corporation itself does not act as an insurer per se. Rather it enables others, namely the underwriting members, to do so. And on one of the upper floors, in what is known as 'exposure management', a team of actuaries and GIS experts are taking part in that work by creating a virtual flood disaster in London. As I take the elevator up there in early autumn 2007, the Association of British Insurers (which does not include Lloyd's) is once again threatening to abandon its commitment to making affordable flood cover broadly available to the public. On the upper floors above the Room the assumption is that, as the regular insurance companies get smarter and smarter in terms of understanding their exposure to flooding, more and more of the risk will inevitably end up at Lloyd's. To the people in 'exposure management', this is worrying not only because it is likely to be the bad risks which migrate first, but because the underwriting syndicates, which are made up of private investors, do not have the same amount of information available and cannot perform the same check-ups as their incorporated counterparts. As one of my informants (i3) puts it:

> ***[i3]*** *We don't know how much information they [the Lloyd's underwriters] have. Do they have a sophisticated flood analysis tool? Or do they just say 'ok, you know what? We'll just go based on the Environment Agency web service'. I don't know if you have had a chance to see it? It's a very, very low detail service.*

I have arranged my visit because 'exposure management' has decided to respond to these concerns by including a 'London flood' in their repertoire of so called Realistic Disaster Scenarios – an annual exercise in which all underwriting syndicates go through the motions of assessing their exposure to various catastrophic events (besides major floods these could for example be terrorist attacks on Manhattan, Californian earthquakes, or Japanese typhoons). In other words, my informants are faced with the task of providing the virtual footprint for a flood disaster which can be run against the portfolio of each syndicate to evaluate their exposure, estimate their losses, and thus stimulate an understanding of the risk they take on board[13]. Through the conceptual lens of my research design, these efforts are all about realising flood risk in a way that is different from, say, the Environment Agency's web service. My task, in such a set up, would then be to trace out how that difference is brought about. And so far things are looking good: not only can flood risk be observed in concrete form as it is moved about on the trading floor, but the work of forging this concretisation from a more loosely defined boundary object seems to be conveniently located higher up in the building.

The problems begin to arise when this relationship between object and practice has to be fleshed out in more detail. On our way to the meeting room my informant takes us past the glass wall of the atrium. We are almost at the top of the building and the position offers an impressive vertical perspective down towards the trading floor below. The two-dimensionality imposed on things from this altitude seems fitting considering the reductive condensations by dint of which the risks traded down there acquire their definition: estimated measures of frequency and severity; sufficiently solid to support a price tag. After some more walking we sit down at a table and I turn on the audio recorder. The task is quite clear: the objects are down there, the work that goes into achieving them somehow takes place up here – what is the connection? To ask 'what is flood risk?' is not necessarily going to clarify much in this respect. It

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[13] Because the Lloyd's corporation is ultimately liable if their members are unable to pay out claims and thus act as a kind of re-insurer for them, and since the consequence for the syndicate, should such a situation arise, is the discontinuation of membership, the RDS system is put in place as a way of forestalling the consequences of bad portfolio management.

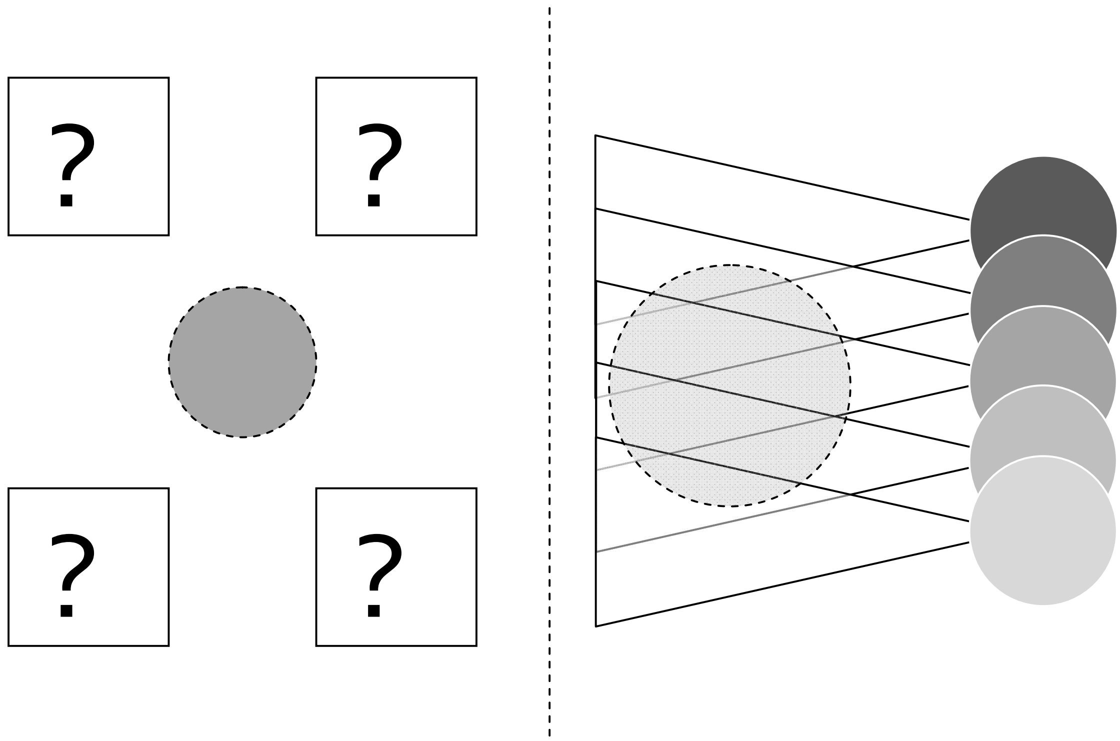
will have to be asked with the ontological conviction that being, in whatever form it might take, is always a becoming (Deleuze, Guattari 1987). It is one thing to state that knowledge is never separate from what is being known, in this case that the development of a virtual flood exercise is not separate from the risk being traded in the Room below us, but it is quite another to extract the architecture of such a relationship from a conversation like the one we are about to have. To assist me in that task I early on enlisted the help of a series of metaphors or templates which took up a central role in my process of 'imagining the field' (Massey 2003).

Most notably Bruno Latour's diagrammatic model of 'circulating reference' (Latour 1999) became the baseline from which I embarked on this imaginative process, and it provided a sounding board which continued to resonate throughout that work (see figure 1.3 and 1.4). The circulating reference model serves a dual purpose in Latour's thinking as both a guide for tracing the becoming of phenomena through a series of reductive and therefore amplifying transformations, and as an ontological argument devised to dismantle what he calls the 'modern settlement' (see also Latour 1991): the Cartesian idea of an extraneous out-there, a realm of mute objects which might be transcendentally gazed upon through the application of valid scientific method. I have stated a few times now that this thesis adopts the view that knowledge does not amount to having ideas about things which are already there, but rather that it is constitutive of the process by which these things are brought about. This diagram supplies principle form to that process. Latour develops it in describing a fieldtrip with a group of earth scientists, pedologists, to the Boa Vista jungle in the Amazonas. Out of the densely vegetated, cacophonic, monkey howling mayhem which constitutes the rainforest in all its multifarious materiality the researchers are able to extract a scientific statement, a claim to knowledge. They accomplish this by systematically reducing its complexity through a series of transformative devices: dividing the soil into a grid, transferring soil samples from each grid cell into a so-called pedocomparator, taking notes about the character of each sample, and so forth, allowing reference to be circulated between simple statements and the complexities on behalf of which they are asked to speak.

To Latour's mind, this process of fabrication suggests that phenomena, however self-contained they might seem in their apparent one to one correspondence between word and world, are in fact materially heterogeneous; that they are inseparably connected to the vast material 'hinterlands' (Law 2004) made absent by their becoming present. 'Phenomena', he writes, 'are not found at the *meeting point* between things and the forms of the human mind; phenomena are what *circulates* all along the reversible chain of transformations, at each step losing some properties to gain others that render them compatible with already established centres of calculation' (Latour 1999, pp.71-72). Knowledge is in other words a process which adds to the world, rather than a mental image resembling it. It has consequences. It is at once both materially situated and standardized into compatibilities capable of travel beyond the locality. To be precise: it is practice; the work of achieving such a simultaneity by transforming complex particularities into simpler and more universal forms. That, to Latour, is what phenomena amount to, and the ontological character of the argument cannot be stressed enough: when I went in to Lloyd's expecting to find versions of a boundary object worked into concrete form, it actively reflected an imagination of the field grounded partly in this figure of circulating reference. I assumed that flood risk would be a phenomenon traceable through a 'reversible chain of transformations'.

1.3 Latour's model of 'circulating reference' (freely adapted from Latour 1999, p.71). Towards the right phenomena are realised in an amplifying process of consecutive reductive transformations leaving their heterogeneous hinterlands on the left absent, though inextricably connected through the circulation of reference. The relationship between world and word, between what is there, and what we claim to know about it, is not one of representation. On the contrary, the process proceeds precisely by dint of transformation, not of resemblance. The challenge is not to cross a Cartesian divide between the subject and the object, but to make simpler things refer to their more complex constituencies.

What is particularly intriguing about the circulating reference model is that it allows objects to be thought of as continua spanning the dichotomous opposition between situated and 'detached' perspectives. The panoptic gaze implied in notions like objectivity, factuality and certainty is an achievement that requires constant work and is only gradually brought about alongside the ostensible disembededness which makes it possible. If one was to adapt this continuum to accommodate the concept of a boundary object, then the diagram seems to suggest a half baked (the lack of completeness understood here as a quality), open-ended type of phenomenon which emerges halfway down the transformative funnel of reduction/amplification; one that has not yet been fully cut loose from its heterogeneous entanglements, a process which must be completed in a bifurcating diversity of further reductions. Following this line of reasoning, figure 1.3 attempts to provide an illustration of the way I initially imagined the field. On the left, flood risk is recognised as a multiplicity and the question arises: how do different concretisations come about? On the right the anchorage in practice, vital to the concept of multiplicity, has been fleshed out using a tweaked version of the circulating reference diagram: concretisation proceeds as initially overlapping but gradually bifurcating processes of reduction/amplification. Flood risk, I envisaged, would imply some sort of shared material situation, from which several possible claims to knowledge would be extractable, each involving different kinds of making absent in order to amplify different kinds of presence.



1.4 – The boundary object adopted into the circulating reference diagram. On the left, it remains to take concrete form in a multiplicity of realisations. On the right, several 'chains of transformation' emerge from the same heterogeneous situation, forming, before they branch off to achieve fully fledged phenomena, a half-baked go-between, just sufficiently solid to be the common denominator, the name under which the different entities on the right will come to be known. In this case: flood risk.

I carried that mental map with me into the interview room at Lloyd’s. The task of connecting the flood risk being traded downstairs in the Room with the work taking place in exposure management was, to my mind, a question of locating the transformative steps in the process. To use a very graphic metaphor: I saw the atrium in the Lloyd’s building as a large amplifying tube, the circulating reference model turned 180° to balance on the trading floor, pointy end down, drawing in the heterogeneous hinterlands of tradable flood risk at the top, focusing them as objects on the tables of the underwriting agents at the bottom. And indeed, at least to begin with, it proved to be a quite productive imagery to work from. My visit to ‘exposure management’ made it possible to start locating some of the transformations at play, while suggesting a range of trajectories that might be followed through elsewhere. My informants were at this point in time trying to procure a footprint for their virtual flood event in London (in a Realistic Disaster Scenario (RDS) exercise the footprint is what specifies the extent of the flooding, its character and its impact on infrastructure and property), and figure 1.5 illustrates this footprint as it appeared in the finished exercise (Lloyd's 2009). Heavy rainfall has moved across the Thames catchment west of London, causing the river to flood in Oxford, Reading, Slough and Henley, as well as producing surface water floods on the outskirts of Heathrow Airport. The scenario specifies a total insured loss of £6.2bn (£4.5bn residential, £1.6bn commercial/industrial, £0.05bn agriculture, £0.05bn motor) which the managing agents are asked to assume their part of when they assess their exposure. The floods cover 194km^2 for a maximum of 168 hours, they cause problems with seepage and pollution, they affect main roads like the M25, M3, M4 and A40, and they disrupt other critical pieces of infrastructure:

> *Major Rail*
>
> *Rail disruption will occur between London (Waterloo) and western services towards Oxford, Bristol, and Cardiff. There will be little disruption to the London Underground system except for flooding of Pinner station on the Metropolitan line.*
>
> *Heathrow Airport*
>
> *Surface flooding will cause disruption to Heathrow Airport with flooding from the west encroaching into Terminal 5 and the end of both runways. Further flooding from the south will affect cargo transit and handling facilities.(Lloyd's 2009, p.48)*

The managing agents are further asked to consider the impacts of business interruptions and reflect on the potential effects of the floods on other types of policies such as travel cancellations, cargo or fine art.

1.5 – Footprint for the Realistic Disaster Scenario 'UK Flood'. From Oxford (top left) to Teddington in west London (bottom right) the River Thames has gone out of bank inundating 194km2 of land. Oxford, Reading, Slough and Henley are severely affected, and outer parts of Heathrow Airport are flooded by surface water. The total estimated insured loss for this event is £6.2bn (Lloyd's 2009, p.47).

The question now is this: what has been produced here? This event never actually happened, it is not simply summing up a disaster which already took place (although admittedly that would also have involved reductive choices about which aspects to consider and which to ignore). The claim advanced in figure 1.5 has the form: 'this could happen'. How does a claim like that become capable of travel beyond Lloyd's? What is it actually referring to? When I visit exposure management in 2007, all this is still up in the air to be decided and I am able to tap in to a variety of ongoing negotiations regarding the kind of data that might be needed, what kind of outputs would be feasible and where/how/when the work could be carried out and by whom. In the context of my fieldwork, which is tentatively groping its way around a variety of potential leads, the RDS presents itself very strongly as an opportunity, an opening where it might be practicable to trace things in their making. In retrospect, however, what I want to flag up is the degree to which it made sense to think of these things as 'flood risk'.

My first bearing is the footprint. It is what I lock onto during the interview, and it quite quickly becomes clear that I will have to go elsewhere to follow through that line of enquiry. The footprint will, as a phenomenon, both have a story of its own, and, as part of a scenario exercise, play a role in bringing other phenomena (potential losses and estimated exposures for example) into being:

> ***[akm]*** *Could you try to explain this phase where you turn this into an RDS? What does that imply, what kind of work is that?*
>
> ***[i3]*** *In terms of RDS (...) we should have an expert in flooding saying 'you know what, I think this would be an extreme risk scenario where you have river flooding, you might have sea surge, you might have flood defence failure, things like that, this volume of water spreading in this kind of scenario'. (...) The first thing would be a footprint, get the elevation, and we can see where the exposure is, and we can see the depth.*
>
> ***[akm]*** *So it's quite basically saying: 'this is the event, and this is where the flood is going to be'?*
>
> ***[i3]*** *Exactly. 'Now, let us know your exposure'. (...) We will be thinking something static, something that already happened. Anywhere water wanted to go, it's already gone there. All we need to know is the footprint for that affected area.*
>
> ***[akm]*** *A snap shot.*
>
> ***[i3]*** *Exactly. And I think, I am not sure, we haven't thought about it, but I think there would be some kind of loss or damage factor as well. Because once you have the flood area, you should come up with some kind of damage factor. For example you say that once you have the flood affected area you can calculate the height of flooding (...) And I think by the time we define an RDS we have to give each managing agent the footprint based on*

either height or damage factors so that they can say whatever damage factor I have in this area, I can calculate to get the loss.

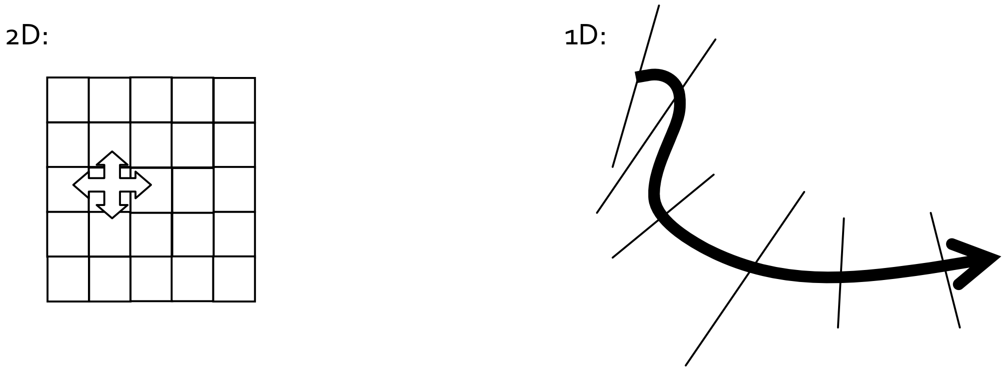
Eventually the exercise will be completed by each individual managing agent, and this, in part, is where I will be able to follow it through. For example: when the scenario specifications state that 'the impact of pollution as an aggravating factor in residential losses' should be considered with reference to 'historical analogues, including the Carlisle floods of 2005' ((Lloyd's 2009, p.48), it involves reductions which will have to be made outside Lloyd's exposure management in relation to particular portfolios and with the mobilisation of specific situated experiences. Likewise, the bringing about of the footprint itself, the imagined flood event which is the backbone of the RDS, seems poised to take place in different settings, and in April 2008, a little over half a year later, I thus find myself displaced to a flood modelling consultancy in rural Yorkshire.

Footprints and Flood Risk: Tracing the Becoming of What?

After several initial considerations regarding the type of flooding the scenario should include, as well as the detail to which it should specify the event, it has now been decided to include potential surface water flooding from a heavy rainfall event. This is not an idle technicality: in the wake of the 2007 floods, and particularly the ensuing Government review which called for 'a national overview of all flood risk, including surface water and groundwater flood risk, with immediate effect' (Pitt Review 2008, p.xii), it has become painstakingly clear that inland flood risk is not adequately understood simply by mapping out what happens when a river goes out of bank. Indeed, the ABI has made it one of its key reasons for prematurely reopening the Statement of Principles (the renegotiations being a main driver behind the development of the

'UK Flood' RDS), by stating that the Government strategy 'needs to incorporate the problems of surface-water, rising ground water and sewer flooding more fully into the policy-making process as the summer floods revealed both the size of this problem and that it has been woefully neglected to date' (ABI 2007, p.25). Two dimensional flood models, which might be able to address some of these problems relating to what happens outside the river channel itself, have only been on the market for a few years, and the ways in which they are being applied to different scales in combination with their one dimensional counterparts vary considerably. In this context, the modeling company I am visiting is promising to deliver the first nationwide UK flood map which takes surface water and rainfall runoff fully into account. Crucially, it is in this capacity that they have been entrusted with the footprint for the RDS. I return in depth to the practice of flood modelling in chapters 3 and 4, but a little introductory detail is needed here to get a sense of what I am doing in Yorkshire and what kind of transformative process I am trying to trace out.

Put very crudely, a one dimensional flood model operates by simulating the discharge of water at the top of a virtual river channel and then calculates the depth of the flow at a series of cross sections as the discharge moves downstream. This allows it to determine, at each cross section, whether or not the river has gone out of bank and estimate how far the inundation is likely to get. Two dimensional models, on the other hand, divide the entire floodplain into grid cells and allow the water to move in all four directions between these cells in accordance with the topography of the landscape. Instead of a vertical profile of the channel and its adjacent floodplain at each cross section, the grid cells are averaged out with a fixed elevation, and the water simply moves to the lower lying cells around it.



1.6 – Two dimensional versus one dimensional modelling. On the left the flood plain has been divided into a grid where each cell is has a fixed average elevation and the water can move in four directions to the lower lying cells around it. On the right, in the one dimensional model, a series of cross sections has been surveyed along the course of a river channel. Each cross section is build up as a slice of the channel and the adjacent floodplain, and as the water moves downstream the model calculates its height and velocity and each of them. Contrary to the two dimensional approach the spread of water across the floodplain is here extrapolated between the cross sections.

One way to combine these two species of flood models is to determine where the river goes out of bank one dimensionally (which is generally considered to be a good way of representing it), and then use a two dimensional model to find out how the flood water spreads across the floodplain. That approach allows the water to move more 'realistically' around structures, through breached defences or simply follow the terrain in more detail. What it does not allow, however, is an understanding of what happens before the water gets into the channel, which is exactly the problem with heavy rainfall: things flood when the drains overload, the soil saturates and the runoff moves towards the nearest watercourse. The modelling company I am visiting has come up with a solution to that problem by discharging water into every single 5x5m grid cell in the UK simultaneously and then modelling what happens as the flows converge on the lower lying parts of the terrain. My informant points to a colourful image on her screen while explaining to me what she is trying to do:

> ***[i23]*** *We are looking for where these structures remain in the DTM [Digital Terrain Model], because in the type of modelling we do, we apply rainfall to the DTM and we let it spread where ever it wants. If you were doing that in a [one dimensional] model you would have a cross sectioned surveyed channel, so you would actually have the shape of the channel within your model, put your bridges in and water would go through them. With this type of modelling, if your water comes to a structure it will stop because there's no way the water can get through if that structure is still in the DTM. So this is what we are looking for at the moment.*

Contrary to what happens in a one dimensional model where surveyed elevation data is used to create horizontal slices of landscape through which the river can flow, this kind of model applies the water directly onto what is essentially a topographic image of the flood plain. The modellers I am visiting have purchased these images from a remote sensing company as a combination of satellite data, which they will use for the bulk of the UK, and higher accuracy airborne LIDAR (LIght Detection And Ranging) data, which they will use for the 60 largest cities. Together these images make up the Digital Terrain Model (DTM) which is what my informant is currently working on. Remote sensing allows large areas to be surveyed from the air and turned into a DTM with relative ease, but there are downsides. Tree canopies and bridges will for example appear as solid blocks in the topography underneath which no water will be able to pass. Figure 1.7, which shows an example of a LIDAR image, demonstrates the problem: buildings and vegetation seem to constitute impenetrable barriers in the landscape but it is highly unlikely that they would actually stop a flood wave from coming through. Remote sensing companies therefore provide this kind of data in a form in which an algorithm has been used to remove buildings and vegetation. The technique, however, is not bullet proof, and together with eight other modellers my informant is going through the DTM manually to try and localise problems that the filters have missed. She does that by running the model using a so called cell multiplier which lowers the resolution significantly from the normal 5x5m grid cells. It enables a coarser but significantly quicker run which can produce preliminary ideas about where flow is allowed, and where it is not.

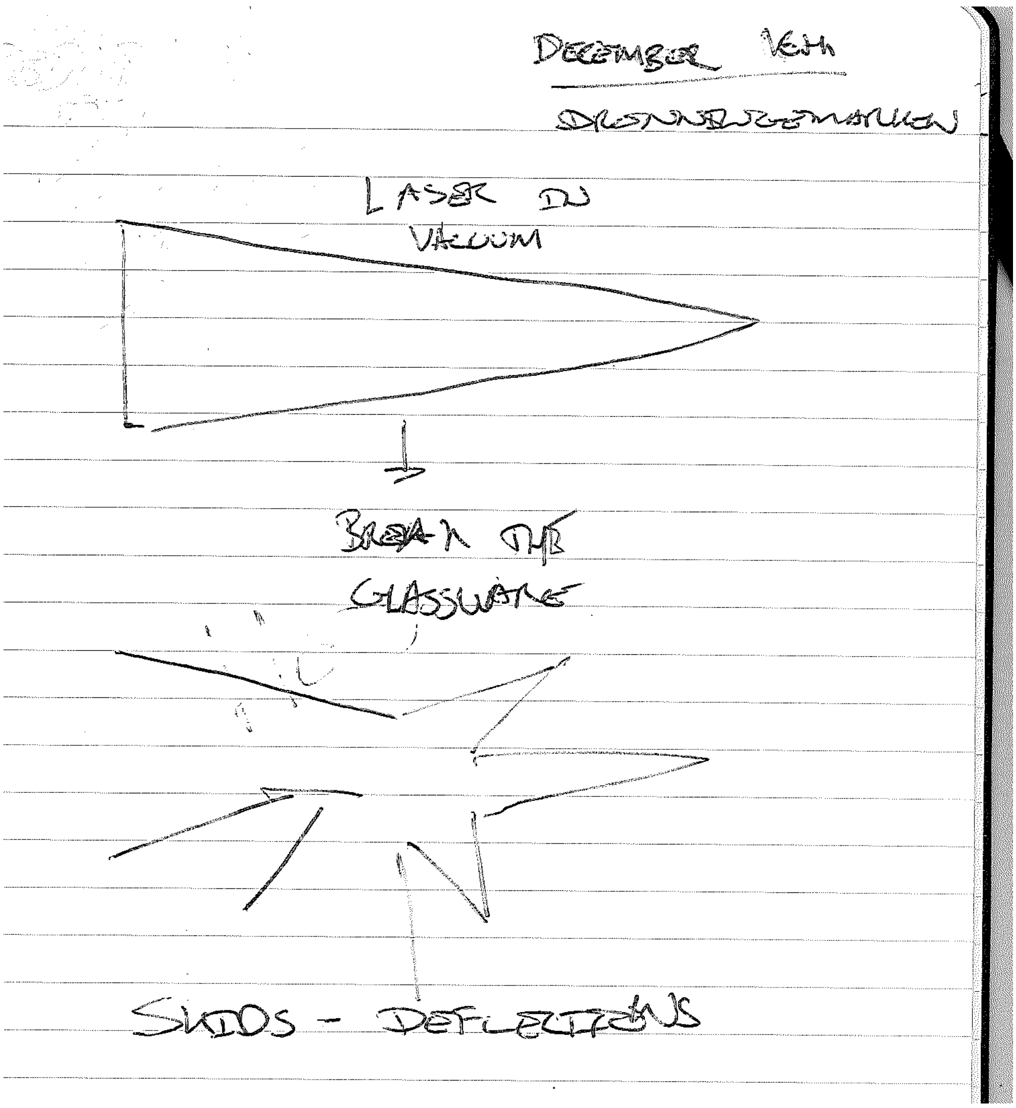
1.7 LIDAR image: buildings and vegetation appear as impenetrable barriers in the landscape.

While we are talking she locates a lacuna of water which has accumulated behind a railroad embankment right where a road is coming under it. Instead of flowing through the viaduct the water takes the long way around and crosses the railroad at a low point further down the line. My informant then manually cuts a digital wedge in the embankment where the road is coming through, allowing the water to pass. It may seem like a very simple operation, but it is these stepwise transformations which will eventually allow the footprint in figure 1.5 to claim that 'this could happen', that it is indeed a *Realistic* Disaster Scenario in a political climate ripe with talk of surface water, drainage issues and torrential rainstorms. The claim rests, among a host of other things, on my informant's ability to make water move 'realistically' between the cells of the DTM. And right now, that means modifying and manipulating the images taken directly of that landscape, although from altitude, into something which they could not have become on their own. The images are of course themselves reductive processes which claim resemblance to what they have fundamentally altered. They do so by successfully circulating reference through the loss of perspective sustained in digital signals returning from a laser point projected from high altitude onto the surface of the earth, and now further transformations are being added by the modellers. There is no *actual* gap in the embankment, there is only a tunnel; the terrain is not *actually* stripped of vegetation, but it has been made so to accommodate the virtual movement of water from grid cell to grid cell; and the grid cells themselves, the 5x5m resolution, is of course a simplification demanding of us that we accept a checked and sharp angled substitute for the gradual curvature of the actual terrain. Likewise, because every cell in the DTM starts with an inflow of water, a rain depth, the modellers have to enforce restrictions on what qualifies as 'flooding'. In principle the whole DTM is flooded right away, and it is decided that, in order to get a meaningful (i.e. 'realistic') output, cells with water levels below 0.3 metres (the depth at which emergency vehicles begin to have trouble getting through, and the depth which normally cause problems in most properties) will not be counted as being flooded. Also, there are technical difficulties involved in making this particular modelling strategy work. With inflow points in every grid cell the software is faced with an overwhelming number of calculations at once. Despite all increases in computing power, which is a precondition for most flood modelling activities in the first place, it still means that the DTM will have to be chopped up into 6x6 km grids which can then be modelled separately and subsequently pieced together by dint of a 500m buffer zone which overlap with the adjacent grid. These are modifications imposed in order to make the DTM commensurable with the modelling software, not to make it resemble the actual terrain 'outside'. Rainfall and its subsequent runoff does not restrict itself to 6x6 km squares, but the reduction in complexity serves the purpose of amplifying the presence of the footprint as a realistic event.

So what is my point? This is merely a limited account of some decisions made by a specific group of modellers whom I happened to interview at a particular point in time. It does not, for example, take into account the myriad reductions which have already gone into making the hydrodynamic equations in the software refer to 'real' water in all its complexity. Indeed, I shall try to do that in chapter 3 where I attempt to unpack what it means to become a hydraulic modeller, and chapter 4 where I mobilise the history of flood modelling in conversation with recent debates about the epistemological status of models and simulations (e.g. Galison 1996, Merz 1999, 2006, Morgan, Morrison 1999, Sismondo 1999, Winsberg 1999), but for now I simply want to make two observations: firstly, that the footprint in the Lloyd's RDS provided a starting point from which it actually became possible to trace things out. In principle I could have followed the aerial surveyors which provided the LIDAR images as well, or the loss modellers who provided the other half of the footprint by estimating the financial impact of the imagined floods. However, secondly, it is not really clear what I would then have been in the process of mapping out. Was I really asking 'what is flood risk'? Surely, the circulating reference diagram is a productive metaphor for thinking about the way in which a host of phenomena come to make assertive claims about reality, how they achieve factuality and compatibility; how the remote sensed images, the DTM, the flood model, the loss model, the footprint or the estimated losses all come to stand for the world. But can flood risk be pinpointed to any one of these phenomena? Even if I had gone to the trouble of following the trace through all these transformations, would I eventually have been able to show how flood risk is made?

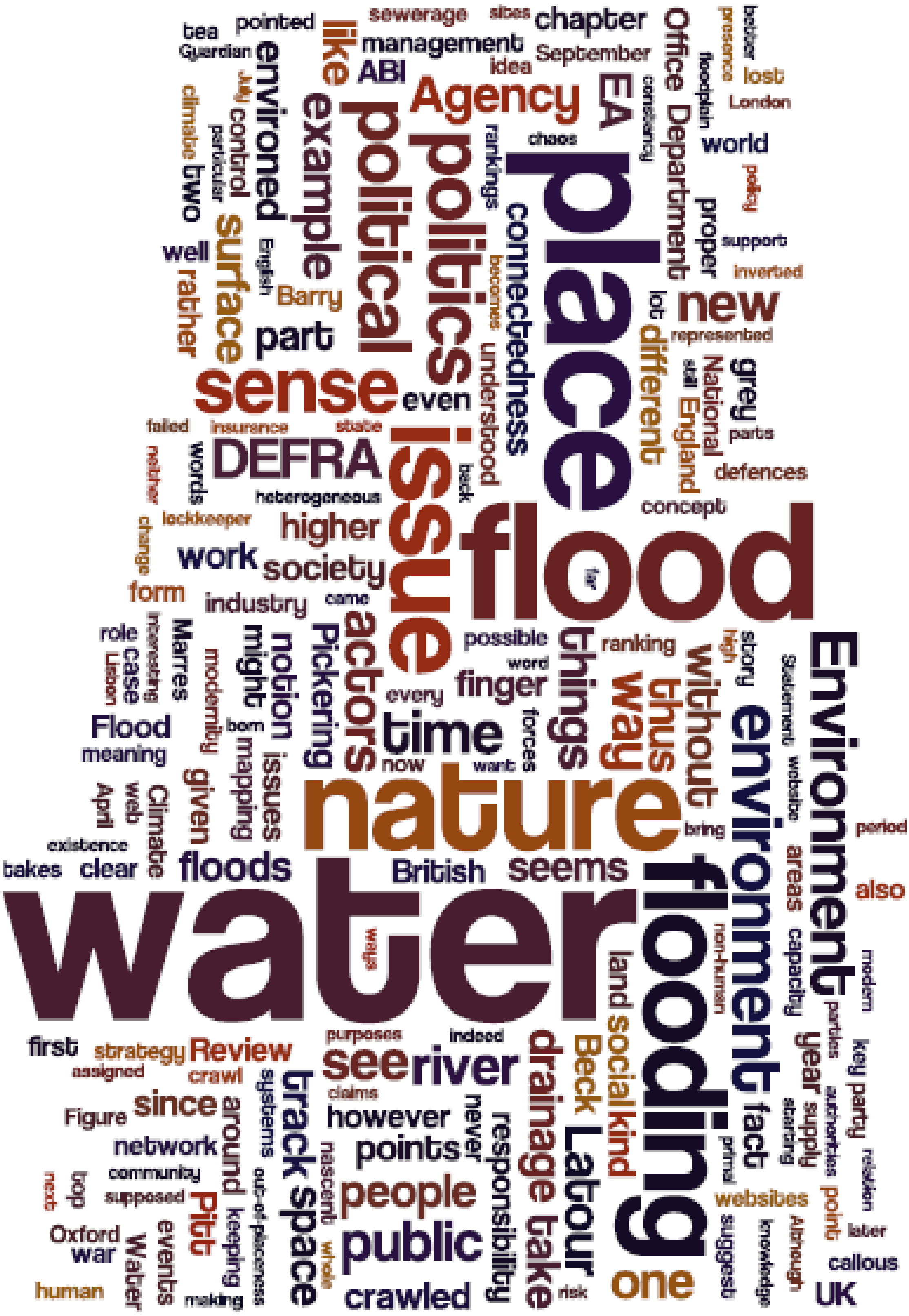
Despite all its qualities, the circulating reference diagram harbours an inbuilt incompatibility with the very stuff that gives risk its flavour: the peculiar cocktail of determinable fact and indeterminable futurity to which William James pointed our attention in the opening quote of this thesis. I only came to realise this gradually, and in many ways it was one of the most productive results of my work in the field, but the imagery I was mobilising with the circulating reference model left me intensely focussed on things which were determinably there, while ignoring the crucial lack of determinability that imbue eventualities with their open-endedness. In framing flood risk as a thing, an object of exchange, a claim to knowledge, I had effectively made whatever I was trying to understand impossible. The field which I was imagining seemed to be populated by realisations and thus somewhat ignorant of risk, which despite all its very real consequences must somehow remain profoundly unrealised. I was able to focus on things like the becoming of a flood footprint, it was possible to bring its socio-technical entanglements into view, but flood risk kept eluding me. In a way, that contradicts my experience of walking into the Lloyd's Room and observing flood risk being traded as a tangible object of exchange – and it is no doubt possible that an insurer would disagree with me that what I have just sketched out above is not the realisation of flood risk – but what I want to argue here is neither that things like estimated losses, fair prices, maps or probabilities are not brought successfully into being, nor that they do not constitute vital parts of the assemblage of the objects that insurers transact when they trade 'flood risk' (noun). My point is simply that equally vital parts of this assemblage are being missed.

Most insurance text books begin with a chapter on the concept of risk. Julia Holyoake and Bill Weipers' 'Insurance' (1999) is no exception. Within the first couple of pages they list a quite diverse usage of the word, including risk as a cause (such as theft, fire or personal injury); risk as the likelihood that something will happen; risk as the object deemed to be at risk (such as a house, a ship or a person); risk as a loss; and risk as the action of taking on a risk. As I noted in the introduction there is something illusively self referential about this last definition of risking as the action of putting something in a position, or taking something on, which *is already risky*. Contrary to floods and flooding, the noun comes very much before the verb here. The consequence is a concept pertaining to things which are already there, thus being of very limited use when it comes to working out how that possibility of that being is invented. In their strife not to settle for a single definition, Holyoake and Weipers allude to a common denominator: 'the underlying idea of uncertainty, what we have referred to as doubt about the future' (p.4). Is it safe to assume that this crucial component of any of the abovementioned usages of 'risk' is simply, and in an unproblematic way, there? I want to recall here Whitehead's (2004) notion of the event as the real element, the dance of molecules, prior any objects abstracted from that event; I want to follow James in trying to 'fall back on raw unverbalized life as more of a revealer' (1987, p.755) and re-imagine my field suspended in a broader set of 'networks of intelligence' (Thrift 2008, p.162) than the ones instructing techniques like remote sensing, simulation modelling or loss estimation. Figure 1.8 is taken from my field diary on December 16th 2007 and shows my own process of coming to terms with the way in which the circulating reference diagram invested my field with a specific ontology of the object, and the subsequent need to introduce a more eventful way of imagining that field.



1.8 Imagining the field: this page from my field diary is dated December 16th (2007) and shows my coming to terms with the inadequacy of the circulating reference model.

This idea of 'the field' is of course an ambiguous one and indeed one which I have just introduced precisely as a product of an imaginative process (Massey 2003). I want to hold on to that notion. In framing the questions driving this thesis I was also framing what I am now able to refer to as 'the field'. Indeed, the changing and provisional nature of my research design did not leave this field unchanged and the most important point to make about the imaginative process producing these delimited domains has to my mind been made above. When knowledge is understood to be a process which enacts what is being known in different ways, it must necessarily include what I am trying to achieve here: this project should be considered as *part of*, rather than *apart from* the 'ontological politics' (Law 2004, Mol 1999) of bringing different assemblages into being. Methodology seems to imply separation rather than symmetry in this context; a preemptive specification of the kind of work suited to retrieve data from what is in advance known and recognized as 'the field'. I have not been able to locate such a treasure trove into which I could venture to retrieve answers for my questions. On the contrary, the field was the product of my questions, just as much as my questions came about in the field. I do not want to suggest that the poor fit between the notion of methodology and the ontological premise of becoming makes the specifics of what is produced as 'the field' irrelevant. On the contrary, the loss of a detached position at safe distance from this situation (both in time and in space) accords these specifics a far more central role as co-producers of the researcher-researched constellation rather than practical obstacles to be navigated by the researcher gathering information about what is to be researched. When James Clifford writes about the ethnographic enterprise that 'getting away lets uncontrollable, unexpected things happen'(1997, p.91), these co-produced alterations of what is 'field' and what is 'work' are very much part of the surprise. As I became interested in the broader question of what it might mean to be risking the flood, I also found myself engaged with new field sites. The next chapter is a direct result of these new engagements.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2. Water Out of Place

Towards a Political Ecology of Flood Risk

> *Floods take the world back to disorder, to primal chaos, to time zero, right back to nature, in the sense of things about to be born, in a nascent state. (Serres 1995, p.51)*

Iffley, February 2007: I had only been in Oxford for a few weeks when I experienced flooding for the first time. Or so I thought. 'Is is it a flood?' I anxiously asked the Environment Agency's lockkeeper as I came down to find the fields next to the river inundated. It was not a flood. Those fields, he laconically pointed out to me, were where the water was supposed to go. I was clearly not the first worried member of the public to ask. The lockkeeper, however, was on top of things. He had a plan. And the undesirable alternative to that plan would have been to flood the populated areas upstream. Quite: half a year later, in July 2007, as rainfall in the Cotswolds exceeded the monthly average by a factor of four, the Environment Agency lost control. Tributaries overloaded and drainage systems collapsed leaving 48,000 households across England and Wales under water. Oxfordshire was among the worst hit areas and while the trade in Wellington boots and windscreen wipers boomed, people evacuated their swamped properties, filed their insurance claims and tried to organize life around cancelled trains, blocked roads, power cuts and the plethora of derived obstructions. The water not only came from the rivers (fluvial flooding), but directly over land (pluvial flooding) and indeed bubbling up through the floorboards of homes and businesses. It was the wettest summer on record (which began in 1766) causing the most severe loss of services in Britain since World War II and some of the biggest peacetime rescue operations ever to be undertaken. 10,000 people spent the night in their stranded cars on the M5 while 350,000 were left without water supply for two weeks after a treatment plant in Tewkesbury succumbed to the deluge. 13 people lost their lives (Pitt Review 2008). In this chapter I jeopardize the orderly notions of environed and environment and try to bring out the patent eventfulness and surprise, the capacity for destructive creation, which lies at the heart of flooding.

Dislocating the environment

What could distinguish the two watery occurrences outlined above from one another? According to the Oxford English Dictionary a flood is an 'overflowing or irruption of a great body of water over land not usually submerged'. But that does not seem to cut it here. Besides significant differences in severity and scale, the one event is no more a case of land unusually submerged than the other. On what grounds then might the lockkeeper be right to refuse the admission of his inundated fields into the category of 'flooding'? One possible answer materializes around agency and control: in the case of mere overflowing, the environment is kept on its leash (behaving as supposed) by whoever, or whatever, it environs (I will tentatively refer to this community as 'the environed'). That scenario makes meaningful the idea of an Environment Agency as an actor which projects its will onto, and exerts some sort of control over, the surrounding natural world. In the case of flooding proper, however, the tables have turned as the environed now submit to the agency of the environment, which is something quite different than its governmental near-namesake (the EA). Yet, besides adding some interesting subtlety to the concept of environmental agencies, such a distinction is problematic. This is not so because of the way the presumably non-human cast of the environment is entrusted with the capacity to act; on the contrary, it is so because it is thoroughly unclear who (or what) is in fact environing who (or what).

During my time as a doctoral student I have passed along the river in Oxford almost daily, a well groomed stretch of the Thames where longboat moorings cut cleanly into the water, and a tract of landscape in which nature seems only feet away from society. The path next to the channel is a remarkable achievement of British industrialisation, constructed for men and horses towing barges between the docks in London, and cities like Reading and Oxford, or the wool farms and quarries further upstream. Right next to it, on both sides, is a riparian environment teeming with wildlife and potent forces of nature. As a symbiotic pair the river and its floodplain precede the meandering line of society wedged between them and transgress it at will when control is lost. Here, tête-à-tête, are the environment and the environed observing a fragile truce. Or are they? Is this really a confrontation between two radically different, and readily locatable, modes of existence (that of nature, primordial and reified, and that of culture, wilful and responsible)? No doubt that such a monomaniac spatiality would be presumed by attempts to define flooding as a loss of human control over nature, but is it credible? At closer inspection the keenly demarcative riverbank reveals itself as an ongoing effort requiring maintenance and reconstructive work. Remains of abandoned moorings loom at low water; unkempt vegetation branch out into the cloudy stream or shoot from invisible points beneath the surface; sandbags and barriers tell the story of subsidence and erosion. The adjacent floodplain comprises reserved nature as well as arable land, sports grounds, residential areas, rowing clubs and a rubbish dump. The river itself, long since tamed by a system of locks to provide navigable water for the barges, supports a broad range of pleasure boating activities and is sought out for its fish by anglers and herons alike. It is at once a historical piece of infrastructure, a racecourse for rowers, a recreational oasis and a part of the natural environment. Where, then, is the fissure through which nature came trespassing into the province of society in July 2007? Can it be located?

What is at stake is the 'bicameral collective' which Bruno Latour proposes to dismantle by doing for 'nature' what feminism did for 'man': 'wipe out the ancient self-evidence with which it was taken a bit too hastily as if it were all there is' (2004, p.49). As comparative anthropology will attest, there is nothing 'natural' (in the pristine and non-cultural sense of the word) about the concept of nature. Circumpolar tribes like the Ojibwa, for example, see no absurdity in maintaining family relations with other-than-human grandfathers (Ingold 2000), the horticultural Ajuar of the Amazon basin consider the primordial forest around them to be the cultivated gardens of a bigger people (Descola 1994), and many Melanesian societies get by without the concept of nature all together (Strathern 1992). Neither in the West, a.k.a. the 'North Atlantic rim societies' (Macnaghten, Urry 1998, p.4), can nature claim an untouched constancy. While the naturalist collectors of early modern Europe mirrored their undertaking in a wondrous and sometimes monstrous world of strange occurrences and otherworldly beings (Daston, Park 1998), it was only with the later arch-modern conception of 'society' that this autonomy was exacted from a type of 'nature' in which the non-humans newly exiled from the emergent social realm could be referred to a disentangled existence as mute objects and exogenous forces (see for example Latour 1999, 1991, 2004, 2005b). Here, in this particular instance of history, nature took on the role of 'the environment', the only position from which an acclaimed precedence can really make sense, and did so, according to Marilyn Strathern, with the very clear purpose of creating a context of its own from which to work 'as a kind of grounding conceptualization of knowledge, for understanding the intrinsic character ('nature') of anything' (1992, p.194). It is exceedingly difficult to locate a fissure between these crumbling autonomies and it seems that flooding deserves a definition which does not rely on their clear, and thus breachable, demarcation.

Regardless of how we may talk or write about a clearly distinguishable 'out there', there is not a lot to suggest that such a distinction is being rigorously *practiced* along the North Atlantic rim today. Our relationship with non-human creatures, for instance, is far from the mute and objective affair that such a demarcation would elicit. We too endow certain animals with personality or stage them as reflective others in our own subjective formations (Ingold 2000), we have even conceived the notion of 'speciesism' with its entourage of political agendas like oppression and liberation (Cudworth 2003). Indeed it is possible, at least to a degree, to construe our scientific interest in non-human species as being ultimately an interest in ourselves (see for example the papers and debates on primatology collected in Strum, Fedigan 2000), and it is thus not only in practice that the apartheid of the bicameral collective is being challenged, but in a proliferate new discourse on nature aimed at repatriating on the inside of society the non-human Diaspora exiled under the tutelage of modernity (several authors actively promotes this agenda, see for example Latour 2004, 2005a, 2006, Whatmore 2002, Hinchliffe 2007). These new symmetries are perhaps nowhere articulated with the same poignancy and transgressive oomph as in the work of the human-animal hybrid which is Californian feminist Donna Haraway and her dog Ms Cayenne Pepper:

> *We have had forbidden conversation; we have had oral intercourse; we are bound in telling story on story with nothing but the facts. We are training each other in acts of communication we barely understand. We are, constitutively, companion species. We make each other up, in the flesh. (Haraway 2008, p.16)*

Now it would probably be a metaphorical stretch to suggest that flooding is a form of oral intercourse between environed and environment, but it is tempting to try and construe it as the kind of making-each-other-up to which Haraway attributes the very material assemblage of woman and dog (for another compelling example of co-creative animal human relations see Despret 2004). The notion of environed and environment as constitutive companions rather than pre-given constituents is a potent one. It opens up new possibilities and promises to realign nature with its etymological origins, in Michel Serres' sense of a nascent state of 'things about to be born'. How is this?

Making each other up

A year after the floods, on June 27th 2008, the Malton Mercury reported that three people (one of them aged 91) were having tea on a couch in Pickering Beck (North Yorkshire). They did so 'to bring home the point that people [in Pickering] are living on a knife edge because of the Government's failure to protect homes'. If the happening was out of the ordinary, then the message was certainly not: flooding is some*body*'s responsibility. It is not just a simple case of victimized humans and felonious rivers, but an implication of a far more composite set of actors (I shall return to the cast later in this chapter). As a caricature, however, and perhaps inadvertently, the tea party in Pickering Beck immediately prompts questions about the catalyzing forces driving this broader implication. Was the malice lurking in the river prior to the potted plant and the furniture? What sense would notions like (neglected) 'responsibility' or (lost) 'control' have made without a patch of wet firmly in sight?

2.1 – Tea party in Pickering Beck.

Following the catastrophic earthquake, fire and flood which levelled Lisbon to the ground in 1755 and sent shockwaves of horror and disbelief through Europe, Rousseau wrote a letter to Voltaire in which he contended that a disaster caused by humans (!) could and should have been avoided by them. Had the people of the city only had the wits to build lighter and at lower density, had they realized the danger of returning to the rubble for their material belongings, the forces launched upon them by an indifferent nature might not have had such a severe impact. At Lisbon, argues Susan Neiman (2002), nature was exiled to its callous and detached modern form as philosophy stripped natural disasters of godly intent and any relation to moral evil traditionally ascribed to them by theodicy. Embodied in Rousseau's letter is the notion that humanity, now distinguished from blind nature by its (monopolistic) intentionality and capacity for meaning, would eventually be able to control and mitigate the exogenous perils launched upon it by indifferent and, thus, calculable forces. The tea party in Pickering Beck at once reiterates this ambition and lays bare its paradox: the finger points at society, with implicit reference to the callous disinterestedness of nature, rendering impossible any speculation as to why a finger must be pointed in the first place, with reference to the same callous disinterestedness. Nature might be the cause, but it cannot be held responsible. The interesting question is really how these roles are assigned, how the distinction between nature and society takes place, and in the theatrical spectacle in Pickering Beck it does exactly that; it takes place. The tea party is in the river to demonstrate what happens when humans do not heed their responsibility and keep the water out. However, by moving into the river it seems to dramatize instead the key reason why there was ever an 'in' and an 'out' to keep and a responsibility to be heeded.

Humans have quite a track record for seeking out and exploiting the civilizing proximity of water. The mounds of discarded oyster shells and periwinkles left by the Mesolithic hunter-gatherers as they slowly settled down along the coast of Northern Europe attest to that; so do the rice grains buried in the silt covered banks of the Yangtze 10,000 years ago; and so do a range of other archaeological finds preceding the classical examples of floodplain civilization in Egypt and Mesopotamia (Mithen 2003). The furniture – and here I mean not only potted plants and sofas but the diverse set of materials furnishing society – has for a very long time been moved if not into the river itself, then at least very close to it. So close, in fact, that the

Environment Agency estimates 5 million people in England and Wales to be the potential victims of future flood events[14] and almost 5,000 infrastructure sites, including schools, power stations, sewage treatment plants, and health care facilities, to have a significant annual probability of 1.3% or higher of being flooded (ABI 2007). That seems to warrant that the finger is pointed at what is deemed 'human' or 'social' with even more incriminating insistence, which is indeed often the case, but it only serves to further the entrenchment of the bicameral demarcation I am trying to evade. By mobilizing co-creative notions like Haraway's fleshly making-each-other-up I want to suggest that floods are part of the reason why a finger can be pointed at particular formations of the environment and the environed at all. Probing our ideas about wilderness and wildlife Sarah Whatmore asserts that such concepts are best understood performatively 'as a relational and fluid achievement' which 'render the experience of radical difference delineating the human from the animal, the civilized from the wild, as a con-figuring (...) rather than a holding apart' (Whatmore 2002, p.17). Flood events, I contend, can be fruitfully understood as key constitutive moments in the con-figuring of the environed and the environment which then become, in every meaning of the word, fluid achievements. To further substantiate that contention I return below to the opening examples of this chapter to ask once more how they might be distinguished?

Flooding as water out of place

The argument advanced by the lockkeeper about the water complying as supposed is still of key importance albeit for different reasons. If flooding proper is to be associated with a

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[14] http://www.environment-agency.gov.uk/homeandleisure/floods/ 25.09.2009

nascent state in which things are about to be born, it must first and foremost be framed as capable of summoning what Serres refers to as 'primal chaos': a situation in which things are no longer their old selves; a situation in which they do not align with presupposition. From a perspective within the conceptual world of humanistic geography such a framing can be constructed in relation to place, and in particular the sense of being out of it, since things which are not 'in place' cannot truly be themselves (Cresswell 1996). Place came to be distinguished from mere location as a phenomenological frame for human life, a sedentary notion thick with meaning and available through experience (see for example Relph 1976, Tuan 1977). In present discourse place retains this conceptual thickness, but a newfound focus on mobility, migration and globality precludes it from being exclusively locally bounded (see for example Massey 1993, 1994, 1997). Whether prompted through the movement of hikers (Lorimer, Lund 2008), tuna (Bestor 2003), sheep (Gray 2003), money (Thrift 1996), or papayas (Cook 2004), places are understood to be practiced, lived at first hand, a notion resonating Michel de Certeau's intimate urban encounters as he walks the streets deep down below the panoptic gaze of Manhattan's skyscrapers (Certeau 1984). This conceptual versatility is much needed when sorting out the ins and outs of place in a landscape interlaced by flows. A river is of course never in place in the sedentary sense, neither is the traffic of boats and barges traversing it or the strollers trailing its path, but it is nonetheless a place – a place thickened with meaning by, and experienced through, its conveyance and transitoriness (the same goes for many of its adjacent and seemingly locally bounded places: through the downstream migration of stone, for example, the Cotswold quarries connote St. Paul's Cathedral in London and vice versa; through the occasional inundation of designated sections of floodplain Oxford acquires its green layout and reserved patches of 'nature'). This enables an understanding of un-flooded riverine topographies as being entirely 'in place' despite their flux and changeability. There is no lacuna of out-of-placeness residing some*where* waiting to trespass into whatever is in place next to it. Even the flow of water, thoroughly regulated and colonized by locks, riparian rights, water framework directives, drainage boards, and environment agencies, displays the territorial stability associated with place (although these neat appropriations of the river are of course effects of more messy and contradictory practices (Blomley 2008)). How then to construct an outside to this all-inclusive placeness from which flooding proper can derive its meaning?

The notion of territoriality is central. Though the character of the relationship is subject to debate, territorializing processes seem inextricably linked to placeness (see for example Storey 2001, Delaney 2005). For the purposes of this chapter I want to adopt the broad definition of territoriality offered by Gilles Deleuze and Félix Guattari in the form of 'striated space' (1987, ch.12). For Deleuze and Guattari, striation is the work of a State apparatus (abstractly understood as sovereignty) which relates territory to an arborescent sense of self-rooted 'being' in compliance with an intrinsic structure. Striated space, in other words, involves the keeping of things 'in place', appropriated and disciplined like the armies on a chess board. Opposing, or rather infiltrating, and thus incubating this arborescence is a 'smooth space', the unbounded rhizomatic domain of a rambling war machine characterized only by its 'fundamental indiscipline (...), a questioning of hierarchy, perpetual blackmail by abandonment or betrayal, and a very volatile sense of honor' (p.395). It is the metaphorical equivalent of the Go game and its 'nonsubjectified' pieces with purely situational and exterior properties (originating in ancient China, Go has a very simple and non-specific layout consisting intersecting lines on which two players place identical and static black or white stones, but a strategically challenging and unpredictable game play in which the opponents attempt to capture each others' stones by surrounding them):

> *Chess is indeed a war, but an institutionalized, regulated, coded war, with a front, a rear, battles. But what is proper to Go is war without battle lines, with neither confrontation nor retreat, without battles even: pure strategy, whereas Chess is semiology. (Deleuze, Guattari 1987, p.389)*

In this sense, my first encounter with water overflowing 'land not usually submerged', the inundations at Iffley Lock, was a chess-like spectacle in which rules of engagement were observed. *Although out of its channel, the river was not out of character*. It was dis*located* without being dis*placed*. Flooding proper, however, the stuff of July 2007, bears more resemblance to the war machine: a dissolvent flow observing no demarcation and honouring no allegiance. Binaries like nature/society, dry/wet, saline/fresh, gilled/lunged, cultivated/wild, clean/contaminated, insured/uninsured provided no obstacle and were wholly disregarded. In a territorially complete topography where even fluids are expected to comply as supposed, that kind of smoothening liquidity constitutes a form of banditry, a betrayal of supposition from which a profound sense of out-of-placeness profuse. And yet, the coup d'état does not materialize, the war machine is neither enemy invasion nor organized rebellion, there are no battle lines, there will be no takeover and there can be no surrender. Smooth space does not rival striation, at most it temporarily resets it; but it can never take its place. In fact, its logic is incommensurable with place. *It does not take place*. What it does, rather, is 'to take the world back to disorder, to primal chaos, to time zero, right back to nature, in the sense of things about to be born' (Serres 1995, p.51). Flooding is in this sense a profound case of water out of place: it dissolves existing constitutions and instigates new ones, but it is itself thoroughly unconstitutional. It does not comply with supposition. In this respect flooding (as water out of place) has a lot in common with the creative concept of risking I am trying to craft. But the link is not only metaphorical. In fact, deprived of its status as extraneous hazard and reinvented as a co-producer of the techno-political alloy, flooding and its characteristic non-compliance must now be counted as an integral part of what it means to be risking the flood. Anything else would be to reiterate the modern paradox swishing about the furniture in Pickering Beck; it can never simply be the object of other actions.

Towards a political ecology of flood risk

> *At the end of a long journey of (unintended) discovery undertaken in the hope that it would place humanity at a safe distance from cruel, since unfeeling and callous, nature, humanity found itself facing human-made evils every bit as cruel, unfeeling, callous, random and impossible to anticipate (let alone to nip in the bud) as were the Lisbon earthquake, fire and high tide. (Bauman 2006, p.63)*
>
> *Politics does not fall neatly on one side of a divide and nature on the other. From the time the term 'politics' was invented, every type of politics has been defined by its relation to nature, whose every feature, property, and function depends on the polemical will to limit, reform , establish, short-circuit, or enlighten public life. (Latour 2004, p.1)*

250 years after the events in Lisbon, floods are no less heterogeneous or complicated than they were then. Although an ever expanding body of knowledge on their mitigation and prevention is available to us, floods continue to evade the human-nature divide imposed upon them. Where to point the finger? At the incoming waters? At the political neglect? 'In the

Netherlands,' writes Wiebe Bijker, 'politics is water, and water is politics' (2005, p.512). As the water started receding on the 30th of July 2007, a commentary in the Guardian reviewed the emergency as it unfolded in the pages of the press:

> *"What went wrong?" asked the Times and the Guardian last week. "It rained a lot" was not the answer they were looking for (...) Such events are traditionally described as acts of God but, despite the efforts of the Bishop of Carlisle, the press has written the deity out of the script. "Whose finger is on the nuclear button?" the papers used to ask. Now they want to know whose finger is in the dyke - or, rather, who's taken their finger out. The policy issues rose in unison with the waters. "Gordon Brown was under pressure last night," declared the Sunday Telegraph, hopefully. Ministers had been warned in advance, yet flood barriers (which could have saved all of 30 houses) had been held up on the motorway. "Where were the emergency preparations to clear ditches and drains? Where were the sandbags and pumps?" demanded the Mail. "Why are electricity sub-stations and waterworks not being protected?" the Mirror wished to know. "Why doesn't the Severn have diversion channels and water storage areas?" asked Ross Clark, more technically, in the London Evening Standard. All papers wondered why people were living on flood plains, a question which, unfortunately, the Romans weren't around to answer. (The Guardian, 30.07.2007)*

Just like the tea party in Pickering Beck the fingers are pointed away from disinterested nature, the rains might have been the cause but they could not be made to take the blame. Wherever water gets out of place there is someone responsible for not keeping it in there (since, conversely, the logic of being in place implies that a place has been accorded and a responsibility assigned). From September 2008 to April 2009 I tracked the web presence of the UK flood issue as it formed around three different sets of entry points online. The idea was to compare the issue from the perspective of policymakers, insurers and NGOs respectively. The tracking was carried out every second week using a web crawler to determine the network structure between interlinked websites[15]. It provided a preliminary idea about the kind of

[15] This process is known as co-link analysis .

actors implicated by the issue, their relative importance and the way they relate to one another. Performing the track regularly over time also provided an opportunity to observe changes in this composition. Figure 2.2 maps out the top 50 nodes in a network which was crawled from the website of the National Flood Forum (NGO track) on January 7th 2008.

2.2 Issue map cropped from the pages of the National Flood Forum using IssueCrawler (07.01.2008). Top 50 nodes displayed.

I started the NGO track from the pages of the National Flood Forum because it has a very concrete and immediate stake in the flood issue. As a charity with a network of almost 250 local flood groups, it was conceived and created by flood victims to provide advice and support for other flood victims and people at risk of becoming so. Apart from the forum's own website, it is thus not surprising to find public bodies with a direct responsibility for flooding represented as part of the issue. These include the UK Parliament, the Department for Environment, Food, and Rural Affairs (DEFRA), the Scottish Government, the Environment Agency (EA), the Scottish Environment Protection Agency (SEPA), local communities, the Met Office, and the Government's UK Resilience and Preparing for Emergencies information sites. Be it through warning, mitigation or protection these are actors tasked with making sure that water stays in place. But they are not the only ones implicated by such a displacement, should it materialize. If figure 2.2 tells the story of anything it is of an issue extending far beyond failed defences, overloaded drains and the immediate nuisance of swamped properties. On this day in January 2008 the list of implicated parties also comprised the Ministry of Defence (MOD), the Ministry of Justice, the Treasury, the Courts, the Department for Children, Schools and Families (DCSF), the Department for Work and Pensions (DWP), the Information Commissioner's Office (ICO), the regulator for the water and sewerage industry in England and Wales (OFWAT), the Department for Business, Innovation and Skills (BIS), the Association of British Insurers, the Home Office, the Office of Public Sector Information (OPSI), the UK National Statistics, the National Audit Office (NAO), the Department for Culture, Media and Sport (DCMS), the Security Service (MI5), the Parliamentary and Health Service Ombudsman, the Department for Transport (DFT), Natural England, the Forestry Commission, English Nature, the Energy Saving Trust, English Heritage, the Climate Challenge Fund, the Department of Energy and Climate Change (DECC), the Highways Agency, various government news sites and the Guardian. Together, these actors articulate the fact that flooding is also damp classrooms, delayed curricula and the labour lost when parents have to look after their children at home; that it is financial markets coping with unexpected losses and reviewing forecasted futures which can no longer be trusted; that it is protected and preserved natures overwhelmed by less protective and preserving natures; that it is sewage on the skin and in the drinking water; that it is an opportunity to commit crime and cause havoc; that it is the way houses are built and the way land is used; that it is a media event; and that it is, in all these ways, *political* in the broad sense of the word proposed by Andrew Barry when (building on the work of Giorgio Agamben (1993)) he sets 'the political' apart from 'politics' in its assorted forms:

> *At various historical moments, trade unions, feminists and environmentalists have all sought to broaden the institutional and discursive space of what we call politics. But if politics is a way of coding a historically variable cluster of practices, then the political can, following Agamben, be understood as a space of dissensus and contestation which is not reducible to politics. Indeed, one of the key functions of established political institutions has always been to place limits on the possibilities for dissensus and restrictions on the sites in which political contestation can occur. (Barry 2001, p.207)*

In relation to the extensive out-of-placeness of flooding, it seems fruitful to explore the proposition that dissensus and contestation precondition politics without being reducible to it. Both are disorderly notions which resonate with multiplicity and the facilitating role ascribed to them contrive the public as something unmistakeably nascent: 'that which is political,' writes Barry, 'is that which opens the space of politics' (p.7). Indeed, flooding seems to open up that space, but, in playing such a pivotal democratic role, its out-of-placeness is paradoxically exacerbated. As Latour points out, one of the relentless questions of modernity takes the form: 'how to replace the dangerous trade of politics by the serious and safe knowledge of some better established science?' (Latour 2005a, p.37). And even though attempts to do so are doomed to fail since there is no transparent or complete way of representing the dissensuous realm of the political (at least not without 're-presenting' it (Latour's wordplay) in less dissensuous formats), the strive for incontestable solutions is still the predominant credo of political thinking. Politics is in other words committed to a quest against its own possibility (this is what Barry calls the prohibiting 'scientisation of political decision making' (Barry 2001, p.80)) leaving it plain but absurdly clear that flooding, in spite of its chaotic ability to open up the space of politics, can, neither in this sense, be considered as being 'in place'. What it does do, however, is to offer a perspective on the way in which floods come to be key moments in the con-figuring of environ*ed* and environ*ment*. By resuscitating the Lipmann-Dewey debate on the 'phantom public' (Lippmann 1922, Dewey 1927) Noortje Marres contends that 'democratic politics is called for when no social community exists to take care of an issue' (Marres 2005, p.214). She thereby reverses conventional political logic by claiming that the formation of complex issues is not the discursive work of pre-existing publics, but materially composite and heterogeneous assemblages of parts concerned, what Michel Callon calls 'hybrid forums' (Callon, Lascoumes et al. 2009), through which publics are called into being (see also Marres 2007). In upsetting territorial stabilities and refusing to conform, flooding becomes unavoidably implicating. To be out of place precludes the idea of having a community assigned for care and attention – flooding, on the contrary, leaves that kind of constellations with failed missions of keeping things in place and provokes new ones to form.

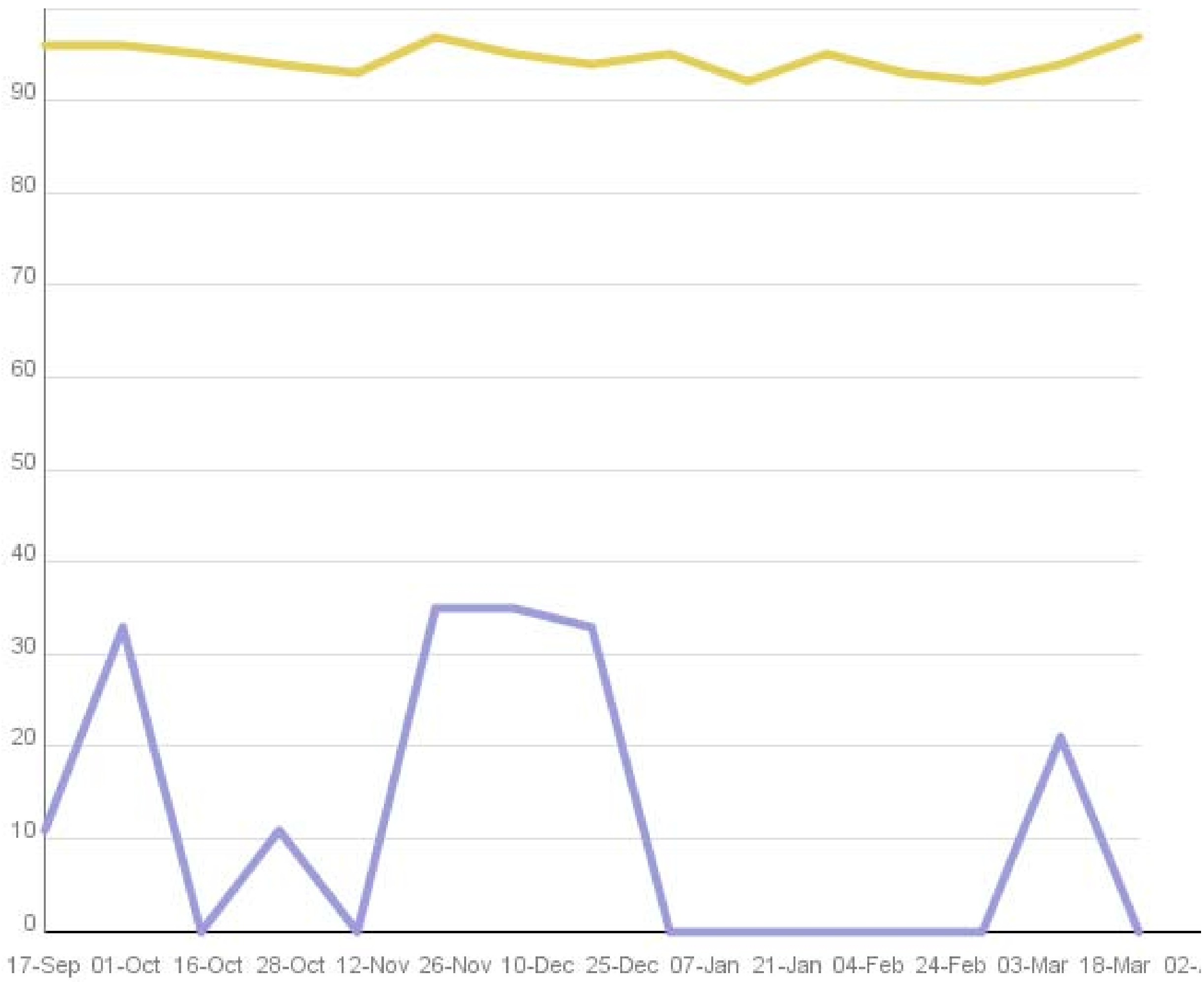
This reversed notion of the public reverberates a recent orientation in Actor-Network studies towards 'the social' (see especially Latour 2005b) and the ensuing quest to vindicate

Gabriel Tarde's monadic sociology (Latour 2002, Toews 2003, Barry, Thrift 2007). Instead of mobilising the social as a higher order being, the classic Durkhemian organic analogy in which the social group is understood to be more than the sum of its parts and thus takes on sui generis existence, focus is on collectives and assemblies, which are, as their names suggest, brought into being by the coming together of constituent parts. The notion of an organic whole looses explanatory power and becomes instead what is to be explained. In 2005 a report from the Benfield Hazard Research Centre listed social justice, flood hazard, disaster readiness, future outlook, regulatory authorities, London, sewage and drainage, health, flood mapping, small businesses, climate change, flood defences, flood warning and dissemination, lack of preparation, flash floods, landslides, rising groundwater, insurance claims handling, flood claims excesses, buildings regulations, dams and reservoirs, canals and waterways, the Water Framework Directive, the Office of the Deputy Prime Minister (ODPM) versus DEFRA, priorities, and participation as composite problems to be targeted in managing the English flood issue (Crichton 2005). That kind of complexity is not endowed with the holistic promise of an overarching logic to which a scientised politics can aspire. In mapping the highly complex issue forming around the license renewal of a power station on the river Isar near Munich, Kordula Kropp notes that 'the arguments and evidence advanced to support the highly divergent claims and demands (...) were unable to cite any shared evaluative vocabulary or authoritative ultimate criteria for evaluating ecological systems (2005, p.489). Dissensus prevails and although 'the modern *agora* has been moulded and shaped by the Enlightenment' (Nowotny, Scott et al. 2001, p.204) there is no assurance that more or better knowledge will eventually turn dis- into con-sensus. This is precisely the kind of issue to which no one community can be appointed: since it is deprived of meaningful higher order laws, since it has no sui generis existence, there is nothing (literally: no thing) for a group to identify or be tasked with. It is the difference between romantic and baroque complexity, the latter refraining from the abstractions that allow the former to integrate what 'appear to be a heterogeneous lot at the phenomenological level to a single entity at a higher level of organization' (Kwa 2002, p.25).

It seems plausible to suggest that flood issues are complex in the baroque sense of the word: their assemblage is possible not as a function of a whole but in the absence of a whole. Their formation presupposes the dislodgement of things from their place. That kind of complexity is at pains with finding room in the Enlightenment version of the public, making Marres' inversion of the concept attractive as a way of reimagining flood issues as dissensuous instigators of democratic politics, instead of well defined problems with equally well defined communities assigned to the pursuit of their solution. In the words of Latour, this lack of predefinition calls for 'dingpolitik':

> *It's clear that each object – each issue – generates a different pattern of emotions and disruptions, of disagreements and agreements. There might be no continuity, no coherence in our opinions, but there is a hidden continuity and a hidden coherence in what we are attached to. Each object gathers around itself a different assembly of relevant parties. Each object may also offer new ways of achieving closure without having to agree on much else. In other words, objects – taken as so many issues – bind all of us in ways that map out a public space profoundly different from what is usually recognized under the label of 'the political'. (Latour 2005a, p.15)*

Web crawled issue maps like the one shown in figure 2.2 were developed as a way of mapping this formative process (see for example Marres 2004, Marres, Rogers 2005). Although disadvantaged by their exclusion of actors without e-presence, they force some symmetry into the account: relevant parties are mapped out purely on the basis of their attachment to the issue in question, not their allegiance to particular communities or their common goods and goals. Issue mapping is in other words a way of extending the account to all things political (within the restrictions imposed by the web format) rather than limiting it to politics. Using the data from the web crawls I did between September 2008 and April 2009 it is possible to explore the changing constitution of the UK flood issue as it unfolds over time. Figure 2.3, 2.4 and 2.5 are all derived from the crawls in the policy track which had starting points on the flood related web-pages of the Environment Agency and DEFRA websites. Based on the ranking of actors over time (their relative attachment to the network) these figures visualise the transforming makeup of the issue (for the purpose of visualisation I have inverted the rankings so that higher numbers reflect better connectedness).



2.3 Ranking of the ABI (blue) and the EA (light brown) over time between September 2008 and April 2009 in the networks crawled from the DEFRA and EA websites. For visualisation purposes the rankings have been inverted so that a higher value on the y-axis represents a stronger connectedness. There were never more than 100 actors represented in any given crawl which makes values above 90 a definite indicator of a top 10 connectedness.

Figure 2.3 shows how the Environment Agency remained very well connected with a high level of constancy while the presence of the Association of British Insurers was considerably weaker and more fluctuating. It is of course possible to speculate that the starting points of the crawl will automatically take centre stage and that their high ranking would thus reflect a methodological bias. Indeed, DEFRA appears equally constant and even slightly stronger connected than the Environment Agency in the policy track (DEFRA and the EA being the two starting points here). However, results in the NGO track (crawled from the website of the National Flood Forum) and the insurance track (crawled from the website of the Association of British Insurers) do not support this conclusion since both DEFRA and the Environment Agency have the same high-ranking constancy here. In fact, they are significantly better connected than the actual starting points in both tracks. Rather, the fact that the formal domain of flood politics exudes constancy simply suggests that the main public bodies tasked with keeping water in place are unavoidably and repeatedly enrolled as concerned parts of the issue. What is perhaps more interesting is the way in which the plethora of not so directly concerned parties suspends the issue in a far more fluctuating and transformable political ecology. The latest version of the Statement of Principles was signed in June 2008 and it is in this respect not surprising that the ABI has got a relatively weak and unstable connection to the network in the period immediately following that settlement. Web crawls cannot be initiated retrospectively and although it would have been very interesting to follow the involvement of actors like the ABI in the period between the summer 2007 floods and the new Statement of Principles a year later, I did not take up this methodology in time. In fact, it was after a last minute shut out from the increasingly sensitive re-negotiations between DEFRA and the ABI, which I was otherwise lined up to follow close hand, that I was forced to re-think my fieldwork and adopt web crawling as a new strategy for generating material. Yet, the surge in connectedness recorded in late autumn still tells a story. On the 24th of November Alistair Darling, Chancellor of the Exchequer, released his 2008 Pre Budget Report. It was greeted with heavy criticism by insurers who believed that spending on flood defences had not been adequately prioritised. On the 26th of November the ABI's Director of General Insurance, Nick Starling, told the Insurance Newslink that:

> *The Chancellor failed to understand the importance of flood defences last year and has failed once again this year. To bring forward just £20m of expenditure, from the £850m allocated, is a token gesture and a missed opportunity.*
>
> *Building this nations flood defences is a much more quicker and straightforward way to spend money and improve the nation's infrastructure than some of the areas the Chancellor has focused on*

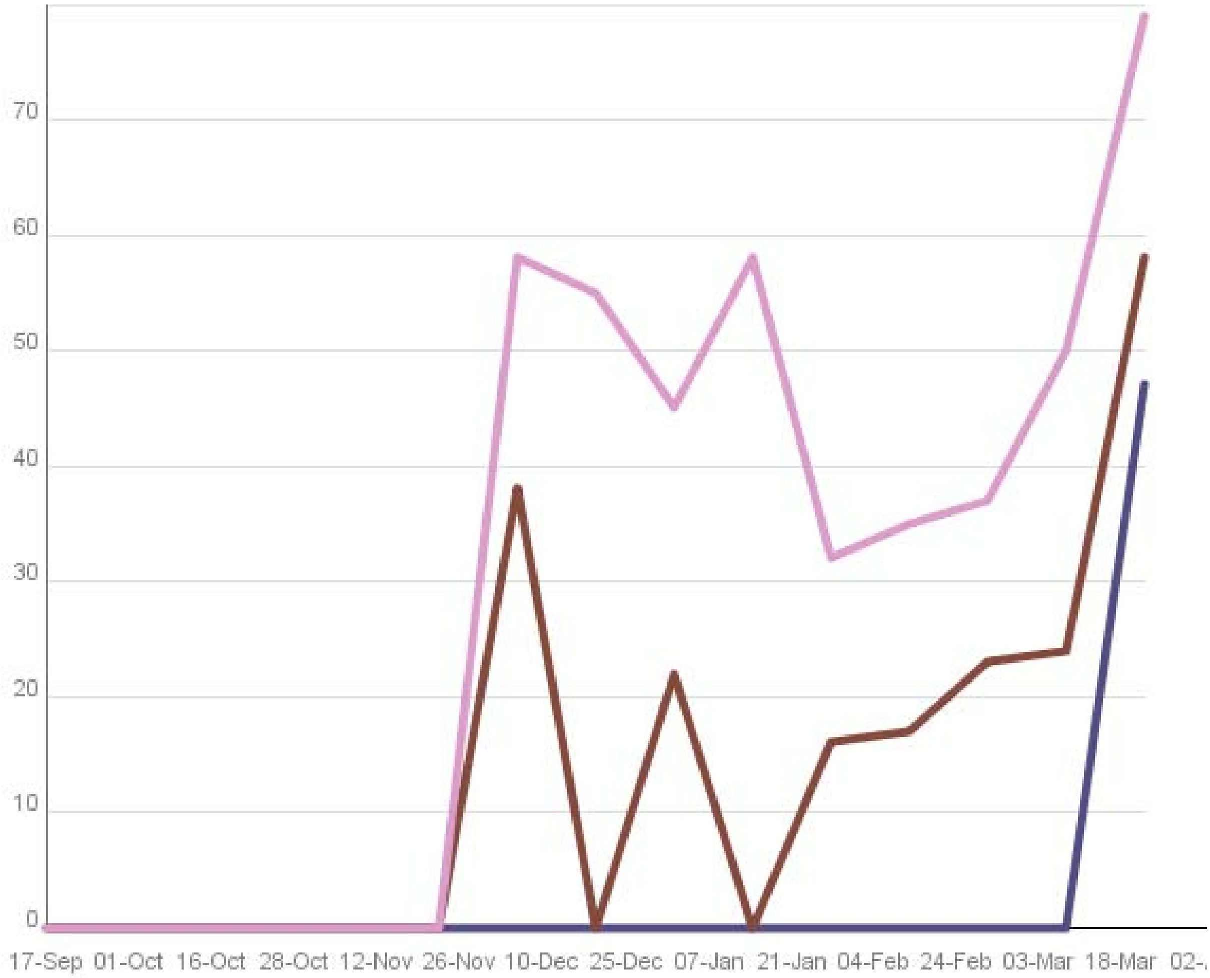
Likewise, in late February 2009 the EA published its annual Development and Flood Risk report which revealed that over the past two years 16 development projects had been given planning permission despite the EA advising specifically against it. This provoked a sharp response from the ABI who, as part of the new Statement of Principles, had pushed hard for, and subsequently gotten, a new Planning Policy Statement (PPS25) which they were still waiting to see the effect of. That corresponds well with the spike recorded on March 3rd.

Figure 2.4 compares the presence of climate change in the issue through the ranking of the Intergovernmental Panel on Climate Change (IPCC) and the UK Climate Impacts Program (UKCIP). It is evident that while climate change seems to be a more or less constant and quite high ranking theme in the period crawled, it becomes so by the changing involvement of different actors. 2008/2009 was the year leading up to the COP 15 summit in Copenhagen and the IPCC received a lot of coverage on all sorts of climate related issues, including floods, in that period. In early 2009, however, the Institute of Mechanical Engineers (IMechE) published a critical report on what it saw as a lacking UK adaptation strategy (IMechE 2009). Reducing carbon emissions, it argued, would not do it alone and spending would have to come up on infrastructural adaptation to the consequences of climate change now. Tasked with disseminating advice and information about adaption, the UKCIP thus acquired a central role in the flood issue in late February and early March 2009.

2.4 Ranking of the UK Climate Impacts Program (dark brown) and the Intergovernmental Panel on Climate Change (light green) over time between September 2008 and April 2009 in the networks crawled from the DEFRA and EA websites. For visualisation purposes the rankings have been inverted so that a higher value on the y-axis represents a stronger connectedness. There were never more than 100 actors represented in any given crawl which makes values above 90 a definite indicator of a top 10 connectedness.

Any given crawl in the policy track yielded upwards of 100 implicates, and each one of them could effectively be explored in this manner. That, however, is beyond the scope of this chapter which is not aiming to determine the totality of composites making up the flood issue (arguably an impossible task given its transformability). Rather, I merely want to try and convey a preliminary idea about morphology: the ways in which the issue forms and changes.

One more example will hopefully bring home the point that the public which constantly emerges and re-emerges out of the nascent state of primal chaos imposed on the world by flooding proper (water out of place) is a volatile and heterogeneous assembly which does indeed 'feed of controversies' (Latour 2005b). Figure 2.5 follows the involvement of water supply actors by comparing the rankings of OFWAT (the regulator for the water and sewerage industry), British Water and the Consumer Council for Water. Although not entirely in sync, it is quite clear that water supply only becomes part of the issue halfway through the track (a similar pattern shows on the NGO and Insurance tracks). 'To begin to understand how surface water flooding happens, and hence to be able to develop modelling and mapping techniques,' wrote the Pitt Review in its evaluation of the summer 2007 events, 'organisations such as the Environment Agency, the Met Office, water companies, local authorities, planning and highways authorities, and riparian owners will all need to work together to pool their expertise and data'(Pitt Review 2008, p.48).



2.5 – Ranking of OFWAT (light purple), the Consumer Council for Water (dark brown) and British Water (dark blue) over time between September 2008 and April 2009 in the networks crawled from the DEFRA and EA websites. For visualisation purposes the rankings have been inverted so that a higher value on the y-axis represents a stronger connectedness. There were never more than 100 actors represented in any given crawl which makes values above 90 a definite indicator of a top 10 connectedness.

The Pitt review concluded that water companies 'play a particularly important role given their responsibilities for sewerage', and that 'evidence from the summer demonstrated that insufficient capacity of drainage systems can play a crucial part in surface water flooding' (Pitt Review 2008, p.xvii). That in turn led the review to make the following two recommendations:

> *RECOMMENDATION 21: Defra should work with Ofwat and the water industry to explore how appropriate risk-based standards for public sewerage systems can be achieved.*

> *RECOMMENDATION 22: As part of the forthcoming and subsequent water industry pricing reviews, Ofwat should give appropriate priority to proposals for investment in the existing sewerage network to deal with increasing flood risk. (Pitt Review 2008, p.xviii)*

In December 2008 the Government gave its full support to both of these recommendations (DEFRA 2008) but noted also that 'a holistic response is required that properly takes account of the costs and benefits offered by each component of surface water drainage. Increasing the size of sewers may be part of that approach. However, sewers will always have limited capacity to take surface water, and surface flow management is needed to mitigate the consequences of severe rainfall.' In the wake of the 2007 floods a thorough review of responsibilities relating to drainage and surface water issues was called for both by the insurance industry (ABI 2007) and the Government's own commission tasked with investigating the events (Pitt Review 2008). On June 25th 2008 the Secretary of State for Environment Food and Rural Affairs thus announced that local authorities were to take responsibility for surface water management and in December that year the official response to the Pitt Review asserted that Local Authorities were to be allocated £27m to deliver 'leadership on flood risk management in the 50 highest priority areas; including surface water management plans, tackling of surface water problems, mapping of drainage assets, and oversight and maintenance of sustainable drainage systems (SUDs) for new housing, etc.' (DEFRA 2008, p.25).

What we are seeing is the birth of new primary responsibilities for keeping water in place. This is now increasingly becoming a task for the water companies. These are of course very superficial mappings, but they attest to the way in which flooding sustains its presence in the public domain long after the water has receded by being constantly and productively trespassing, not only in the immediate aftermath of the actual inundations, but in wave upon wave of nascent chaos. In the next three chapters I temporarily, and artificially, detach myself from this fertile political ecology and engage in detail with some of the professional techniques deployed to establish both the facts and the possibilities of flooding. Eventually, however, the outputs of these techniques will have to be absorbed into the broader geography of the flood issue, in the same way as their deployment is firmly rooted in the dynamics of that issue.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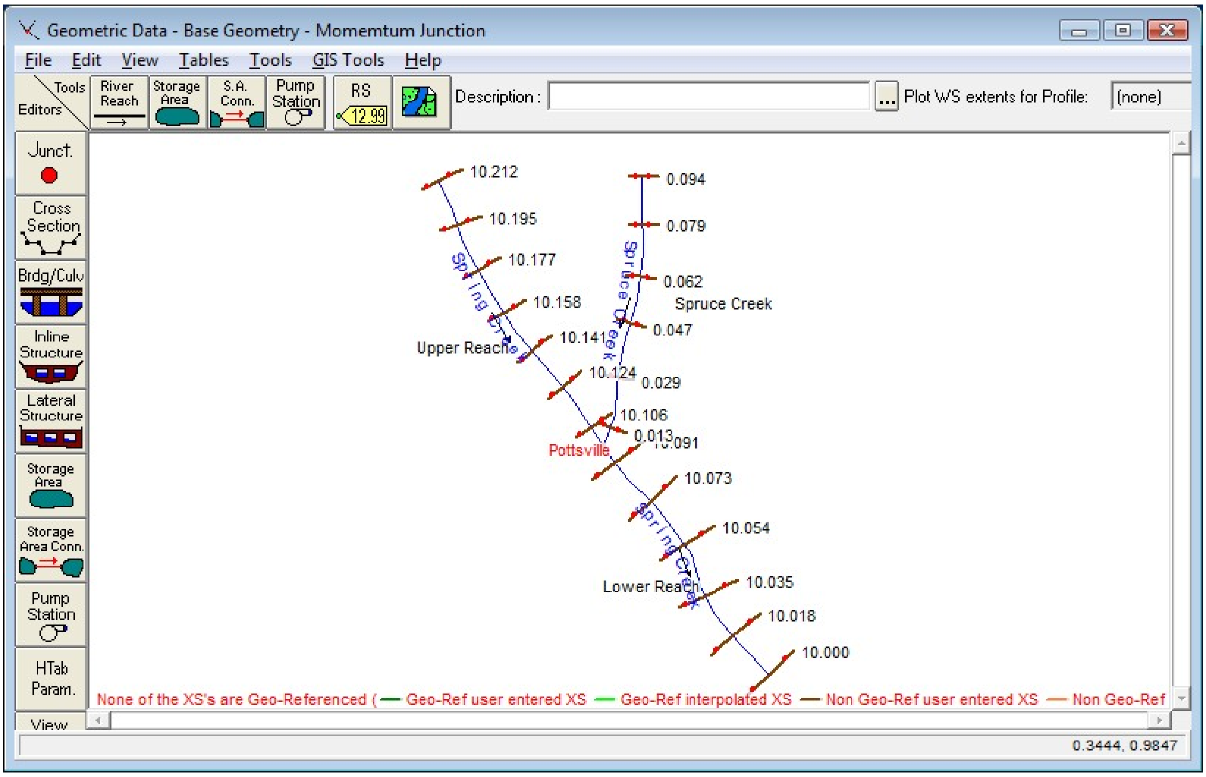
3. The Becoming of a Model-Modeller

Geometry, flow and the assemblage of water worlds

> *The problem is not, and cannot be, that of representational relations between the model and the concrete, or between the formal and the models. The problem is that of the history of formalization. 'Model' designates the network [réseau] traversed by the retroactions and anticipations that weave this history: whether designated, in anticipation, as break [coupure], or in retrospect, as remaking [refonte]. (Badiou 2007, p.54)*

Durham University, May 2007: Our instructor sings our praise as the water levels skyrocket and the ground fades away beneath a transparent layer of blue. 'Congratulations, you've got flooding'. And what a flood it is: in a matter of seconds we have turned a dry river channel into a deluge of biblical proportions. The flow quickly reaches the top of the animation window in a freely standing square column, making it plain clear that we might have succeeded in creating *a* flood, but not a particularly credible or realistic one of those. The piece of software we are trying to familiarise ourselves with on the laptops this afternoon is called HEC-RAS (the Hydraulic Engineering Center's River Analysis System) or simply HEC in modeller banter. It was developed in the 1990's by the US Army Corps of Engineers as a one dimensional hydraulic model and has been one of the most widely used software packages for determining water levels and designing engineered structures in rivers and on flood plains (for a good overview see for example Frost, Knight 2002). Operating it is surprisingly straightforward: it runs in Windows, offers a graphic display of the river system, and features like culverts, bridges and reservoirs can be easily edited and their effects monitored. Having grown up with computer games I quickly find myself in a familiar mode of trial and error. *What is this? Where does that* *go? Wonder what would happen if...* I have to repress a strong impulse to feel my way around the pushbuttons and drop-menus and try to follow our instructor instead. Neither I, nor my fellow trainees, who constitute a newly formed trans-disciplinary research group working with flood modelling, have prior experience and the need for training is palpable. As we are about to find out, becoming a modeller entails quite a bit more than learning which buttons to click.



3.1 Screenshot from HEC RAS: overview of a river system, notice the graphic interface which makes it possible to experiment with different types of engineered solutions along its course.

This chapter represents a change in pace. After my initial attempts to reissue flooding with a properly *political* ecology, taking stock of the variegated ways in which its out-of-placeness betrays existing constellations and dynamically sparks new publics into being, I now want to take a step back. In the introduction I suggested, by proxy of William James' discussion of indeterminism, that the risking of floods must hinge on the ability to concoct a specific cocktail of determinable fact and believable possibility. And as I began to explore in chapter one, these facts and possibilities are not only brought into being in various communities of practice (they do not pre-exist the reductive process of knowing them) but are also intimately bound up with one another through the specific technique of simulation modelling. I now return to explore that technique in a little more detail. As I suggested in chapter 1, this thesis can be seen as a process in which I have learned how to ask a different kind of question about flooding and the ways in which it becomes controversial. An initial interest in the enactment of a multiple object (the risk of flooding) gradually morphed into an interest in something much more eventful (the risking of floods). It goes without saying that such a process cannot anticipate itself. Thus, much of the work that has gone into generating materials and bringing them into conversation with each other through consecutive spells of writing and rewriting has been premised on evolving versions of a painfully provisional research question. The present chapter not only takes its cue from some of the earliest fieldwork I did, but I also wrote it in a draft form long before the rest of the thesis found its current direction. To varying degrees the same is true for the two chapters succeeding it, but rather than seeing what they do as obsolete efforts in the pursuit of an agenda which has long since changed, I want to see them as complicit in this change. It makes sense to do so not only because they are part of the account, but because the techniques with which they engage, those involved in the procurement of actual fact and credible possibility, are absolutely essential to the concoction from which indeterminacy, and hence the risking of floods, derives its potency and 'liveness'. In a sense, then, the change of pace represents a return to a different way of asking questions which is not per se interested in the broader event of flood risk, but at the same time it seeks to bring out a crucially important element of that very event.

Models are interesting because they sit, at times uncomfortably, somewhere in between theory and experiment; a situation in which they become 'a form of glue, simultaneously epistemic and social, that allows inquiry to go forward, by connecting the ideal and the material' (Sismondo 1999, p.258).The position is uneasy because it enacts the model as both a theory based construct which is 'expected to have outputs that can be compared with data' (p.250), an experimental setup which can be 'tinkered' with and observed (Dowling 1999), and a 'creative form of problem solving' (Nersessian 1999, p.14) capable of generating conceptual change on its own. Models are, in other words, intricate compromises which must 'simultaneously look like theory — because they have to explain, predict, and give structure — and like practical knowledge — because they have to connect to real-world features' (Sismondo 1999, p.258). A side effect of this apparent awkwardness, I will argue, is that models are actually very well suited for turning observable facts into credible possibilities. And in doing so, they are anything but ideal constructs or mere theoretical analogues. As a relatively new way of doing science (models were only gradually accepted into academia from the 1950s onwards (Bailer-Jones 1999)), modelling is often associated more or less exclusively with the technological breakthroughs in digital computing (Dowling 1999). This reliance on virtual reality (in itself an interesting term which begs to have its latter half firmly underlined) has further exacerbated epistemological concerns about the uneasy status of model outputs as being validated neither through their adherence to the formal domain of theory, nor through their direct experimental engagement with the material world (see for example Casti 1997).

But as Alain Badiou stresses, arguing precisely for a *materialist* epistemology of mathematics, the real problem has got less to do with a model's ability to represent either the formal or the concrete, and more to do with the quite material process of formalization on which the ability to model relies. Materiality, he contends, 'does not begin with machines *stricto sensu.* A formal system *is* a mathematical machine, a machine *for* mathematical production, and is placed within the process of this production' (Badiou 2007, p.43). By engaging first with flood models, and later on, in chapter 5, with so called catastrophe models, I want to argue that these techniques not only output facts and possibilities which become absorbed into the wider political ecology of flood risk, but that they are themselves intimately located within that material setting. This point is only slowly developed over the next three chapters. On the one hand they will tell a story which reassuringly seems to meet all criteria for a cartography of things to come (it becomes possible to draw a principle sketch of the way in which facts and possibilities can be ordered into a future which is contemplatable without being predetermined), but on the other hand, and in particular read on the backdrop of the previous chapters, they reveal cracks and disjunctions in this neat cartographic machinery which provokes reflection and further analysis in chapter 6. Simulating floods in HEC-RAS, for example, presupposes not only the carefully crafted machinery of a model, but the attunement of a body, that of the modeller, to that model. It presupposes a certain corporeal discipline which will constantly feed the world into the model and vice versa. In doing so, modelling is firmly rooted in the political ecology into which its outputs will eventually be absorbed.

In the next three chapters, then, I turn to the facts of flooding. When I talk about facts I shall do it in the sense of what experts certify as factual. It might thus be more accurate to say that in these chapters I turn to the science of flooding, and indeed I do, but I shall have as my prime target the products of such a science. I shall thus reserve the term for the output of a particular subset of practices, namely those focused on bringing about indisputabilities. The plural forms are important here since highly diverse forms of expertise are at work to produce (scientific) knowledge about floods. Two main groups might be tentatively sketched out: the probabilistic/mathematical practices and the deterministic/physical practices. The former would treat floods as discrete events that occur with certain intervals, and include disciplines like statistics, probability theory and actuarial science. The latter would treat floods as physical processes related to the properties of water and its environment (atmosphere, soil, vegetation, etc.), and include hydrologic sciences like meteorology, oceanography, limnology and hydrology. There are good reasons for considering this way of dividing things a tentative sketch: all hydrologic sciences are crucially dependant on statistical data, for example, and incorporate all sorts of probabilistic assumptions about frequencies and magnitudes. Conversely, the measurement and recording of flood events for statistical analysis owes a lot to hydrology both in terms of instruments and calculation methods. For the purposes of this chapter, however, it is a somewhat useful distinction. The probabilistic/mathematical practices have always been intimately engaged not only in the production of facts but also in the production of markets. I shall thus return to them in chapter 5 and concentrate, for now, on the deterministic/physical ones.

How to account for 'the becoming of a model-modeller'?

As I began to flesh out in chapter 1 – imagining my field as a series of interconnected transformative processes along the lines of Latour's 'circulating reference' diagram (1999) –

the scope of these early enquiries, fashioned in the image of a long since transformed research question, was to account for the ways in which the facts of flooding are made possible in and through practice. And in a sense, that is still the point, except these facts are no longer envisaged as enactments of the risk of flooding, but as ingredient processes in the risking of floods. To Annemarie Mol such 'praxiographic' narratives must 'always have composite objects' (2002, p.156), which naturally invites investigation into their composition (to authors like Latour this invitation becomes more of an insistence that that such 'agencies', for this is what they are, should never be 'presented simply as matters of fact but always as matters of concern, with their mode of fabrication and their stabilizing mechanisms clearly visible' (2005b, p.120)). However, this notion of composure also gives rise to questions of where and how that kind of investigative work might be carried out? In this chapter, for example, I depart from my own training experience with a piece of hydraulic modelling software. This is not unproblematic. The composition of objects is in many ways already done, the facts of flooding are there beforehand, pieced together in some other place or in some other time. Embedded in the software are, for example, all sorts of settled assumptions about the movement of water in riverine environments. The basic set of hydrodynamic shallow water equations for open channel flows solved in one-dimensional models like HEC-RAS were published by the French mathematician Adhémar Jean Claude Barré de Saint-Venant in 1843 and are simply known as the Saint-Venant equations. They are derived from an even more basic set of equations named after another Frenchman, the engineer Claude-Louis Navier, and the Cambridge physicist George Gabriel Stokes incorporating the Newtonian laws of motion into fluid mechanics. The core science of one-dimensional hydraulic modelling was done in the 19th century and the reason why models like HEC are still relatively new has got everything to do with the dramatic developments in computing power and not a lot to do with the underlying physics and the equations in need of computing.

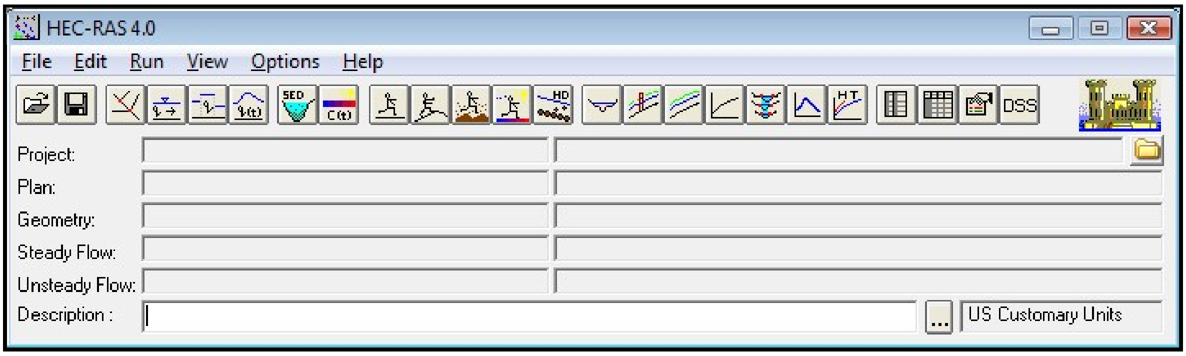
In this sense the software is packed with what Latour calls 'immutable and combinable mobiles' (1987, p.227), each composite objects in their own right, surely, but long since trimmed and domesticated to be readily at hand and by no means 'matters of concern'. The same might be said for the software as such: it was developed during the 1980s and 1990s and is widely used off the shelf by consultant engineers who generally do not question or unpack its constituent code. In this respect the modelling I am engaging here represents nothing more than '*additional* work, a slight enhancement of the three qualities (...) mobility, stability and combinability' (Latour 1987, p.236). Thus, the problem remains: how to write about the composition of something that is long since composed? The composite objects with which I am dealing have, in the words of Geoff Bowker and Susan Leigh Star, lost their 'anthropological strangeness,' they have become 'naturalized,' stripped from the 'contingencies' of their 'creation' and their 'situated nature' (2000, p.299). As much as this naturalisation presents a serious problem it also offers a clue to how it might be omitted. The anthropological strangeness may be lost for the hydraulic engineer or the flood scientist, but, perhaps, not for me. At least not in the situation in which I find myself at the outset of this chapter, training to become something utterly alien to my background as a human geographer. Naturalisation is a state not only of the model but also of the modeller, or rather: the composites from which the model is realised include human bodies as well as hardware and code in the same way as the modeller, the becoming of which I am here part of, must be understood as a more-than-human constellation (Whatmore 2006). As Andrew Barry notes contemplating interactivity and experimentation in the sciences:

> *The body of the practising scientist has become disciplined; capable of performing meticulous practical tasks and making exact observations but no longer serving as an experimental instrument in itself. The process of science education is, at least in part, a matter of turning the untutored body of the student into that of a reliable technician (2001, p.131).*

In the following I attempt to treat the tuition of my own body as an experimental opportunity to address the model-modeller in its making. Profiting from my exotic and undisciplined point of departure, the aim is to provide some backlighting for screening the host of enigmatic black-boxes encountered in the software. I follow through, step by step, though not necessarily chronologically, what it takes to 'make the model run'. As will be clear, the task requires a lot more tuning on my part than on that of the model.

Making the model run 1: geometry

One of the first things that strike me as we are told to start HEC-RAS is the scant simplicity of the interface (see figure 3.2). Besides the evocative pushbuttons with their flood related iconography, I am met with a series of blank slates. There is neither river nor water to be seen anywhere. An empty field says 'Geometry,' another says 'Unsteady Flow'. What does it want from me? What is it asking me to do?



3.2 HEC-RAS start-up screen – what does it want?

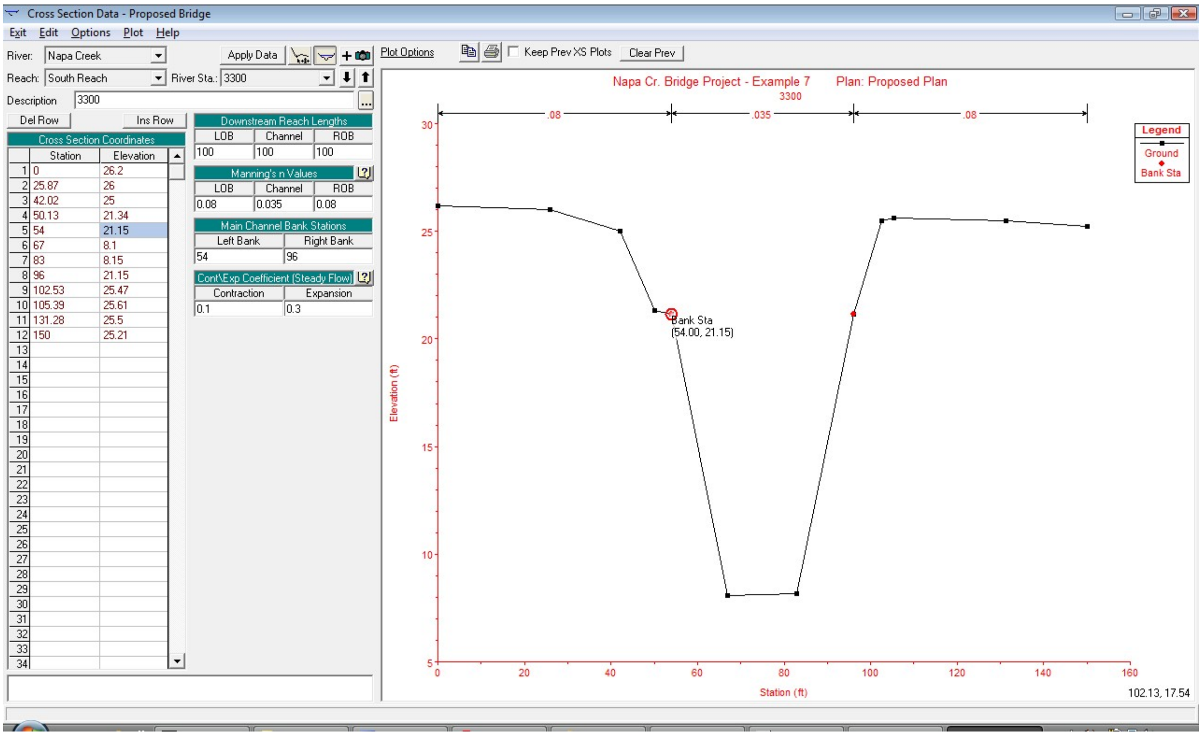
It seems that the buttons are just waiting to be used, oozing a magic promise along the lines of 'push me, and I will tell'. But tell what, exactly? As the program sits there in front of me I think of Latour's encounter with the mass spectrometer, 'the reified part of a whole field of physics', in the Salk laboratories:

> *It is an actual piece of furniture which incorporates the majority of an earlier body of scientific activity. The cost of disputing the generated results of this inscription device has been enormous. (Latour, Woolgar 1986, p.242)*

I wonder what corner of the sciences HEC might be reifying – that is if you can call computer code a thing, not to mention 'an actual piece of furniture' – and what it would take to dispute whatever it is about to tell me. But so far nothing happens: I push the buttons only to see more blank slates pop up. In turn, the device will produce a host of numbers, water levels, which can even be animated as virtual flood events (as experienced in the introduction to this chapter). Before we can get to this, however, we will need to provide the software with something to flood and something to flood it with: it needs a floodplain, a channel, and some water. Or rather: it needs 'geometry' and 'flow'.

Step one in 'running the model', or what is sometimes just called 'modelling' (not to be confused with the 'modelling' referring to the process of building a new model)[16], is the construction of a geometry. Built up as a series of cross-sections lined out along a stretch of river, successive stages through which the flow will eventually pass, it offers a first impression of what one-dimensionality entails (figure 3.1 provides an example of this way of conceptualising the river system in one dimension; for a principle sketch see figure 1.6). As opposed to an actual river, this virtual version will only allow water to move in one direction, namely downstream from cross section to cross section (vertical and lateral motions being absent). A cross section is constructed as a series of data points, each with a 'station' and an 'elevation' coordinate specifying the lateral and the vertical location of the point respectively. Here is a first, but fundamental, transformation of the actual river and its flood plain: in order to turn it into geometry it must be reduced to points. Had this not been a training excercise this task would have involved the mobilisation of survey instruments and charts. We, however, are supplied with readymade data by our instructor and can simply key them in. Figure 0.2 shows a window open with a cross section consisting of 12 such data points which have been keyed in to the columns on the left. The elevation and the station coordinates are specified for each of them and point 5 and point 8, at station coordinates 54ft and 96ft, have been assigned as the main channel banks. This is very important: water levels above this point (21.15ft elevation) are how the model construes 'flooding'.

[16] In her analysis of event generators used in particle physics, Martina Merz (1999) deliberately omits the word 'model' when referring to the software. Instead she reserves the term for the programmers' conceptual idea of the physics they are trying to put to work in the form of computer code in order not to blur the distinction. It could very well have made sense to do something similar here. However, my fluctuating and less well defined use of the word 'model' reflects the multiplex usage encountered in the field.



3.1 Cross section data. The left bank station is highlighted at 21.15ft elevation, which is the height at which the flow of water becomes 'flooding'. Under 'Manning's n Values' the roughness coefficients have been set both below the bank stations in the channel, *n* = 0.035, and above them, on the floodplain, where *n* = 0.08.

Between the columns with station/elevation coordinates and the graphic outline of the cross-section are some further tables to be filled out. One of them is titled 'Main Channel Bank Stations', this is where we have to decide on the limits for what should count as flooding, another is asking for 'Manning's n Values'. This *n* value, our instructor tells us, represents a 'roughness coefficient'. But whereas plotting the cross section as a series of coordinates seemed if not straightforward then at least a familiar way of treating a landscape – echoing embodied experiences with maps, strategy games or orienteering – I have no sounding board for 'roughness coefficients'; it evokes no response. Manning's *n*, it turns out, serves as a kind of remedy for the smooth sterility of the straight lines making up the geometry with little resemblance to the irregular, deposited and vegetated condition of floodplains and riverbeds.

What *n* conveys to the model is a notion of things like trees, brush, grass, tarmac, debris, gravel, ruggedness, cleanliness, messiness or smoothness, and it sums it all up in a measure of 'roughness' (The story of how Manning's *n*, named after the Irish engineer Robert Manning who proposed it 1889, became the preferred measure of roughness in hydraulic engineering, though in some respects an unlikely candidate, is told by Whatmore and Landström (2009)). In figure 0.2 the *n*-value has been set to 0.035 below the banks and 0.08 above them. According to HEC's hydraulic reference manual this means 'clean, straight, full, no rifts, or deep pools' but with 'more stones and weeds' in the channel, and somewhere between 'light brush and tree in summer' and 'heavy stand of timber, few down trees, little undergrowth, flow below branches' on the floodplain (Brunner 2008, ch.3 p.14). Again our instructor provides us with readymade numbers to be keyed in (later we are told to play around with them to see how changing roughness coefficients change the way the model run). Nonetheless, these *n* values represent a fair bit of 'real world' complexity and particularity translated into a single number, and it would be relevant to know how this translation takes place. In a still quoted book from 1950's on the subject of 'Open-Channel Hydraulics', the process of coming up with a roughness coefficient was envisaged like this:

> *At the present stage of knowledge, to select a value of n actually means to estimate the resistance to flow in a given channel, which is really a matter of intangibles. To veteran engineers, this means the exercise of sound engineering judgement and experience; for beginners, it can be no more than a guess, and different individuals will obtain different results. (Chow 1959, p.101).*

What this sound engineering judgement more precisely refers to remains unclear, but it could be speculated that a disciplining of the body is also involved here. Some guidelines are suggested for the uninitiated:

> *(1) to understand the factors that affect the value of n and thus to acquire a basic knowledge of the problem and narrow the wide range of guesswork, (2) to consult a table of typical n values for channels of various types, (3) to examine and become acquainted with the appearance of some typical channels whose coefficients are known, and (4) to determine the value of n by an analytical procedure based on the theoretical velocity distribution in channel cross section and on the data of either velocity or roughness measurement (loc. cit.)*

Surprisingly, considering the general upheaval which followed in the wake of the digital revolution, not much has changed in this respect. Choosing an *n* value is still done predominantly by analogy and with the aid of guidebooks and tables like the one in the HEC-RAS manual quoted above. Chow's book itself contains an early example of a photographic reference with *n* values progressing through a set of 24 riverine scenarios. The first photo represents the *n* value 0.012 (minimum roughness) and depicts a smooth surfaced concrete slab canal. In the fourth photo the concrete canal is covered with a fine layer of algae and drifting sand – *n* increases to 0.018. Towards the last photo, and an *n* value of 0.150, the irregularity increases, more vegetation blurs the transition from river channel to flood plain, and on photo 24 trees have fallen over into the river and debris is drifting along the bed (Chow 1959). Figure 3.3 shows present day examples of such photographic references for Manning's *n*. They are part of an online resource made available by the United States Geological Survey[17].

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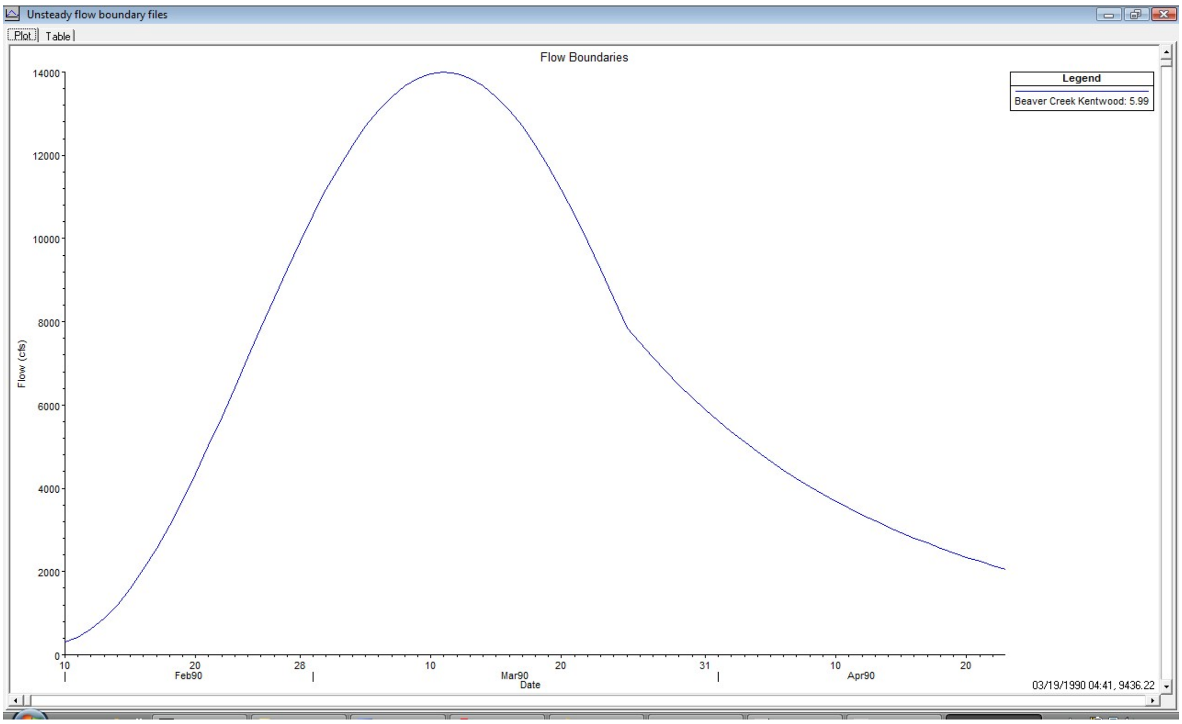
[17] http://wwwrcamnl.wr.usgs.gov/sws/fieldmethods/Indirects/nvalues/index.htm (24 February 2009).

3.3 From the USGS website: on the left n = 0.028, on the right n = 0.073.

For the purpose of our training session, where we are simply told what values of *n* to use, no attempt is made to develop our potentially foetal 'sound engineering judgement'. Yet, it does become clear to me that rivers can have 'roughness,' a concept which simply was not on my radar before I embarked on this exercise. Obviously, having seen rivers, I knew about vegetated banks or gravelish beds, but I never thought about them in terms of attenuation before. One thing is learning to assign the correct value of *n*, but it presupposes learning to think about the concept of *n* in the first place. The cross-section data sheet in figure 0.2 requires a mental or bodily correspondent to make sense as it cannot, on its own, perform the task of turning gravel into roughness coefficients or channels into station/elevation data.

Making the model run 2: flow

The geometry is in place. At this point HEC is, quite apparently, no longer a blank slate. However, it still needs water to produce flooding. And in the same way as floodplain and river channel came into virtual being in the form of data points, water is fed into the model in the form of 'hydrographs'. Again, transformation is necessary: the actual flow of the river must become points in time with corresponding discharges (ft^3/s). Conveniently, as was the case with the geometry, our instructor provides us with a readymade set of data. All we have to do to get the water running is key it in. This is done by specifying the so called 'boundary conditions'; what happens, that is, before the first and after the last cross sections in the system. We are instructed to tell the model at what rate the water comes in, and at what rate it is able to get out again. Figure 3.4 shows a plot of a hydrograph with the increase and subsequent decrease in discharge over time at a specific cross section. At this point I am not aware of it, but treating water in this way, as mass and momentum, fits neatly into the hydrodynamic equations constituting the micro machinery of the software. Like petrol for a petrol engine, refined into something quite different than the crude oil from which it came, hydrographed water is poured onto a geometrized landscape.



3.4 Flow hydrograph: discharge as flow in ft3/s (Q=A·V) is shown on the vertical axis.

The key components in this high-octane virtual water, mass and momentum, is packed into the letter *Q*, discharge, shown on the vertical axis of figure 3.4 as flow in ft^3/s. But *Q* was not always so servile and attuned. To the Roman emperor Nerva's commissioner of waterworks Sextus Julius Frontinus, for example, discharge seems to have been a far more refractory concept. Or rather, it was supposed to be simple, equalling the width times the depth (the cross-sectional area), of the flow: $Q = A$, but as Frontinus was making plans for the water supply he encountered a persistent misfit between his calculations and his observations. There was simply not the same amount of water coming out of the aqueducts and fountains, as he had estimated. Discharge was, to use the Stengerian metaphor of 'dialogue' (Prigogine, Stengers 1985, p.4), talking back, putting $Q = A$ at risk in the process. A compromise was reached by introducing 'unknown leaks' and 'ordinary Romans' who, in the words of the historian Asit Biswas, 'seemed to be experts in tapping water without 'bothering' the authorities' (1970, p.91). As Frontinus and his measurements could not on their own make $Q = A$, further allies had to be drawn in as buttresses. *Q* could indeed be *A*, under the condition that a mix of shady transactions and reputed wastage provided constructional leeway for the statement. In fact, or hence propped up, *Q* remained *A* until the end of the 16th century: after the flooding of Rome in 1598 Giovan Fontana da Meli undertook the task of tracing the water flowing into the Tiber from its system of tributaries. At any given point he did this by measuring the width and the depth (*A* without *V*) of a cross-sectional slice of the flow.

The perseverance of this assemblage of discharge is somewhat puzzling, not just because of the effort it took, but because of what it backgrounded in the process. Alternative dialogues on the measurement of *Q* were taking form simultaneously in the first century A.D. One of Frontinus' contemporaries, the Greek scholar and mechanical engineer Hero of Alexandria, had such a conversation with a sundial and a lead pipe in the Egyptian dessert where he was testing the use of siphons for irrigational purposes and needed a way to determine the amount of water supplied by a spring. In other words: he needed a measure of *Q*. The lead pipe, which was rectangular in shape, could be used to divert the water into a dug out reservoir. This allowed for both the measurement of width and depth of a flow cross-section, *and* the amount of water supplied. So far *Q* could be *A* – had it not been for the sundial. With the introduction of time it became clear that the reservoir filled up in different tempi, even though *A* remained constant:

> *It is to be noted that in order to know how much water the spring supplies it does not suffice to find the area of the cross-section of the flow which in this case we say is 12 square digits. It is necessary also to find the speed of the flow, for the swifter is the flow, the more water the spring supplies, and the slower it is, the less. (Hero quoted in Biswas 1970, p.87)*

What was invented, namely velocity (*V*), was essentially a replacement for the thievish Romans and the leaky pipes needed to uphold the simple relation of $Q = A$. Instead *Q* could now be $A \cdot V$ without any further need for buttressing. Curiously, though, this did not happen. Not until 1628 when Benedetto Castelli, a mathematician at the monastery of Montecassino (coincidentally the place where Frontinus' original manuscripts were preserved for posterity), derived it again in the form of five axioms:

> *Axiom I: 'Sections equal, and equally swift, discharge equal quantities of water in equal times.'*

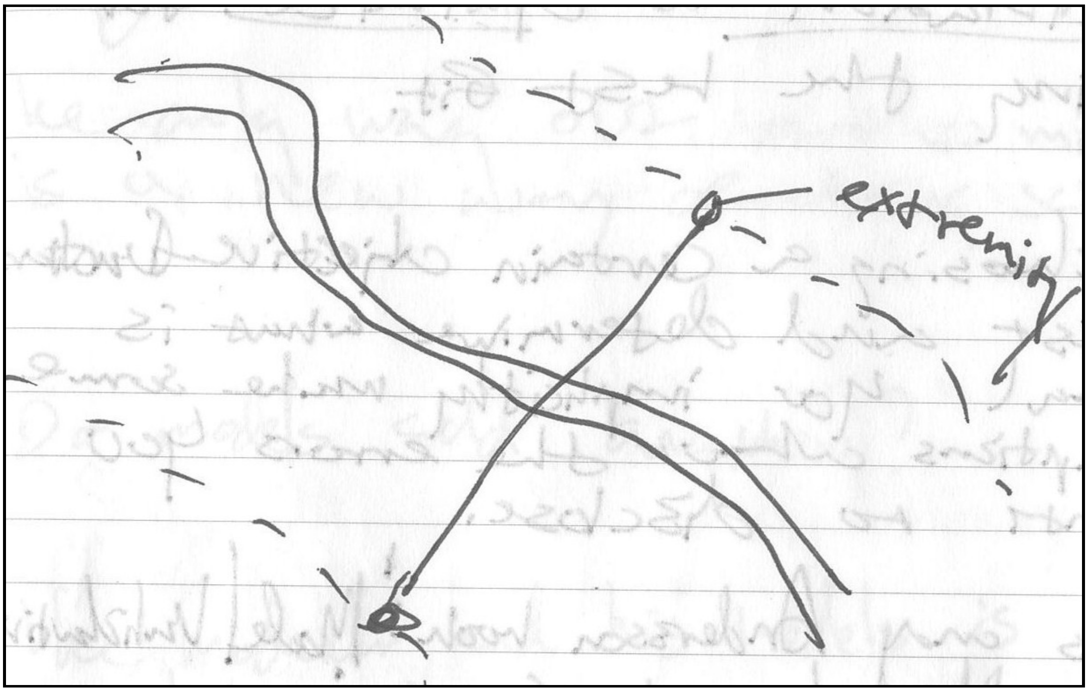
> *Axiom II: 'Sections equally swift, and that discharge equal quantity of water, in equal time, shall be equal.'*
>
> *Axiom III: 'Sections equal, and that discharge equal quantities of water in equal times, shall be equal.'*
>
> *Axiom IV: 'When sections are unequal, but equally swift, the quantity of the water that passeth through the first section, shall have the same proportion to the quantity that passeth through the second section. Which is manifest because the velocity being the same, the difference of the water that passeth shall be according to the difference of the sections.*
>
> *Axiom V: 'If the sections shall be equal, and of unequal velocity, the quantity of the water that passeth trough the first shall have the same proportion to that which passeth through the second, that the velocity of the first section shall have to the velocity of the second section. Which also is manifest, because the sections being equal, the difference of the water which passeth, dependeth on the velocity (Castelli quoted in Biswas 1970, p.172).*

When I go to the trouble of historizing discharge and the assemblage of *Q* in this way it is to make clear that as I key in the boundary conditions I am embodying a very particular notion of water as a relation of speed and mass. I am complying with the machinery; a compliance which cannot be taken for granted.

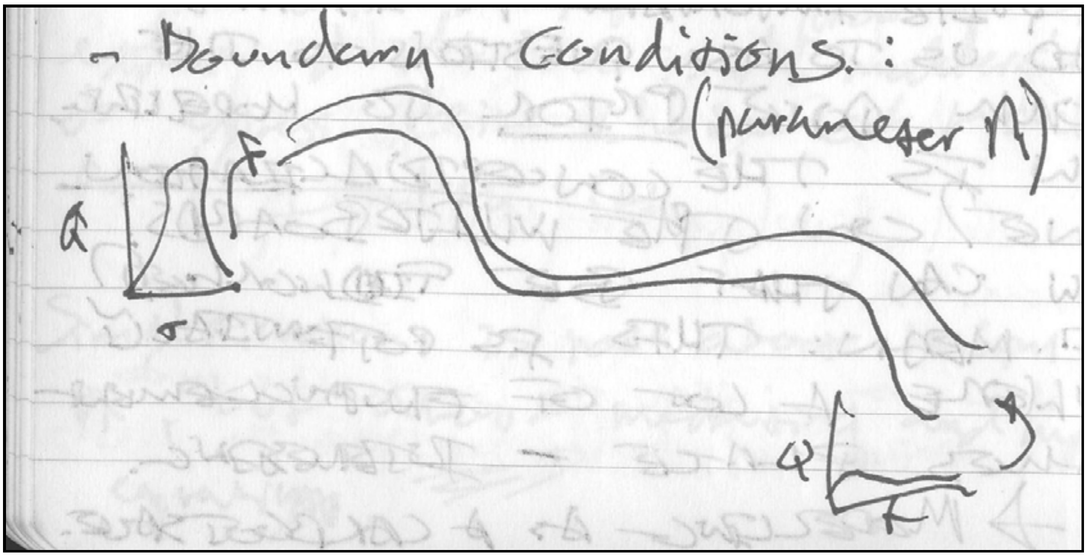
Making the (perceptual) model run 3: water world

It is now clear that HEC-RAS is not working without me. This is obviously true in the sense that unless I start the program and make use of it, it will remain inert. But it is also true in the more profound, or radical, sense that HEC can be no more of a flood model without me, than I can be a flood modeller without HEC. What we (me, the trainee, and the software) have stepped into – training to plot channels as data points, turn vegetation into *n* values and regard water as mass and momentum – is a transformative process in which hyphenated model-modellers are becoming. 'Human bodies have been transformed by and into a horse's body', writes Vinciane

Despret on the somewhat different, yet related example of skilled riders. 'Who influences and who is influenced, in this story, are questions that can no longer receive a clear answer' (Despret 2004, p.115). It might serve to shift the attention back to me, the becoming modeller. Figure 3.5 and 3.6 are scans from the pages of my field diary dated that afternoon in May and show my first conceptualisations of cross-sections, geometry, boundary conditions and hydrographs.



3.5 Field notes: conceptualising the channel in its flood plain with cross section and extremities.



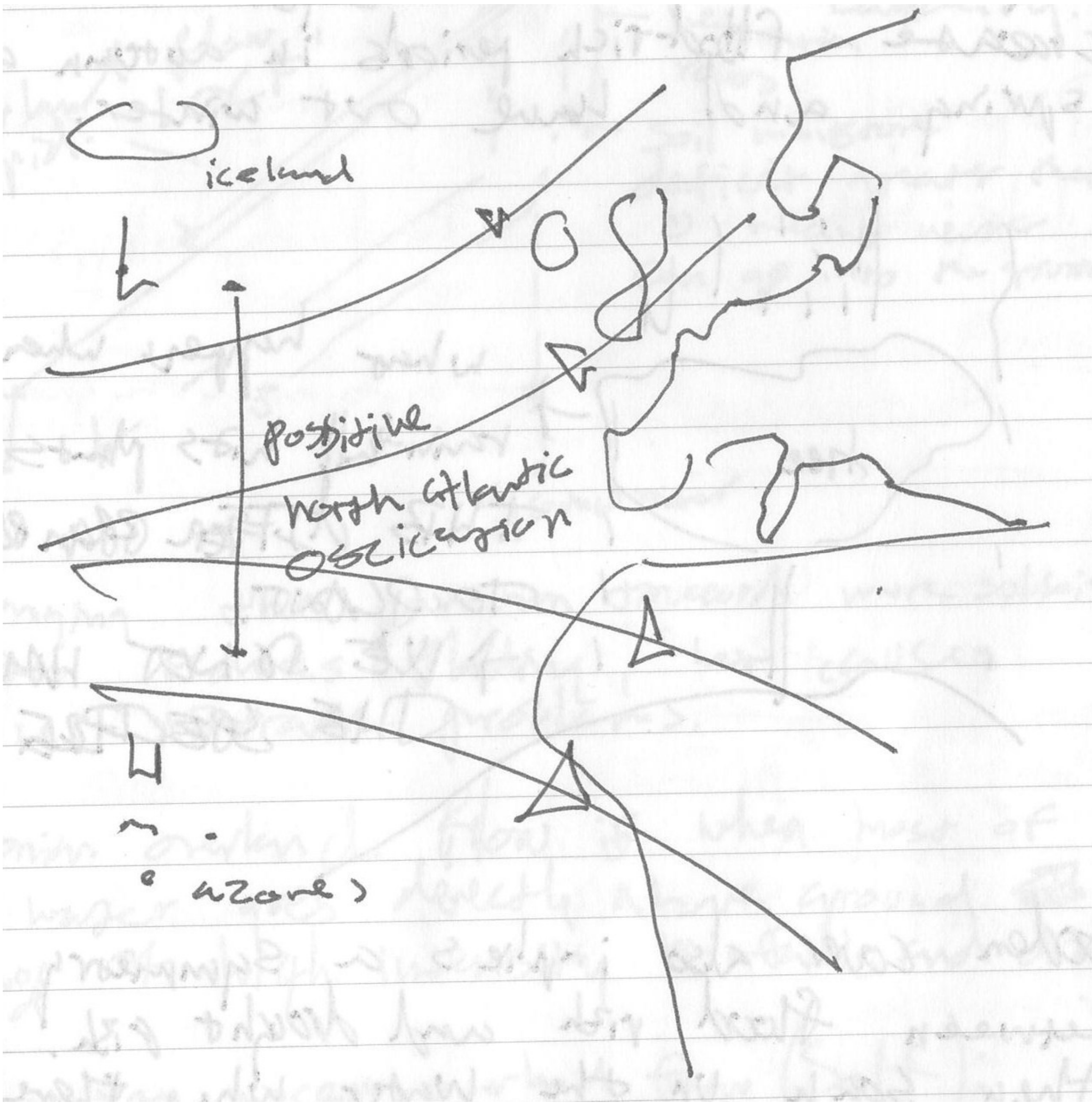
3.6 Field notes: understanding boundary conditions and hydrographs.

They do not have the neat finish of the screen-dumps from HEC-RAS, in that respect they are distinctly human, but they are not too different from them either. The rider has ‘learned to act in a horse-like fashion, which may explain how horses may be so well attuned to their humans’ (ibid.). Despret calls it anthropo-zoo-genesis – it might be rephrased as anthropo-techno-genesis to fit the context – and to really appreciate this co-creation I want to turn to the pre-training we received before actually having a go at the laptops and a concept brought to the fore by our instructor in this process: the ‘perceptual model’. So far I have been talking about the model as the program, HEC-RAS. I am now going to talk about the model as the way we envisage the environment simulated by the program.

‘Being able to relate your perceptual model of the environment to the computer models you will be using,’ stresses our instructor, ‘is important.’ There are no computers in the room at this point and the attention centres on a flipchart where one of my fellow trainees is drawing up the profile of a landscape. The challenge is to produce a ‘hydrological cycle’ and we are brainstorming on things that might have a place in it. 'Clouds,' shouts one, 'the sea,' says another, 'some kind of human settlement,' 'groundwater,' 'trees,' 'rain,' even 'a glacier' is suggested. We end up with a rough sketch of diverse ways in which we think water might be circulating the ecosystem. Our instructor thinks it very good, and makes a few additions. Effectively, what we have constructed is a world *assembled around water*. In its very basic form it represents a way of thinking about things without which the science of hydrology would be impossible. Why is the human settlement there? Because it consumes water, and subsequently disposes of it. Why is the glacier there? Because it retains water. Within the hydrosphere of the earth, water can and must always be accounted for. It is an assemblage summed up in the mass balance equation:

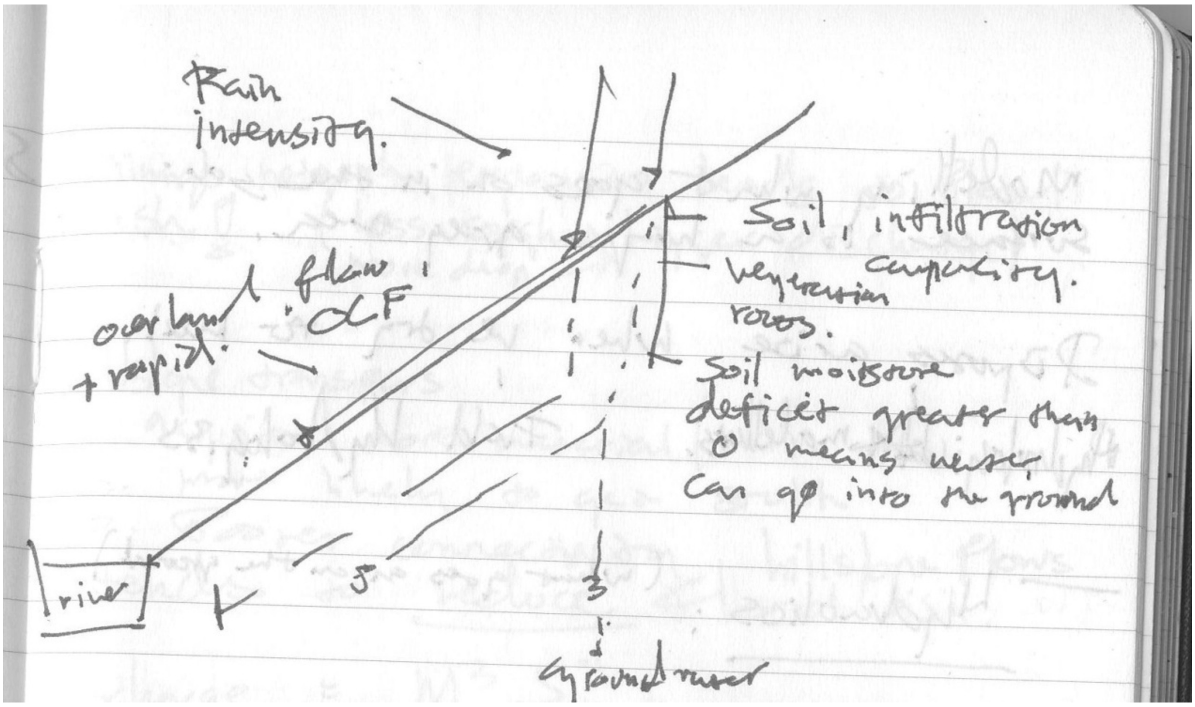
$$P - Et = \pm\Delta S + Q$$

If evapotranspiration (*Et*) is subtracted from precipitation (*P*), what emerges is a change in storage (*S*) plus discharge (*Q*). In other words: if you want to know how much water might be liable to flood you, you essentially want to know how much water comes down as rainfall, and how much of that is either evaporated or retained somewhere. The water unaccounted for is discharge. Through the becoming of this water world some things acquire importance while others fall into oblivion. Orchestrated around a liquid skeleton, held in shape by the principle of mass balance, ramified and connected as a consequence of its fluidity, an assemblage of materials takes shape so as to position hydrology in its distinctive spatiotemporal matrix. Departing from our hydrological cycle, we start exploring: What would generate precipitation? What would affect evapotranspiration? At one point Iceland and the Azores are drawn in along with frontal systems sweeping across the British Isles from the Atlantic (see figure 3.7). As the meteorological depression shifts from south to north, the North Atlantic Oscilation (NAO) shifts from negative to positive. Instead of drawing dry and cool air away from continental Europe, heavy rainclouds are pushed in over the UK. A warm ocean favours a high pressure zone over the Azores and a depression at Iceland, NAO+, leading to annual as well as longer term fluctuations in precipitation and more or less flood rich periods. For example, the increase in UK flood events experienced in the late 1990s and early 2000s, our instructor tells us, coincided with a transition in the North Atlantic from a cooler to a warmer phase and a subsequent change from NAO- to NAO+.



3.7 Field notes: NAO+, frontal systems sweep across the UK propelled by a depression at Iceland. An arrow indicates the interchange of negative and positive states.

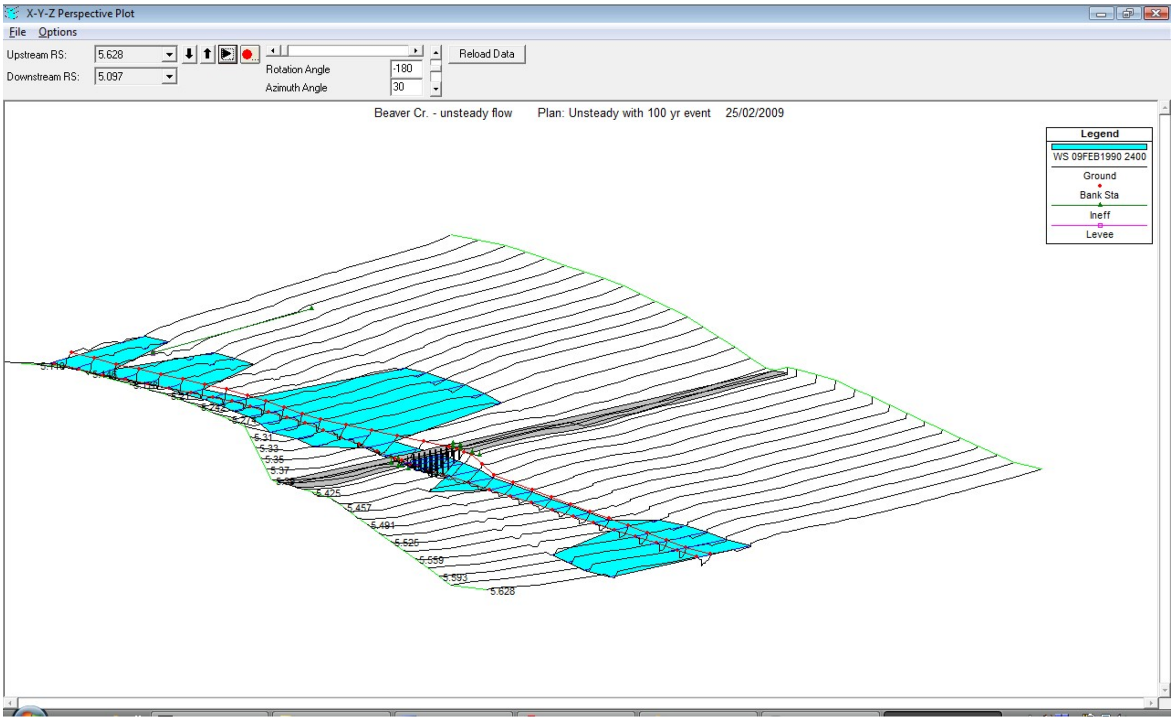
And the NAO is just one of the ways in which we begin to orient our perceptual model in time and space. Another looks downwards, towards rainwater on the ground, and indeed underground, instead of upwards towards frontal systems in the sky. As I begin to sketch out in figure 3.8, a variety of soil related properties, such as slope, drainage, saturation, vegetation or conductivity, are spun into the assemblage as water makes its way over/through land from rainfall to river channel. What is the 'infiltration capacity' of the soil? To which degree will roots conduct water into the subsoil as opposed leading it over land? How much precipitation will be stored as ground water? How much will be absorbed by vegetation and led back into the atmosphere as evapotranspiration? How long, if ever, before rain water ends up in a river?



3.8 Field notes: water on the ground - conductivity, saturation, drainage, overland flow.

What I want to argue is that all these perceptualising efforts, in which we engage with the aid of our instructor, are what found our attunement to the model. But it is not as straightforward as to mean that, in assembling our water worlds, we weed out any discordant faculties presented to HEC-RAS by our undisciplined perceptions of the environment. In fact, these assemblages are also about realising what HEC *cannot* do. There is thus an interesting duality lurking between the lines of my field notes. In one sense they attest to a growing awareness of water, how it must always be accounted for, and how that accountancy dictates the implication of a variety of materials across a range of spatial and temporal scales. In that sense it does indeed ferment a way of thinking about and around water which will eventually enable me 'to HEC'. But, in another sense, my notes also highlight a void or a disjuncture. The directions in which water moves across the pages of my field diary, the expanse of the geographies sketched there, the cast of actors comprising anything from Atlantic depressions to moisturised subsoil: these are all at pains with finding room within a piece of software like HEC-RAS. In essence, what I will be modelling during the following days of my training will take place in the bottom left hand corner of figure 3.8, namely in the river channel itself and on its immediate flood plain. Contrary to our perceptual model on the flipchart, water will neither be moving vertically nor laterally across the direction of the stream. Further simplification is necessary to achieve this one-dimensionality.

What is so far missing from my account of trying to make the model run, is some sort of engine. I have learned to turn a riverine landscape into geometry, data points and roughness coefficients, I have mastered the refinement of water into discharge, but for what reason? Figure 3.9 shows the end result of a run in HEC, the movement of hydrographed water across a geometrised landscape, a movement that cannot happen by itself. The physics are indeed, returning to Latour's notion of the inscription device, still reified, embedded in the software which consequently seems to be doing things on its own.



3.9 Flow simulation: water levels are calculated and animated for each cross section of river.

Trying to locate the disjuncture between computer model and perceptual model necessitates an unpacking of this acquired agency. It is in the engine room of HEC-RAS that the reduction to one dimension is orchestrated, and it is subsequently here that the specs for hydrographs and geometries are churned out. The machinery at work is composed from the Newtonian principles of mass and momentum conservation. They come formalised and calculable by a computer in the form of the hydrodynamic Saint-Venant equations which can be written like this:

Mass conservation: $$\frac{\partial A}{\partial t} + \frac{\partial Q}{\partial x} = q$$

Momentum conservation: $$S_f = S_o - \frac{\partial y}{\partial x} - \frac{v}{g}\frac{\partial v}{\partial x} - \frac{1}{g}\frac{\partial v}{\partial t}$$

By relating the model composites (cross-sectional area *A*, time *t*, incoming discharge *Q*, length of reach of river *x*, additional flux to section *q*, friction slope S_f, bottom slope S_o, velocity *v*, acceleration due to gravity *g*) to each other, they catalyse the run. Mass conservation, for example, dictates that the amount of water that goes into the model must be equal to the amount of water that comes out of it, thus establishing a relationship between the station/elevation data and the hydrograph. If the channel gets narrower, water levels will have to come up. Similarly, momentum conservation obliges the model to keep the velocity of the hydrograph stable unless the slope or the roughness of the channel warrants otherwise. The important thing is that these differential equations are absolutely powerless without us, the modellers. They relate elements, but they do not render these relationships calculable. For example: the mass conservation equation establishes a relationship between the cross-sectional area (A), time (t), incoming discharge (Q) and the reach of the river (x), and conditions any change in discharge at any given point along the flow of the river on a change in this relationship. It might be that more water is sent flowing through length of the river initially, or it might be that the time it takes to flow through a certain cross-sectional area changes – both would allow discharge between two points to change without compromising the principle of mass conversation – but before any of this can work, the world must be translated not only into these letters, but into versions of them with calculable values. Effectively, that is what I have been trying to describe above. Roughness coefficients, for example, are a way of turning the gravel on the bed and vegetation on the banks into numbers which can justify a change in speed of the flow (without compromising momentum conservation) or a change in the amount of water attenuated (without compromising mass conservation). Hence motorised, the *n* values we keyed in can be put to work in relation to elevation data and discharge:

$$Q = \frac{d^{\frac{5}{3}} s^{0.5}}{n}$$

If depth (*d*) goes up, discharge (*Q*) goes up. If slope (*s*) goes up, discharge goes up. If roughness (*n*) goes up, discharge goes down. Tied in and related through a set of formalisms the composites of the model are made to do something meaningful. Geometries and flows have been grinded to support this meaningfulness, the model seems to close itself around a working whole, the reification of a specific subset of hydrodynamics. I know from my training experience – from the hydrological cycle on the flip chart, from the perceptual sketches of the environment in my field note – that things are missing. Everything is not here. But these are absences for which I have been able to account through my attempt to become a modeller. These are networked absences, co-conspiring parts of an arrangement to make the model speak on behalf of a world much wider than itself. As our instructor points out, there would be no point in models if they were replicating in every particular the things modelled. The point in models, in other words, is their transformation of the things they model into simpler forms. It is this specific and purposive process of doing away with things, which I have been able to engage from my position as a trainee.

Of course, the question of what is missing can by no means be answered in full from my point of view as I am in part guilty of providing an account merely of what works, instead of the alternative layouts of flooding silenced by its success. This is the type of account criticized by post-ANT scholars for its managerialism (see for example Star 1991) echoing Donna Haraway's admonitions about 'being on to the god trick and all its dazzling – and, therefore, blinding – illuminations' (1988, p.584). 'If all power is networked-power,' writes Rose Capdevila and Steven Brown, 'then what is cut away is any space for *differing* with networks' (2005, pp.38-39). In the way of thinking about modelling developed above, I offer no real space for differing with networked power. I can only account for what we (the model-modeller, HEC-RAS and I) do – not what we should do, neither why we do it. What I account for, then, is essentially the way in which the model-modeller becomes effective. As noted, efficiency relies on absence, on limiting the extent of the model so as to make it model rather than replicate. What emerges from my experimental engagement in the becoming of a model-modeller is the location of what seems to be a disjuncture between perceptual and computational model. There are key moments at which things are left out in order to circulate reference between the hydrodynamic equations and the riverine environment, and some of them, the moments where the modeller becomes able to motivate his choice of model by leaping across the gap into one-dimensionality, seem particularly interesting. They contribute to a feeling that the disjuncture between perceptual and computational model might not be so much of a disjuncture after all. There is a definite sense of continuity in paving the road for vegetation to translate into roughness and water into discharge, but it requires us to think about the model not only as a set of equations which have been tweaked, discretized and parametrized, into a functioning piece of machinery with a navigable interface, but as a constellation including human hard- and software (flesh, skill, perception, judgement) as well as. Here, it seems, is the focal point of the anthropo-techno-genesis: the acquisition of the translational capacity to make the world enter the model. It raises questions about the relationship between the data based computer model and the material world it is modelling. What are models actually doing when they model as opposed to replicate? To what extent does it make sense to talk about continuity; the somewhat counterintuitive idea that a simulation in virtual reality is very real, and not so very virtual? What, if anything, sets the model apart from the things modelled? In the following chapter I explore the differences between physical scale models and computational data models as I ask: What are models doing? I suggest that they might be doing a lot more than traditionally ascribed to them by the philosophy of science. I turn, in other words, from the ways in which models are done, towards the things models do. There is a point to this sequence: by asking first how models become it is now clear that they do so as model-modellers; asking what models do should take this hybridity into account.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4. Wet Slabs and Dry Labs

What is Modelled in Hydraulic Modelling?

> *Are the officials really going to wait twenty years? Are they going to spend millions of florins building and destroying wharfs, thus blocking the traffic of the busy harbour? They do not have to, because the years, the rivers, the amount of florins, the wharfs, and the tides have been scaled down in a huge garage that Professor Bijker, like a modern Gulliver, can cross in a few strides. The Hydraulics Laboratory has found ways to render the harbour mobile, ignoring those features deemed irrelevant, like the houses and the people, and establishing stable two-way connections between some elements of the scale model and those of the full-scale port (...) Professor Bijker and his colleagues dominate the problem, master it more easily than the port officials who are out there in the rain and are much smaller than the landscape.(Latour 1987, p.231)*

There is a stretch of the tidal river Severn between Narlwood Rocks and Hempsted where the estuary grows narrower and the stream starts meandering. Just after a major bend at Newnham the low water channel has to cross an area called Frampton Sands laid bare by the withdrawing tide. Between 1926 and 1933 a carefully casted crew of actors came together to determine the route of this channel. Included among them were sands from Calais, Surrey and Bedfordshire, a couple of silicas, and some powdered emeries from the Greek island of Naxos. In the course of their proceedings some of them would disqualify themselves while new ones, such as three different types of ground pumice, would enter the stage. Now, there are two things to be said about the trials to determine the route of the low water channel across Frampton Sands: they were never about determining the route of the channel, and they did not take place at Frampton Sands. In fact, they were about something completely different, namely the harnessing of tidal energy, and they took place in a 50 feet long replica of the estuary moulded in Portland Cement onto a series of cardboard profiles in a laboratory at the University of Manchester (see figure 4.1).

4.1 – Constructing the Severn estuary model. The bedrock was cast in Portland cement onto a frame of cardboard cross sections. A paraffin-soaked wooden island is seen towering from the seabed (Allen 1947).

What I want to argue here is that models do something very real to the world they model. In the previous chapter I attempted not to treat the facts of flooding 'as if [they were] the most primitive, solid, incontrovertible, undisputable materials' (Latour 2005b, p.112). Instead of embarking on an epistemological critique of what proper flood science is or should be I made an effort to let others sort out the facts and allow the actors to deploy their worlds themselves (with the slight twist that I became myself an actor in this deployment). As it became clear, however, it is questionable how much of this work could actually be done from the point of view of the training session, within which my account was situated. Trying to follow, step by step, what it means to 'make the model run' offered a useful way in, but in the attempt to provide some backlighting for screening the host of enigmatic black-boxes encountered in the software, displacements became necessary. At this point I want to make one further displacement from which to think about the relationship between the model and the world it models. And that displacement will take me back to a time before microprocessors and computers to explore the operations of physical scale-models. The demarcation between model and modelled is no longer as seemingly straightforward, the same water flows in the model and in the world modelled, there is no digital/material divide to be invoked. According to Stengers the sciences 'invent possibilities of representing, of constituting a statement that nothing a priori distinguishes from a fiction, as the legitimate representation of a phenomenon' (2000, p. 86). Interestingly, the prevalent construction sites for facts about flooding, namely computer models, produce statements that nothing, neither a priori *nor posteriori*, it could be argued, distinguishes from a fiction. Indeed, their *fictitious capacity* – their ability to simulate hypothetical events – is essential to their modus operandi.

Models share many experimental features with another prime scientific construction site, the laboratory, and are in fact sometimes referred to as 'dry labs'. As Martina Merz points out, both laboratories and computer simulations necessitate a disembedding or reconfiguration of objects, making it 'possible to extract results from them in ways that advantage the scientist precisely *because* they have been partly disembedded from their natural environments' (Merz 2006, p.169). While this invention of fact constituencies by dint of transformation has been successfully recorded in the case of laboratories (e.g. Latour, Woolgar 1986, Latour 1988, 1999) it is debatable how, or indeed whether at all, something similar can be done with simulations. As mentioned in the previous chapter, a recurrent issue is the unclear epistemological status of simulation (see for example Winsberg 1999, Harré 2004) which is often construed as being somewhere in between theorising and experimentation (Galison 1996, Sismondo 1999), a bit of both (Dowling 1999), an unfolding continuum of positions between what Hans-Jörg Rheinberger (1992) calls 'epistemic things' (from which questions arise) and 'technological objects' (from which answers can be sought) directed toward different goals in the research process (Merz 1999), or in pragmatic terms simply 'a third way (...) where theory and experiment stumble (Küppers, Lenhard et al. 2006, Sergio Sismondo notes that simulations are often judged to be 'more or less useful rather than more or less true' 1999, p.247). In the context of models as potential laboratories these concerns are echoed by Tarja Knuuttila when she writes that:

> *Models are typically made out of different stuff and embodied in a different scale than the things modelled. Whereas experimentation under laboratory conditions means experimenting with the objects of interest themselves, the experiments provided by models seem to be virtual at best, giving us merely 'surrogates' for reasoning. (2006, p.41)*

It can of course be debated to what extent laboratory experiments are actually engaged with 'the objects of interest themselves', or if the disembeding and reconfiguration of objects needed to make experiments work is any different from the process of making the 'stuff' of models work to the effect of being 'surrogates for reasoning'. Is it fair to say that whereas objects of interest are re*configured* in the laboratory, they are altogether re*placed* in the simulation model? If so, here is the root of Knuuttila's epistemological concerns: laboratory ethnographies seem to ground experimentation 'in physical reality, as [their] (...) effects are produced with the help of material machinery' (2006, p.41) bolstering their performative view of science against accusations of eroding relativism from more representational approaches. Models, it seems, are not as easily grounded.

Stengers suggests that the constitution of facts takes place in risky dialogue with nature (risky in the sense that it is precisely not a monologue) in which 'whatever we call reality, (...) is revealed to us only through the active construction in which we participate' (Prigogine, Stengers 1985, p.293). Again: the facts are not merely the facts, they have become through a process in which things (in the literal sense) have had to change (become reconfigured), compromises have been made and new alliances forged. Whereas Knuuttila addresses the legitimacy of modelling as a process of scientific discovery – pointing out its lack of grounding in physical reality (as opposed to the laboratory machinery's material engagement with the same) – my business with modelling is of an altogether different kind. Nonetheless: though I have no ambition to settle truth claims or sorting out *what* is fact (and even less what is not) these concerns direct attention to an interesting feature of models and their operations by exposing their fictitious capacity. Is their highly effective and imaginative outputs made possible purely by their disembeddedness, the result of an isolated existence safely beyond the matter/information divide, or are they effective across such a divide, performing not only in virtual but in material reality as well? In this chapter I put this question to the point by examining some unmistakeably 'wet' modelling practices which are wholly incongruent with the idea of dividing reality into material and virtual domains. In the following, simulations are not compatible with the idea of the 'dry lab'.

Experiments in Scale: The Art of Physical Modelling

Since the late 19th century scientific books and papers have been regularly published on the subject of hydraulic modelling. But there is a drastic shift in the content of these publications. Beyond a certain point in time, approximately 35 years ago, flood models seem completely different from how we know them today. Books from the early 1980s (see for example Kobus 1980, Sharp 1981) deal with scaled down replicas of actual rivers or coastlines, physically constructed for hands-on experimentation. The development of computer contributed to changing that, and there is, in this respect, nothing that sets hydrology apart from other sciences making use of models, besides, perhaps, the lateness of the shift (the earliest experiments with hydraulic computer models took place in the 1960's, but it was only with the advent of micro-computing that it really took off in the 1980s). Peter Galison (1996) recounts how scientists like Enrico Fermi and John von Neuman embarked on the development of thermonuclear weapons in the aftermath of World War II assisted by computer simulations. Another computerised modelling outcome of the war was flight simulators. In 1929 German engineers had patented an electromechanical simulation device the likes of which were used by both sides throughout the war (Küppers, Lenhard et al. 2006). Towards the end of it these devices were hooked up to analogue computers providing a far more realistic interaction with pilots and gunners. In general, computing seems to have been a tremendous step forward for modelling as a platform for science. In their introduction to 'Simulation – Pragmatic Construction of Reality' the editors write:

> *The introduction of the computer permitted critical advances on three fronts: (1) Simulated experience became more 'realistic' due to finer-grained responses and shorter response time. (2) More situations and variables could be introduced. (3) The new capacity to inject information into simulation based on real-time solution and representation of complex mathematical equations not only refined simulated learning but also transformed simulation into a research tool. (Küppers, Lenhard et al. 2006, p.6)*

This tendency was of course only reinforced with the introduction of digital computers, but although digitalisation has also meant dramatic changes to the field of hydrology, the contention that it was the computer that 'transformed simulation into a research tool' simply does not hold water here (to use a topical expression)[18]. By 1930, thoroughly techno-mechanical hydraulic models were widely used across the universities of Europe. The first permanent purpose-built laboratories were founded at the polytechnics in Dresden (1898) and Karlsruhe (1901) and the Versuchsanstalt für Wasserbau und Schiffbau in Berlin (1903). 30 years later similar institutions had been established in Leningrad, Toulouse, Padua, Vienna, Stockholm, Delft and Zürich. In 1935 these developments led to the founding of the IAHR (the International Association of Hydraulics Research) which, by the end of the 1970s (while hydraulic computer models were still in their foetal stage (Ippen 1968)), counted 300

[18] The same can probably be said for other disciplines as well. In his 1953 Nobel Prize address, for instance, Linus Pauling stressed the need for physical molecular models in the study of protein structures, a field where numerical calculations and structural formulas were proving increasingly inadequate (Francoeur 1997).

institutions and over 2000 scientists among its members. Curiously, this account of the origins of hydraulic models provided by Helmut Kobus (1980) makes no mention of activities in the UK. As such, this slightly Germanised version neglects the importance of an absolutely key place in the invention of hydraulic modelling altogether, namely the Whitworth Engineering Laboratories at the University of Manchester (what was then Owens College).

It might not be entirely misguided to say, that the potential of hydraulic scale models was discovered by accident. In 1884 the engineer and physicist Osborne Reynolds presented a paper to the Royal Institution of Britain titled 'On the Two Manners of Motion of Water' (Reynolds 1901, ch.48). He was addressing a problem with the theory of fluid motion that had long been well known in hydrodynamics but still kept puzzling the scientists: it seemed to fit well the empirical observations – but only in some cases. What Reynolds suggested was that water was not merely water but could be divided into two distinct classes of water depending on its manner of internal motion:

> *I have already pointed out that the problems of fluid motion may be divided into two classes: those in which the theoretical results agree with the experimental, and those n which they are altogether different. Now what makes the recognition of the two manners of internal motion of fluids so important, is that all those problems to which the theory fits belong to the one class of internal motions. (Reynolds 1901, p.155)*

What he had established was the difference between steady and unsteady, or what is sometimes called sinuous, flow. He had thus laid the foundation – invented the possibility – for solving a fundamental problem in hydrodynamics, namely the theorisation of turbulent fluids and their behaviour[19]. Over the following years he constructed various experimental demonstrations showing how the change of states affected the flow, one of which was designed to show the effects on the circulation of water in the tidal Mersey estuary[20]. In 1887 he built two, somewhat rough, models of the area in the Whitworth Laboratories, they were scaled differently and proportioned so as to make maximum use of the limited space (see figure 4.2).

4.2 – Reynolds' first Mersey models. In this blueprint both models, which are scaled differently to compare scale effects, have been fitted with automatic tide generators (Allen 1947).

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[19] Today, Reynolds' work is important to the operation of computer models in providing the theoretical understanding of different flow dynamics necessary to the simulation. In particular 3-D modellers, engaged in reproducing the vertical motions in a flow, talk about Reynolds stresses and Reynolds numbers (for a history of the Reynolds number see Rott 1990).

[20] A full account of this experiment can be found in Reynolds' 1887, 1889, 1890 and 1891 reports to the British Association (Reynolds 1901, chs. 55, 57, 58, 59).

They were fitted with a tide generator, a wooden pan able to dispense water into the model, and were meant to demonstrate, through the motions of a moveable sand bed, how the tidal bore created turbulent water in the estuary. But then something surprising happened: In the first instance the tide pan was raised and lowered by hand, but as at the first trial it became evident that the model was not only going to show the expected circulation, but was also capable of showing, by the change in the position of the sand, the effect of this circulation on the configurations of the estuary, it was arranged that the model should be worked from a continuously running shaft. The working of the model by hand at once showed that there was only one period of working (about 40 seconds) at which the motion of the water in the model would imitate the motions of the actual tide in the Mersey. There are two changes at play here: the realisation that this is in fact a model of the estuary as such, not merely the tidal bore; and the establishment of a relationship between spatial and temporal scale (the fact that scaled down physical models rely on the appropriate scaling down of time for their ability to model). Later, Reynolds speculated that this could have been foreseen as a function of the relationship between wave height and vertical scale of the model, and between period and horizontal scale of the model, but it was his corporeal engagement with the machinery that brought the realisation about. Besides being the first known example of a running hydraulic model, the Mersey estuary experiments also strikes a note to which all subsequent physical modelling experiments have had to tune up: the effects of scale. The actors assembled to determine the route of the Frampton Sands low water channel, the gathering from which this chapter took off, were no exception.

Sands On Trial: Gibson's Severn Model

The spring tides at Avonmouth have a mean range of 40ft and are among the strongest in the world. In 1926 the Committee of Civil Research decided to investigate the effects of exploiting this potential energy source by constructing a barrage across the Severn at English Stones. This would include building the hitherto largest mobile bed scale-model in Britain to simulate conditions in the estuary, a task which was delegated to Gibson and his assistant Allen at the Whitworth Engineering Laboratories in Manchester[21]. It was Gibson who decided to involve the different kinds of sand, silica, emery and pumice. Having constructed the basic outline of the model in cement he devised a test to determine what material would be best suited for the moveable bed. He knew from earlier projects that the choice of bed material was important. In 1887 Vernon-Harcourt had experienced problems when using silver sand in his modelling experiments with training walls in the Seine estuary[22]. The channel depths were off and the mobility of the material was impeded by the development of a film-like crust covering its surface under water. A range of alternatives were then tested:

> *Some substance was required, not necessarily sand, insoluble in water, easily scoured, and therefore not pasty or sticky, and sufficiently fine or light to be carried in suspension to some extent by the currents in the model, and not merely rolled along the bottom like the silver sand. (...) Pumice in powder proved too sticky; and flower of sulphur was too greasy to be easily immersed in water. Pounded coke was too dirty to be suitable, and particles of it floated. Violet-powder became too pasty in water; and fuller's earth and lupin seed exhibited similar defects. The grains of coffee grounds were too large in water, and moved*

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[21] Detailed first hand accounts of the enterprise are found in Gibson's two reports to the committee (Gibson 1933, the first report deals with the modelling of the estuary, the second with the proposed barrage; they are accompanied by an extensive set of charts and diagrams) and in Allen's later recollections in his book on 'Scale Models in Hydraulic Engineering' (Allen 1947, ch.5).

[22] An account of these experiments can be found in Vernon-Harcourt's report to the Royal Society of London (1888-1889).

> *up and down in the currents too readily; whilst fine sawdust from boxwood and lignum vitæ swelled in water, and was carried along so very easily by the stream that no definite channels were formed in it. The powder obtained from Bath brick, which was experimented upon for some time in the model, both without and with training walls, yielded more satisfactory results, as besides affording shifting channels like the silver sand, it accumulated at the sides of the estuary when the training walls were introduced in the model. It, however, gradually became too compact, so that the current could no longer produce much effect on it. (Vernon-Harcourt 1888-1889, pp.511-512)*

Finally the choice fell on a very fine type of sand from the Bagshot beds near Cobham in Surrey which was found to give good results. For the purpose of the Severn model, however, Gibson was not satisfied with finding the finest obtainable substance that would behave like sand immersed in water without dissolving or swelling up. His master, Osborne Reynolds, had used Calais sand for his model of the Mersey estuary, which seemed to have worked quite well. After sampling sand from the Severn estuary at Framilode, Sharpness, Portishead, Cardiff and Barry Island, Gibson found that the mean diameter of sand from the two estuaries laid exceedingly close to one another (0.00893 inches in the Severn vs. 0.00825 inches in the Mersey) – Calais sand might therefore have seemed an obvious choice for the bed material. But Gibson was convinced that 'there should be some relationship between the scale ratio of the model and of the bed materials' and, furthermore, 'that the size of the grains should differ in a much smaller ratio than the linear dimensions of the estuary and model' (1933, p.23). If this was indeed the case, it was no longer just a matter of finding a substance that would work, but of relating the choice of substance to the scale effects of the model. To determine this, the silicas, sands, emeries and pumices had to be sorted out. First step involved a set of sieves with different mesh numbers (representing the number of openings per lineal inch). The Cobham sand from Surrey was split into two groups: one that would pass through an 80 mesh and one that would pass through a 50 but retain itself on an 80 mesh. The powdered emery from Naxos was sifted to three degrees of coarseness passing through a 50, an 80 and a 120 mesh respectively. The Leighton Buzzard sand from Bedfordshire was sifted through a 24 and retained on a 50 mesh. Thus homogenised, the samples (now consisting of two silicas, three Naxos emeries, two sands from Cobham, one from Portishead and one from Leighton Buzzard, and, as the trials went on, to be joined by three ground pumices and one further sand sample from Calais) were then measured and weighed to determine their exact properties[23]. A microscope fitted with an eye-piece measuring scale and a bottle of water proved essential to this task. Under the microscope the longest and shortest diameter of a single grain could be measured. These values could then be averaged on a sample of 50 grains to a 'mean diameter' and a 'ratio of longest to shortest diameter' (a way of expressing roundness). The bottle of water could be weighed with and without a sampled substance immersed in it to determine the 'density' of the sample. Thus suspended in multiple frames of reference the potential bed materials were put to work.

[23] A full record of this including a series of tables is found in Appendix C to Gibson's second report (1933).

4.3 – The Severn estuary tidal model in the Whitworth Engineering Laboratories, University of Manchester. At this point the proposed barrage has been put in approximately half way down stream at English Stones. The stretch between Hempsted and Narlwood Rocks (the bend at Newnham and the subsequent broadening of the channel at Frampton Sands) is seen in the foreground (Allen 1947).

The stretch between Hempsted and Narlwood Rocks proved a convenient test site because of a complete set of soundings obtained from this area by two consecutive surveys (one made by Captain Beechey in 1849 and another by the Admiralty in 1926). A second stand-in for the estuary was thus available in the Whitworth Laboratory in the form of charts. The difference between these and the model being, that they were already in agreement as to the formation of the riverbed (which had been plotted on to them). The test materials could then be deployed one at a time to perform channels, shoals and banks which could be subsequently measured (see figure 4.4) and checked against the projected formations from the actual estuary.

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4.4 – Cross sections 42 to 45 (just upstream from Narlwood Rocks) showing the deposition of bed material – at this point the 120 mesh powdered Naxos emery reproduced the bottom level of the low water channel from the 1849 survey exactly while the Leighton Buzzard sand formed a significantly shallower, and the 120 mesh silica a somewhat deeper channel (Gibson 1933).

In the first version of the model, which was constructed with a horizontal scale of 1:100, this deployment was done by distributing the substance equally throughout the section. A number of borings had been carried out by the surveyors allowing what was thus known to be rocky parts of the bed to be cast in cement. Everywhere else, adequate space was left for the moveable bed material to settle into its own formations. The soundings from the 1849 Beechey survey was initially used to mould an accurate replica of the sand bed which was then removed and a similar quantity of each test material measured out accordingly. It took about 300 simulated tides (about 5 hours) for the sand samples to settle into their formation and about twice as long for the emeries. This was when the disagreement over the route of the low water channel across Frampton Sands emerged. Here is how Gibson describes the results:

> *Under survey conditions the low water channel cuts across from Frampton Breakwater to Brimspill, afterwards hugging the western shore to Severn Bridge. With some bed materials this condition is produced in the model, but with others the deep water channel hugs the eastern shore as far as Tites Point and the Waveridge sand disappears. This is the case with the coarsest of the emeries, coarse and the fine Cobham sands, the Portishead sand, and the 120 mesh silica sand. Those which give the correct channel are the two finer emeries, the 80 mesh silica, and the Leighton Buzzard sand (Gibson 1933, p.26).*

Figure 4.5 shows the channel as it crosses from the eastern (lower) to the western shore between Frampton Breakwater and Brimspill in the actual Severn estuary.

4.5 – The section at Frampton Sands (Gibson 1933).

Of the four materials agreeing with the survey charts on how to route the low water channel, the 80 mesh silica sand reproduced best the observed conditions in the estuary in general (bank heights, channel depth etc.). However, for reasons not pertaining directly to the tests on bed material it was decided to reduce the vertical distortion in the model. While maintaining a horizontal scale of 1:8,500 the vertical proportions were reconstructed to 1:200. Gibson then decided to run the tests again, this time without the coarser emeries but with the introduction of the Calais sand and the three qualities of ground pumice. As the trials progressed the riverbed modelled was agreeing more closely with the riverbed charted. An auxiliary channel across Noose Sands, also found in the actual estuary, started to form and an interesting change in the group of materials reproducing the correct route of the channel across Frampton Sands emerged:

> *It is in this portion of the model that the difference of behaviour of the different sands is most definitely evinced. The tests show that the following sands reproduce estuary conditions well, the degree of agreement being the order shown:-*
>
> *80 mesh silica sand.*
>
> *120 mesh silica sand.*
>
> *120 mesh emery.*
>
> *50-80 mesh Cobham sand.*
>
> *The remaining sands show the general tendency to develop a channel along the eastward side of the basin as far as Tites Point as was evident in the original model. Although in a smaller degree. (Gibson 1933, p.29)*

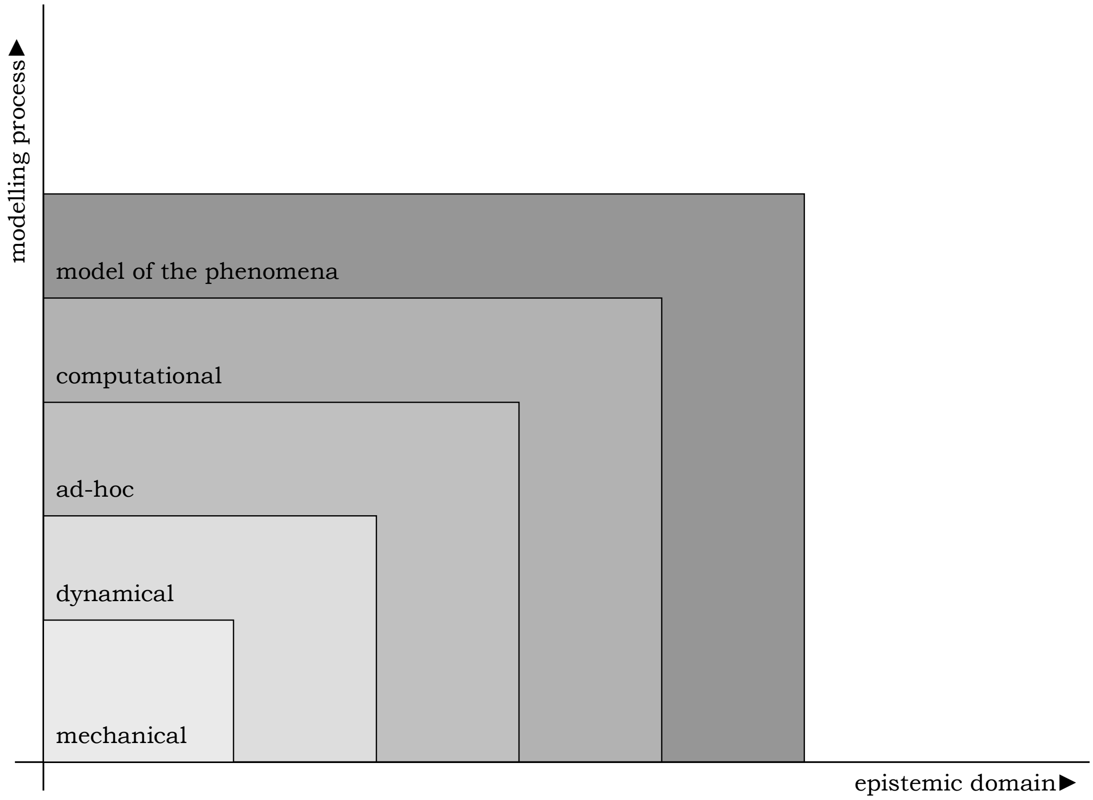
Of the four materials reproducing the correct Frampton channel in the 1:100 vertical scale model only two remained. Four materials seemed to have changed their minds: the Leighton Buzzard sand and the 80 mesh emery had stopped agreeing with the charts, whereas the Cobham sand and the 120 mesh silica were suddenly in accordance with them.

Fictitious capacities

> *These [popular] images, by their very nature, blur what scientists call 'facts' with 'fiction', the products of human imagination. It is by means of such blurring they bridge the gap between science and society. (Nowotny, Scott et al. 2001, p.189)*

The point here is to challenge the idea that simulation models replace the objects which laboratories reconfigure. The interesting thing about Reynolds' and Gibson's experiments in scale is that they are at once unmistakeably material and crucially reliant on intervention, either by reconfiguring or replacing the objects of experimentation. I want to argue that the work it took Gibson and Reynolds to make their models 'model' is in principle no different from the work it takes to make a computer model like HEC-RAS run. Whereas these physical setups had to deal with the effects of reducing scale, computer models must deal with the effects of reducing dimensionality. Instead, I want to focus refocus the discussion about laboratory versus model and suggest that the difference between experimentation and simulation (because there is a difference here) must be found in the power to invent the possibility not only of establishing something as fact, but of churning out believable future possibilities. Simulation models *do* something – they reconfigure what is observably there – but they also transgress it. They assist the pragmatic leap of faith beyond 'the facts'. Gibson's efforts to make the sands and the silicas agree with the scale of his model is in this respect very closely related if not to the philosophy of computer simulation, then at least to its practice. What is modelled in hydraulic modelling is ultimately something which has yet to take place (although it might be calibrated and verified against what has already taken place). Henri Bergson wrote that 'the true, according to William James, does not copy something which is: it announces what will be, or rather it prepares our action upon what is going to be' (Bergson 1946, p.255). If that is to be taken at face value, perhaps the epistemological status of simulation models is not that troubled after all.

Eric Winsberg (1999) makes a hierarchical distinction between 'mechanical', 'dynamical', 'computational' and 'ad-hoc models', all inferential steps in the enterprise of producing 'models of phenomena' (see figure 4.6). The mechanical model, for example, is the 'bare bones characterization of a physical system that allows us to use the theoretical structure to assign a family of equations to the system' (p. 279). In the case of HEC-RAS this would be the Newtonian principles of mass and momentum conservation. To turn these differential equations, what is now called the dynamical model, into a computational model they must be 'converted into discrete algebraic equations for which solutions can be cranked out by the computer' (p. 282). This process is normally known as 'discretization' or 'parameterization' and has recently attracted attention from the sociology of science (e.g. Sundberg 2009). In HEC-RAS the equivalent would be the calculable shallow water equations, the actual engine room, in which discrete parameters like Manning's *n* are related to discharge, slope and depth of the channel. Ad-hoc assumptions can be either eliminative, taking into consideration limitations of computational power, or creative, filling gaps left by these eliminated processes with what Winsberg calls an empirical 'fudge factor'. When asking what is modelled in hydraulic modelling, all these steps are plausible, yet quite diverse candidates: conceptualising the physics of a riverine environment is no less 'modelling' than compromising spatial or temporal resolutions against available computational power in order to get a smooth run. The latter, however, is not the inevitable outcome of the former, which is why Winsberg argues that the epistemological domain of the model must expand for each inferential step.

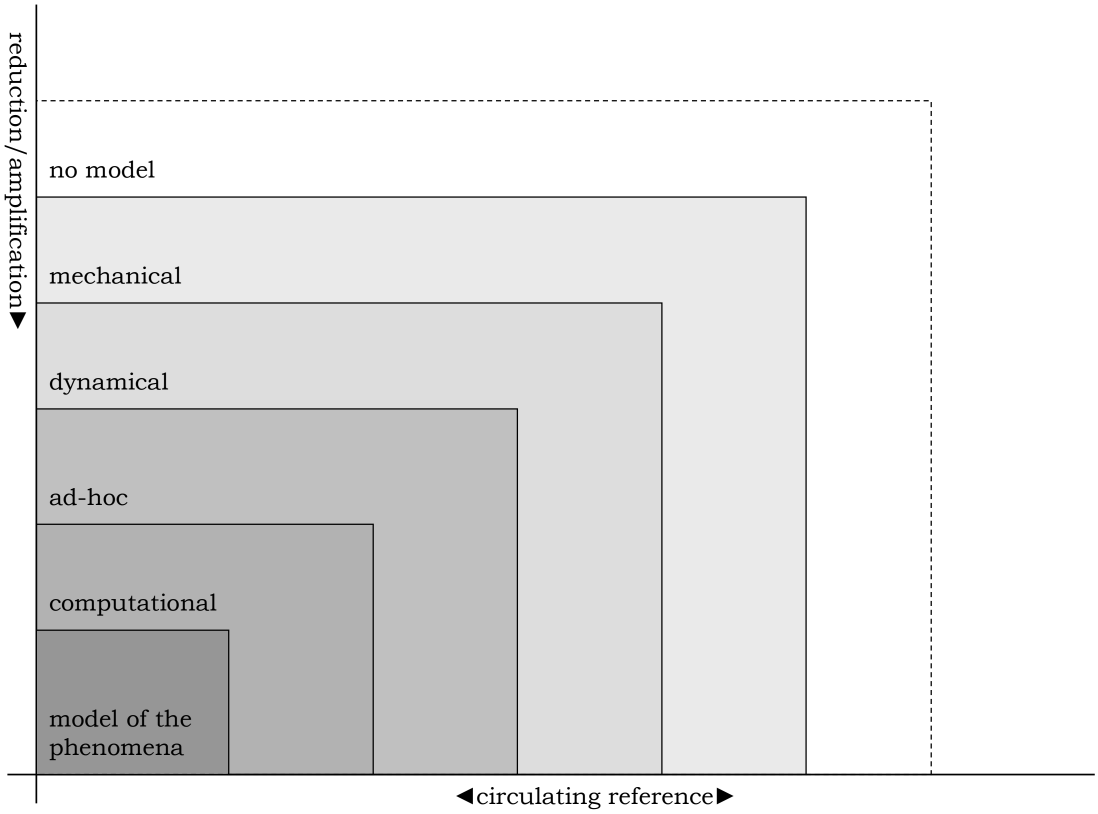


4.6 – Winsberg's hierarchy of models (my illustration, freely after Winsberg 1999): as the inferential process progress towards a 'model of the phenomena' by the transformation of equations into other equations, the epistemic domain expands.

To Winsberg the hierarchy demonstrates how the process of turning differential equations, for which no analytical solutions are possible, into the algebraic machinery of a working model is essentially epistemic in the sense that new knowledge is added (as opposed to the inevitable results deduced from existing knowledge). I want to turn it somewhat on its head. The epistemological concerns are, again, not mine, so I shall leave them aside. On the other hand, the sense of how new actors are hooked up to the assemblage of flood-facts, thereby transforming them in the course of the modelling process, seems crucial to what I am actually concerned with here. Some re-orientation is necessary though. Whereas it is illustrative to

Winsberg's epistemological argument to focus solely on equations – his main concern is to trace out how, and with what right, mathematics come to stand for the world in an experimental setup – there is nothing underwriting the positive discrimination of equations when trying to work out what is modelled in hydraulic modelling.

John Law (2002) has convincingly shown how such formalisms are heterogeneous in all their simplicity, oscillating between that which is present in their terms and all the things that are simultaneously made absent by them. In common language use 'to model' something is to shape it, to frame it, to make it similar in form to something. The effect of simulation, it must be noted, is constructively brought about by carving and moulding the dissimilar until it, as the sculptor would express it, 'begins to model'. This can be said about equations turned into other equations, but it certainly can also be said about whatever is turned into equations in the first place. The gap between math and material turns out to be yet another continuum. It thus challenges the above mentioned distinction between objects replaced (the case in computer simulations) and objects reconfigured (the case in laboratory experiments) since there is no clear sense of when the replacement takes place, if not in the substitution of real world objects with formalisms (which is now understood to be a reconfiguration). This is a sharp contrast to a common assumption about computer models namely that they, in the words of John Casti, are 'constructed out of pure information, not matter' (Casti 1997, p.13). In figure 4.7 I have turned Winsberg's hierarchy inside out in an attempt to counter this segregation of 'pure information' from 'matter'. It now opens up as a reversed funnel until finally no model is around, stimulating the question: what transformative effort does even a mechanical model take? The dotted line suggests a principally infinite number of bifurcations that, had the graph had more dimensions, could strike root everywhere across the spectrum of models. The route via mechanical and dynamical modelling is just one way in which math and material connects. Terms brought in through ad-hoc assumptions, for instance, could have more direct ramifications across the matter/information divide. Returning to Latour's idea of circulating reference, the modelling process is here understood as the simultaneity of reductions and amplifications. The transformative transition from step to step involves the crystallization of more absence/presence, as objects are disembedded (to the point where they become formalisms) and reembedded in computer code, simulation becomes possible and the software begins to model.



4.7 Reorienting Winsberg's hierarchy so that it propagates across the information/matter divide. I have replaced the inferential process and its one direction with the notion of circulating reference.

It has been suggested that whereas laboratory experiments reside in a realm where real-world objects, matter, can be reconfigured and experimented upon, computer based simulation modelling is something different, detached, relying on pure information to *replace* the real world it is simulating: mathematics substituting matter. It would make no sense to deny that there are numerous differences between building a physical model in cardboard and cement, and creating, or simply using, a piece of software. But what is the difference between, say, the river bed in Gibson's Severn model and the one we produced in HEC-RAS? One is concrete and sand, the other is station/elevation data and roughness coefficients? Matter versus pure information? Another way of looking at it is to say that Gibson's model achieves simulation through a successful transformation of scale while HECRAS does it through a similar transformation of dimensionality. In both cases profound transmutation is exacted of the riverbed. While it might be easy to argue that the data points in HEC-RAS are not the riverbed, but a replacement for it, it is thought-provoking that the same is then true for the materials used in Gibson's model. They are materially different, made out of something else, replacing the actual riverbed *which would not work at scale 1:200*. The geometrised software version of the riverbed is no different. It is something else because the actual riverbed would not work in 1-D. This is not an argument against the importance of the computer. On the contrary: the introduction of the computer enables experiments in dimensions and exacts just that of the other actors in the assemblage of which it becomes part. But it is an argument against the idea that computers demand the replacement of real-world objects where physical experiments can do with the re-configuration of them. The importance of computers is no different from that of cardboard profiles, mouldable cement or accurate charts. Instead of enabling scale as an axis of experimentation they enable dimensionality, but that neither makes them more nor less detached from what they model. On the contrary, they operate by dint of the exact same reconfigurations as any other laboratory experiment. What makes them different, however, is their ability to bring a prolific range of possible future floods to live.


flood
catastrophe
modelling
risk
future
probability
chance
distribution
insurance
flooding
possible
way
model
game
floods
question
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time
one
might
chapter
something
events
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Poisson
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water
hydraulic
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MacKenzie
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hydrological
properties
indeterminable
understand
trying
Doyle

5. Dice-like and Distributed

Time Machines, Space Engines and the Enactment of Risk Markets

> ***[i17]*** *Did he tell you that water can even flow uphill?*
>
> ***[AKM]*** *He didn't, but that sounds interesting…*
>
> ***[i17]*** *As a practical insurance person, however, I have a piece of advice for you: if you're standing on a hillside and there's a flood coming, I would still run uphill rather than downhill.*

Canary Wharf, June 2008: It is a sunny afternoon and the business crowd has taken over the outdoor areas along the waterfront. I am here to talk to flood insurance specialists and the change of scene should not go unnoticed: this chapter is set in the financial hotspot spawning from the City of London, well away from the academic offices and engineering laboratories of its predecessors. Insurance has been a core component of the business carried out here since the German Kaiser invaded Italy in the first half of the 13th century and the fleeing merchants resettled in Lombard Street. Banned from entering the existing guilds, the Lombards made it their trade to lend out money at interest and brought with them from the harbours of Venice and Genoa a taste for funding risky mercantile adventures at sea (Martin 1876). With the late medieval commercial revolution, that combination merged into the modern concept of marine underwriting where risk is transferred to a third party in return for a premium (Roover 1945). Insurance and finance were then and are now kindred practices of the monetary system, a duo found in few places as palpably present as on the banks of the Thames.

While the preceding chapters have explored how future floods are brought about, how the possibility of claiming that 'this could happen' is invented, this chapter has its sights set on the ways in which these possible futures become a profitable business. This will involve making flooding answer to questions of likelihood and cost, a process in which a different set of calculative tools than those native to hydrology must be mobilised. What is essentially at stake is the spatiotemporal formation of these eventualities, the way in which they are correlated and distributed, and indeed the way in which it become possible to contemplate their futurity without invoking the type of prediction or foresight that would ruin both the fundamentally unrealised and undetermined character of risk as well as the gamble of trading it: insurance. This will in the first instance bring home James' point that indeterminacy goes live through a cocktail of determinable fact and believable possibility, and suggest that one way in which that ordered universe materialises is through a process called catastrophe modelling. But the chapter also leaves me stranded in a rather unresolved state of affairs in which the cartography of things to come seems both readily at hand and oddly out of view.

Today insurers control 15% of investments in the London stock market (for comparison pension funds and banks control 13% and 3% respectively) and employs almost a third of the people in the financial services sector (ABI 2008b). The industry accounts for 11% of the total worldwide premium income making it the largest in Europe (Swiss Re 2008) and the stake it has in flooding is considerable: in 2007 premium income from property insurance totalled £8.6bn while £6.7bn were paid out in claims and the summer floods alone accounted for £3bn of that loss, an amount rivalled by no other natural peril in the UK (ABI 2007, 2008b). Responding to claims that an increasingly globalised world obsoletes place and leads to an 'end of geography' (as suggested by O'Brien 1992), a 'space of flows' (Castells 1989) in which capital and information moves frictionlessly around the globe, several authors have nurtured a newfound geographical interest in the relation between space and money. Some have targeted preoccupations with place under the banner of deterritorialisation (e.g. Martin 1994, Cohen 1998) arguing the need for 'a conceptual framework for the study of global finance that is sensitive to path dependence and differentiation but recognizes that no nation-state or region can stand apart' (Clark 2005, p.102). Others have called attention to the persistence of industrial agglomerations and the benefits of location in the knowledge economy (e.g. Henry, Pinch 2000, Sassen 2004, 2005), not least in the context of 'global cities' (Sassen 2001) whose networked 'universalism forces new kinds of particularism' (Thrift 1996, p.231).As noted by Cohen the allegedly declining importance of geography is a statement open to a variety of interpretations. Of particular interest here is the discussion unfolded by Doreen Massey around the fundamentality of multiplicity:

> *No one is proposing (I assume) that screens, or instantaneous financial transactions, or even cyberspace, are abolishing multiplicity. That would be like saying that because a telephone call is instantaneous, the participants in it are merged into one entity. And if multiplicity is not being annihilated (which would render the whole business of transport and communication anyway entirely redundant) then neither is space. The very concept of multiplicity entails spatiality. And anyway, to complete the spectre of everything disappearing into a black hole, how could time annihilate space when the two are mutually implicated (...). So: as long as there is multiplicity there will be space. (Massey 2005, p.91).*

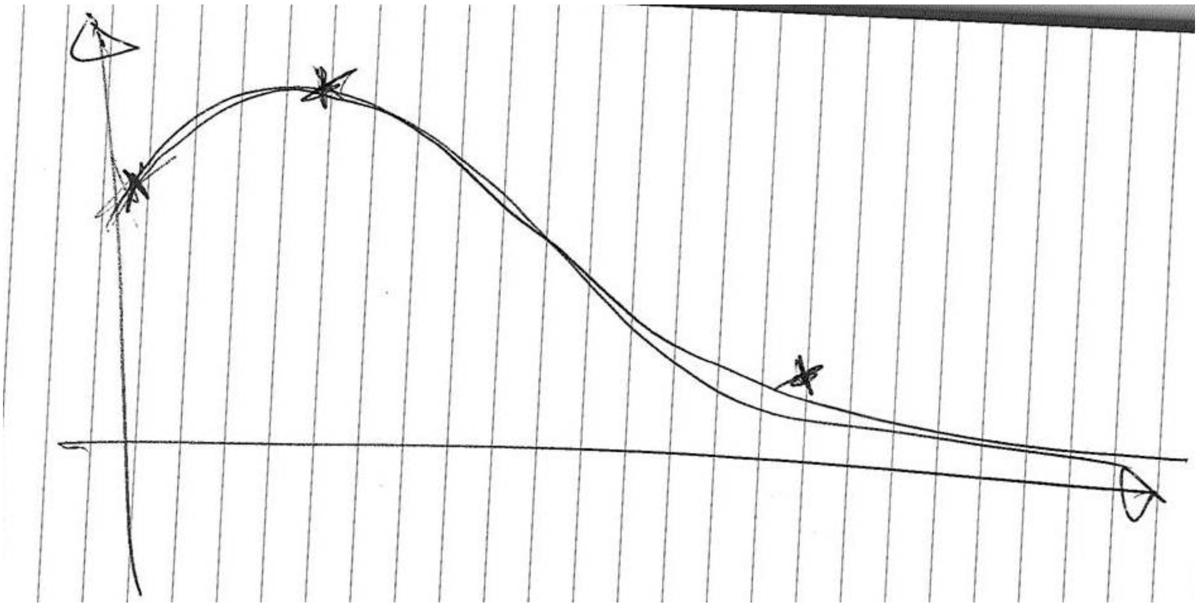
In this layout the possible end of geography is construed and refuted as spatiotemporal, exposing a subtler relation between money and space than the merely locational or place-based. A transaction embodies difference regardless of its instantaneity or disembeddedness, and multiplicity/space is thus at the heart of money itself, rather than a condition to be negotiated or eliminated by it. It adds new poignancy to Thrift's claim that 'money is a set of transacting networks that *both constitute and are constituted by* time, space and information' (Thrift 1996, p.216 my emphasis), and provides a setting for thinking about flood risk as a profitable gamble (which is precisely how an insurer must think about it). When it comes to catastrophe modelling multiplicity is a property of the future, and time is not only spatialized as a 'linear series of instants' (Roberts 1962, p.27) but as consecutive series of correlative possibilities distributed along this linearity. Building on the work of Giddens (1991) Thrift identifies the 'bracketing' and 'colonisation' of time and space as key in the constitution of international credit money (Thrift 1996, p.216). Despite the ensuing disembeddedness, he argues, time and space remain integral, albeit transformed, since in order to achieve disembeddedness very particular space times must be constructed (a similar case has been made by Sassen 2005). What is implied is a notion of 'performance' which is, in Geography at least, traced to the work of Judith Butler (1990, 1993). In this guise 'space is not an anterior actant to be filled or spanned'. Rather, in the words of Gillian Rose, 'space is practiced, a matrix of play, dynamic and iterative, it forms and shapes through citational performance of self-other relations' (Rose 1999, p.248). Money, returning briefly to Thrift's example, does not *have* meaning, rather it *makes* meaning, it 'does not just have a geography; *money is itself a geography*' (Leyshon, Thrift 1998, p.3).

A performative approach to catastrophe modelling offers the opportunity to bring this strand of geography into conversation with the sociology of financial markets. Here, as well, the attention to markets has amalgamated with a newfound interest in performance, which is particularly evident in the research program launched by Michel Callon (1998) and proliferated by authors like Donald MacKenzie (2008, 2009, 2003, with Yuval Milo 2003), Daniel Beunza and David Stark (2004, 2008) or Fabien Muniesa (2000, 2008) in the course of the last decade (MacKenzie, Muniesa et al. 2007, see also the papers collected in Cetina, Preda 2005, Pinch, Swedberg 2008). Rebelling against the Parsonian truce between economics (the technical study of how the market works) and sociology (the not so technical study of the social processes surrounding the market core) (MacKenzie 2005, p.62) the field is united in the effort to rewire 'society' into 'the market', and vice versa. The means by which this enterprise is undertaken are diverse, spanning from an interest in the emotions of market actors (Hassoun 2005) over ethnographic engagements with the role played by 'market culture,' identity, belief and gender (Abolafia 1998, Gao 1998, De Bondt 2005) to a more material or socio-technical focus on 'tools' and 'instrumentation' essential to the operation of trading rooms, where it mediates the abundance of available information (Beunza, Stark 2004, Beunza, Stark 2003), the construction of efficient auctions (Garcia-Parpet 2007) or as support systems for globalised trade (Cetina 2005). What I want to argue is that the performance of risk markets, and in particular those trading flood risk, is spatiotemporal in character. What I am after, in other words, is time machines and space engines; devices with particular performative capacities. 'No tools, no trade,' writes Beunza and Stark (2004, p.389) – in this chapter I set out to explore the tools. Donald MacKenzie's work on the financial derivatives trade is particularly instructive here, as it is not only firmly committed to the materiality of markets (e.g. 2009) but also assertive in its inclusion of mathematics and economics as 'technologies' or devices of this materiality (e.g. 2003). As will become clear, the tools employed by catastrophe modellers to cultivate the necessary time space to make flooding answer to questions of aggregate likelihood are deeply rooted in mathematics.

From determinable to probable

In the offices of the Financial Services Authority (FSA) the man in front of me, a former reinsurance professional (i17), recalls a job he did for a newly privatised Polish insurer back in the 1990s:

> ***[i17]*** *There were no flood models for Poland. But they still had to decide how they were going to quantify the risk. If they get the number too low, then they're not adequately protected against the size of event they might have at a certain level of probability. If they get the number too high, then they pay out huge amounts of unnecessary reinsurance premium which affects their profitability and their competitive position. And there's no model. So how do they decide what to do?*
>
> ***[akm]*** *Did they have a loss record?*
>
> ***[i17]*** *No. There's no data, they have only been in business for a few years. This is why the earthquake people have it easy: in many countries you've got 2,000 years of good data on seismic losses. On flood, really there was very little that was helpful. So we sat down with them and talked about the kind of loss event they thought they might have. Where it might happen, what might cause it, and over the course of the conversation we were able to get from them that they felt that probably 1 year in 5 they would pay a certain number of claims related to flood. There was maybe only a 5% or 1 year in 20 chance of paying out so many claims costing so much, and they felt that realistically the highest amount they were likely ever to have to pay from a flood event, given the area where they had most of their business and so on, was a certain amount. And that effectively gave us – you won't get this on tape but I'll draw it for you – it effectively gave us three points…*



5.1 – i17s drawing in my field diary. Y-axis: probability; X-axis: number of flood events within a given period of time.

> *...and with three data points you can draw a distribution – I can do it now in free hand ... something like that – that's not the best way of doing it of course, the best way to do it is to use somebody who know what they are doing: somebody who knows what shape a flood distribution might have - because different perils have different distributions with different shapes. It's probability of the event and the cost of the loss, and in the end there's a limit as to how hard the wind can blow, there's a limit to where the water can go and all the rest of it. So if we agree that it really can't be worse than a certain point we imagine that is as bad as it gets, the 1 in 500, and if we agreed the 1 in 5 and the 1 in 10, and if someone clever like [former colleague of i17] knows the shape of a flood distribution, they fit the shape of the distribution that they understand to be for flood risk to those assumptions, and you can effectively pack that into a form of probabilistic flood model. Now, it's exceptionally imperfect, it's not based on the hazard and the vulnerability and all the rest of it, it's based on conversation, but it's a lot better than guesswork, it's alot better than nothing.*

Two notions of uncertainty or probability are at play here: one pertains to the imperfection arising from the lack of data, the other to an assumed property of the future. The first notion is epistemic and has to do with credibility, it 'arises from imperfect information and knowledge, which is potentially reducible through data acquisition' (Woo 1999, p.74). This kind of uncertainty is the root of the Polish insurer's problems where it is acknowledged that, had there been a flood model for Poland, and had historical data been available, the situation could have looked a lot different. The key point is the provisional character of uncertainty: it is taken to mean a mendable and thus passing incompleteness of knowledge. The second notion, however, the one which is expressed in figure 5.1, is irreducible and cannot be done away with. It constitutes the other half of what Ian Hacking calls the Janus-face of probability (1975, ch.2), namely that which depends on chance. And because this kind of uncertainty is precisely not construed as epistemic, probability referring here not to the likelihood of being right or wrong but to the likely outcome of a game of chance, it offers itself as an explorable property of the future. There was no model, no data, no loss record, yet the risk facing the Polish insurer could still be contemplated because other characteristics were recognised as being known.

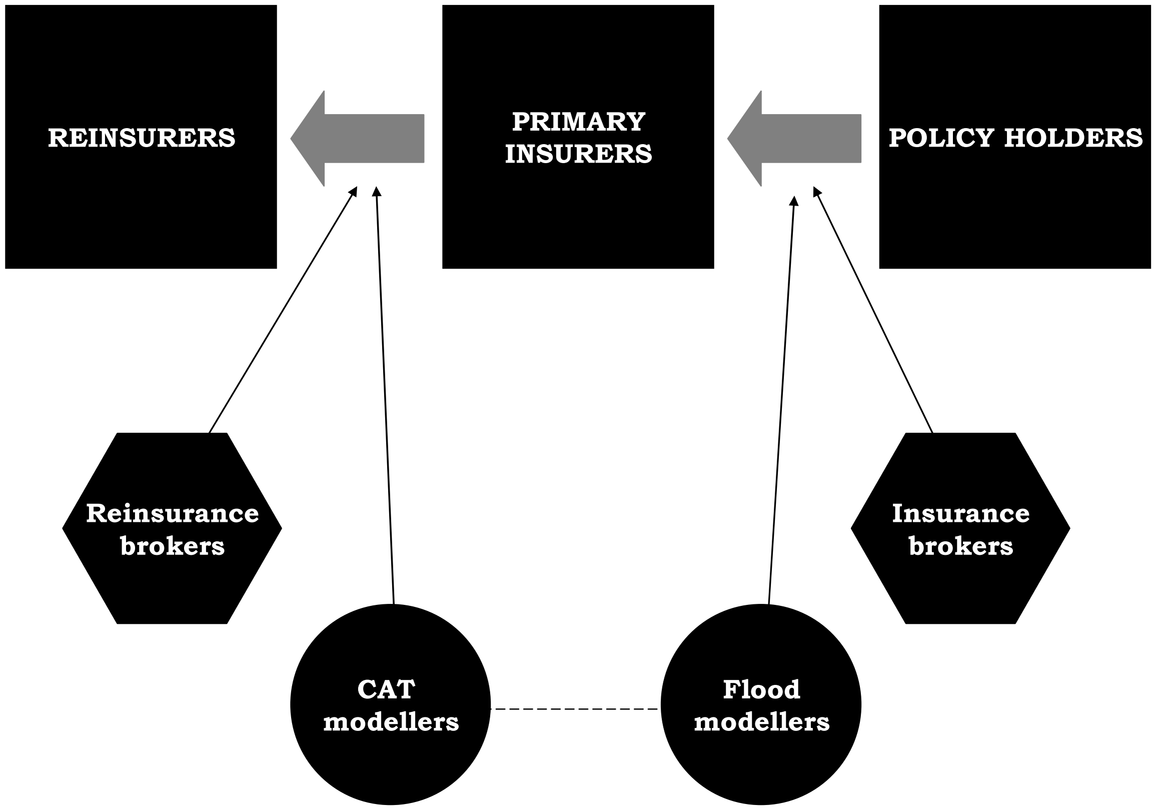
Central here are the graphic qualities of figure 5.1. Rather than a mere reflection of what is already there, it brings something new to the table. It looks like flooding, even when nothing else does. In a manner similar to the way in which flood models claim to represent the flow of water across land, the curve drawn by i17 seems to model something which is determinably out there. What it looks like, of course, is not the extent of an inundation, but the distribution of events over time. And in a manner similar to flood models the curve seems to be capable of projecting this resemblance into the future by transforming correspondence to what has been into assumed correspondence with what will come. It thus possesses related fictitious capacities, but what it brings into being is distinctly different from the possible and plausible futures fashioned in a piece of software like HEC-RAS. By introducing chance it imbues indeterminability, although in an ordered manner, to what would otherwise have become a merely deterministic exercise.

Figure 5.1 is not my first encounter with chance. I have seen these curves before, in other offices in London, met people who 'know what shape a flood distribution might have.' These people, and in particular their probabilistic toolboxes, are the focal point of this chapter. They are not exactly flood modellers, at least not in the hydrological sense, nevertheless they model floods. Their worlds – this seems to be the crucial point of difference – are not assembled around water. Rather, the phenomena they model take the form of events, binaries which can either happen or not happen, and the world in which they eventuate is ultimately assembled around the flip of a coin or the throw of a die. Employed in the re-insurance sector or by the large catastrophe modelling companies, they are in the business of providing the insurance market with an indispensable component of the risk traded: correlated sets of possible futures. Though far more sophisticated than the probability distribution drawn by my informant at the FSA, these futures share one of its most useful characteristics: they too are 'a lot better than guesswork'. That might appear banal. After all: if something based entirely on a conversation is better than guesswork, then it would seem reasonable to think that a state-of-the-art catastrophe model, comprising, as they do, loss records as well as the full spectrum of available hydraulic, hydrological and meteorological data, would also be. But, however much this is the case it does not make it any less noteworthy that, when it comes to the future, we seem to have moved beyond guesswork. That capacity neither springs out of nowhere, nor out of a conversation, nor out of a body of flood related knowledge. The preceding chapters offered a clue to how *possible* future floods are brought into being through what I called the fictitious capacity of hydraulic computer models. The ability to navigate these futures, however, choosing between them, weighing them against each other, comes from somewhere else. It springs from the cultivating powers, harnessed in devices like probability density functions, capable of equipping the future with a set of knowable properties – those of a game of chance – which can subsequently be explored. Julius Caesar allegedly proclaimed that 'the die is cast' ('alea iacta est') when he crossed the Rubicon back into Italy in defiance of the Roman Senate. There was no flood mode for Poland, yet in recognising that a decision needed to be taken the insurers turned to a knowable property of the future. The dice game, it was understood, was on.

Insurers acquire a stake in flooding when they buy up risk from homeowners and businesses in flood prone areas. In the first instance that risk is taken on by a primary insurer who will, in principle, price the transaction like any other actuarial job: the fair price should equal the average loss on the portfolio. It is a statistical rather than a hydrological exercise, provided that records are available from which to derive the average. This, however, is far from always the case and in recent years several primary insurers have enlisted the assistance of hydraulic modellers to supplement their actuarial risk assessments. A prominent example is Norwich Union's £5m project 'Next Map' which entered service in 2004 and became a much publicized affair after allegations that it would lead to reductions in coverage. It was not the first of its kind (in 2002, for example, Royal & Sun Alliance released their Geographical Risk Analysis system) but it was the first to assess flood risk on address rather than postcode level, a project which necessitated the commissioning of an airborne survey to produce a new digital terrain model with an improved vertical resolution of 50cm for the South of England and 1m for the rest of the country (Crichton 2005). Where other insurance companies had relied on data supplied by the Environment Agency, Norwich Union became the first company to seriously challenge this hegemony (although some insurers, like the internet based Esure, had also acquired additional imagery to supplement the EA data). But, while Norwich Union publically claimed (and indeed this is the impression I got from informants who worked on the project) that more accurate flood maps would allow them to take on more business in postcodes which would otherwise be deemed too high risk, and to lower premiums on individual properties which would otherwise have had to accept the same policy as potentially more exposed neighbours, there was widespread public fear that it would lead to redlined properties in otherwise acceptable postcodes and make it even more difficult to get insurance cover for homeowners who had already experienced difficulties. Norwich Union announced that existing customers could expect to have their policies affected (positively or negatively) as the flood map was being rolled out and new information was becoming available (this was done gradually starting with high risk areas such as Norfolk and Shropshire where the 2000 floods had produced heavy losses), and fears were exacerbated when the Environment Agency later that year updated its own flood maps. On August 14th The Financial Times wrote:

> *Hundred of thousands of homeowners could pay significantly higher insurance premiums and face a drop in the value of their homes with the advent of Norwich Union's scheme to re-draw the flood-risk map of Britain.*
>
> *Mapping technology developed by the insurance company can now pinpoint with military precision houses prone to flooding. While this could cut premiums for some homeowners, experts say it could leave some homes uninsurable.*

Address level flood tools are now commonplace in the insurance industry either in the form of actual maps or simply databases matching each property with a flood risk assessment which will normally be in a red-amber-green traffic light format. Because of the way home insurance policies are sold in the UK where 68% of the transactions take place through a third party like a broker or a building society (ABI 2009a) this relatively simple format is required. In a situation where a broker is trying to get a quote for a client from several competing insurers, for example, a traffic light flood risk tool will be able to quickly tell whether or not the property would be refused, accepted or referred to further assessment. RBS Insurance has acquired such a tool (tellingly called Adressology), so has Lloyd's, and Royal and Sun Alliance's Geographical Risk Analysis system is now not only capable of address level flood risk assessments but has also been modified to take drainage problems and surface water flooding into account. While address level assessments have become commonplace in the industry, focus is now on incorporating these types of non-fluvial flooding which have increasingly taken over the agenda and in consequence, as I will explore further in chapter 6, the procurement of more and better EA data in this area has been made part of the latest revision of the Statement of Principles on the Provision of Flood Insurance (ABI 2008a). Whether delivered directly to a primary insurer or supplied through the EA, however, the production of these tools is located outside the industry with external flood modelling consultancies like Halcrow, HR Wallingford or JBA (who did the Norwich Union flood map).



5.1 The transfer of flood risk in the insurance industry. My drawing.

There is thus no doubt that the transfer of flood risk into the insurance community invokes an appetite for flood science in the City. But, as the opening quote of this chapter suggests, the appetite is subordinate to the practicality of insurance, which is essentially about harnessing chance. Choosing to run uphill well knowing that, in theory, so could the water, involves, as do all actuarial enterprises, an estimation of likelihood. Insurance is conditioned by the presence of a perceived hazard, something that is thought possible, and can be understood as the gamble that such a possibility will not be realised. There are two operations at play here: one is about acknowledging the possibility, the other is about making it answer to the question of likelihood. It is only with these two moves that the substantive definition of risk as a combined measure of frequency and severity acquires meaning. Whereas the preceding chapters were concerned with instances of the first move, possibility being here effectuated with the invention of floods as hydrological phenomena, I now turn to the second. Tracking the transfer of risk through the insurance industry offers a prism through which we can start to contemplate how flooding answers to the question of likelihood. Effectively it is a nonsensical question without some sort of spatiotemporal definition. The inquiry must, implicitly or explicitly, be made for a where and a when, and as the transfer of risk progresses those definitions do not remain constant. Neither does the question of likelihood and, notably, nor does the expertise enlisted for the risk assessment.

As shown in figure 5.1, primary insurers are not the termini of the transfer but rather the intermediaries. In turn they will seek to become policyholders themselves and take out reinsurance for the contingency that they should face insolvency and be unable to pay out claims. The space-time of this transaction is fundamentally different than the address level risk assessments defining the transaction between homeowner and primary insurer. To the homeowner, likelihood is a question pertaining to an individual property within a highly variable and often unspecified period of ownership. How likely is it, that floodwater will ever (as long as ownership is retained) come in to the house? Initially that is more or less what the primary insurer wants to know as well except time is now specified by the duration of the policy (there is a difference between buying a property in an area where floods occur on average every 50 years, and having to insure that property for one year only). However, more acute differences materialise when the primary insurer needs to take out reinsurance.

Essentially these derive from the scale and the character of the contract. To the reinsurer, likelihood is a question pertaining to entire portfolios and a particular subset of floods: those capable – on their own or in conjunction – of bankrupting policyholders. The question is not spatially limited to one place with one temporal horizon rather it is a bifurcating inquiry in which multiple likelihoods must be correlated in aggregate space-times. The possibility that floodwater will enter a property must be considered together with the possibility that other properties will be affected at the same occasion. And the possibility of such an event must be considered together with the possibility of other events occurring in the period specified by the policy. This probabilistic complexity is normally produced through a process called catastrophe modelling.

Catastrophe models

In 1992 the hurricane Andrew generated insured losses worth $15.5 billion as it made landfall in the United States. The figure was unprecedented and when a relatively unknown consultancy, Applied Insurance Research (AIR), made an estimate in excess of $13 billion some days before, nobody believed them. The estimate was based on what became known as catastrophe modelling and it paved the road for the uptake of this new kind of expertise in the insurance sector (GIRO 2006). Today it is not uncommon for re-insurance companies like Swiss Re, Hannover Re or Munich Re and major brokers like Benfield, Willis or Guy Carpenter to employ their own catastrophe modellers, but the global market for vendor models is still dominated by three specialised suppliers: AIR, RMS and EQUECAT. Founded between 1987 and 1994 they emerged as a branch of the GIS revolution fuelled by increased computing power in the late

1980s and early 1990s. The purpose of their models is to estimate losses. In contrast to the determinism found in their hydraulic counterparts, the enterprise is probabilistic:

> *(…) catastrophe modelling is not an attempt to predict when a disaster might occur, but a process that allows users to create a meaningful distribution of future events so that associated expected and extreme loss patterns can be developed. This allows exposed parties to gain an understanding of their risks and how they may be financially impacted under different scenarios.(Banks 2005)*

This does not mean that physical or deterministic science has no place in catastrophe modelling. On the contrary: non-actuarial forms of expertise are incorporated at several stages of the process (see figure 5.2). The basic operation of a cat model depend on a stochastic catalogue of disasters, an extensive database of 'real world events that could happen,' as one of my informants put it. The phrasing is illustrative: 'real world' means neither that they have actually happened, nor that they ever will, it means simply that they are possible. They *could* happen. It is not determined whether, when or where they *would*. To ensure this reality-as-possibility, deterministic expertise is enlisted. Seismology for earthquakes, hydrology for floods, meteorology for hurricanes, and so forth – the task is to come up with 'events that could happen'. In a similar manner expertise is needed to turn those events into hazards and specify how they would cause damage (by working out water levels or wind speeds for example). Together the event and hazard modules produce scenarios which can then be linked to the user's inventory of insured assets in order to determine their vulnerability and estimate a loss. Finally a financial analysis is carried out based on a database of policy conditions also supplied by the user (this could be information about excesses or terms of coverage) and the insured loss is estimated.

5.2 – The process of catastrophe modelling (adapted from GIRO 2006).

It might thus be clear that the appetite for deterministic flood science is sustained throughout the process of risk transferral, although the inquiries exiting such an appetite transform. But it is equally clear that the imperatives demanding its implication are not native to the hydrological disciplines. The pressing question is no longer *how* a flood happens, but *how likely* it is to happen and *how costly* it is going to be. Like an informant in the City rhetorically asked me: 'Risk is a quantity that's being measured in pounds in this country, right?' Whereas this is no doubt true for the financial sector, and arguably also for politics, it has so far been wholly absent from my account of flood science. Hydraulic models output water levels in feet, not in sterling; they do not model costs. Yet the risk of incurring costs is exactly what is transferred to a third party in a policy for flood cover (and indeed, this focus on costs can sidetrack hydrological considerations to the extent where banks acting as both mortgage lenders and insurers will prefer to provide cover for a property, which could thus be made mortgageable, if the expected income on the loan is deemed to be worth more than the expected losses on the policy). Catastrophe models make no demands on the end-user to geometrize or hydrograph anything. The work has already been done and is embedded in the software as scenarios. Rather they exact monetization (understood here as the process of enabling things to express themselves in monetary values) and spatiotemporal definition. For the model to model, it needs information about assets, their location, and the period within which a possible loss might occur. It must, in other words, know the space-time and the stake of the gamble. What I want to argue is that risk, as an entity measured in pounds, does not only require a particular kind of geography, but rather brings this geography about through practices like catastrophe modelling.

The Future is a Game of Chance

It is commonly held that Blaise Pascal and Pierre de Fermat, the French mathematicians credited with the invention of the probability calculus, were prompted to their pioneering correspondence in 1654 by a gamester, the Chevalier de Méré, seeking the assistance of Pascal in determining the proper course of action in a game of dice (David 1962, ch. 9). Probability theory germinated out of an interest in the aleatory contracts *already pervasive* in gambling, and while the influence of the Chevalier himself is sometimes questioned (compare David with Ore 1960), the importance of his passion, the games of chance, is not. It provided the terms in which the idea of probability was first formulated, and it continues to constitute the core logic around which probabilities are assembled. Knowing what shape a flood distribution might have is tantamount to being able to imagine flooding as a game of chance: something which has dice-like properties. The proliferation of the term 'aleatory', that which depends on the throw of a die (alea), is not limited to the world of wagers and gambles. It is, for instance, commonly found in juristic works concerned with the equity of chance dependant contracts in fields like marine insurance and life annuities, and 'it is perhaps not surprising,' notes Keith Michael Baker (Baker 1975, p.157), 'that the calculus of probabilities, once elaborated in terms of games of chance, was quickly seized upon as potentially applicable to those probabilities in the social world for which the jurists had prepared the field.' This is fundamental insight when asking how flooding can be made to answer to the question of likelihood: it might have everything to do with likelihood itself, and not a lot to do with flooding in particular. The interesting question is really by what means floods come to be seen as instances of chance, rather than the other way around.

Quite a few authors have written extensively on the history of probability (Hacking 1975, David 1962, Baker 1975, examples include Todhunter 1865, 1990, MacKenzie 1981, Daston 1988) and while they all acknowledge the pivotal importance of renaissance and enlightenment mathematics, many of them also devote some introductory time to the fact that the probability trail runs out somewhere in the archaeological excavations of Assyria and Egypt. This is not to say that there is any evidence that the ancients had a mathematical concept of things like frequencies or stochastic processes (although examples from the Talmud might to some extent be an exception (Hasofer 1967, Rabinovitch 1969)), but the proliferation of dice and dice-like devices for probing the future seems ubiquitous across human history and culture. It suggests that the future was a game of chance long before mathematicians figured out a way of properly theorising that game. It was, for example, not uncommon for the oracles in Greece and Asia Minor to use astragali (an early form of die made from ungulate heel bones) to derive the omens of the gods. Similar usage of randomizers for the purpose of divination has been observed in a number of African tribes, and among Tibetan monks for predicting the coming stages of reincarnation (David 1962, ch.1). To the extent that the future is a game of chance, the difference between an oracle and a probabilistic model is the difference between a game decided by divine intervention and a game evolving in accordance with stochastic principles. In both cases it applies that the aleatory character of the game suffices to bring the future beyond guesswork since a constituent element of such a future – namely the random one – is implicitly acknowledged, randomness being here the notion of multiplicity or outcomes to choose between which is something quite different than chaos. It is important to note this: randomness is an ironed out kind of time in which there is no overlap between outcomes. The die will be either 3 or 5, not both at once. It is not pure chaos. In exploring that randomness, be it as the mouthpiece of the gods or as a domain of mathematics, the future is cultivated. It highlights a tension between the deterministic claims to knowledge accounted for in the preceding chapters and the probabilistic assemblage of flooding engaged here: in asserting that the future, and thereby a possible future flood, has the properties of a game of chance, one is also asserting that the particulars of flooding are, to an extent, secondary. Essential to this relationship is the plurality lost in the word future. It should in fact be many futures, or sets of possible futures. Each of them more or less hydrological elaborate (very elaborate in the case of catastrophe models; not elaborate at all in the case of the Polish insurer having to buy reinsurance without flood models or loss records to go on), but all of them outcomes of the same kind of game, bound together by their allegiance to an aggregated probability of 1:1. The future, in its many possible manifestations, resides in the area under the curve of figure 5.1 with its square measure containing the totality of potential. Outside it there can be nothing, inside it the inevitability of one eventual future must be shared among a not yet realised multiplicity and break down into probabilities. It raises the question about how that kind of futurity, with its stochastic imperatives, amalgamates with the flood phenomena produced by hydrologists and their deterministic models? In his analysis of creativity Henri Bergson contemplates foreseeability and its limitations:

> *Of the future, only that is foreseen which is like the past or can be made up again with elements like those of the past. Such is the case with astronomical, physical or chemical facts, with all facts which form part of a system in which elements supposed to be unchanging are merely put together, in which the only changes are changes of position, in which there is no theoretical absurdity in imagining that things are restored to their place (…) But an original situation, how can such a situation be given before it is actually produced? (Bergson 1944, p.33)*

This attendance to originality implies Bergson's argument that the future is, in a radical sense, unforeseeable. Yet some things, the facts, those fabricated to a standard which does not permit displacements between positions to affect their makeup, the 'immutable and combinable mobiles' (Latour 1987), are nonetheless foreseen. Their mobility is temporal as well as spatial and it is assumed that they will be as immutable tomorrow as they were yesterday. The role of physical flood science in the process of catastrophe modelling is to provide the immutable and combinable raw materials for what is essentially the construction of a die. The catastrophe modelling company I worked with, for example, produced scenarios for each 50 meter grid cell in the UK. They modelled precipitation, hydrology and hydraulic routing to produce about 45,000 flood events, each with an average rate or frequency. These could then be treated stochastically as possible outcomes of random processes (i.e. games involving a 45,000-sided die) to assess the probability of having any number of events in a given area in a fiscal year for example. Probability theory does not transmute as it moves from games of dice to flooding, the rules remain the same. Rather, it is flooding which must become dice-like. Focus is on finding the common aleatory denominator, that which makes flooding no different from any other gamble. It is not the particularities of water and flow, but the cross-cutting ways in which things eventuate that orchestrate this futurity.

Same Dice Game, Different Cologne: Floods, Bombs and Horse Kicks

Vienna, April 2009: In the vast poster exhibition at the General Assembly of the European Geosciences Union I run across a hurricane specialist employed by one of the big catastrophe modelling companies. He has a windstorm simulation running on a laptop and he is very pleased with the way it has turned out. It models the original nicely. As there was no organised systematic tracking of hurricanes in the Mexican Gulf back in the 1960s when the actual event occurred, it is hard to tell whether the simulation is taking the right route or not. What was recorded was the amount of precipitation it produced over the United States, and that is what is accurately reproduced by the model. I am curious to know how that is satisfying to a catastrophe modeller. A real event is simulated, but how does that predict anything? I am looking at it in the wrong way, he tells me. It is not about predictions. It is not about the *truth* in the sense of knowing with exactitude what is going to happen. Rather it is about the *possible*, about generating events that *could* happen. Rainy futures to be, tens of thousands of them, evoked as a first step in modelling the catastrophic.

Bergson is echoed here: a contemplatable future must be made out of immutable and combinable building blocks, which is what the windstorm model is churning out. There is a spectrum between radical unforeseeability and prediction (the future as truth) kept open by aleatory uncertainty which, in the words of Woo, 'cannot be reduced through advances in theoretical or observational science' (1999, p.74). In Bergson it is clear that this kind of futurity is a halfway point at which a limited foreseeability is brought about by enforcing immutability and combinability at the expense of originality and creativity. This is why it makes sense to say that the future is cultivated or colonised. What is still eluding the account, however, is the organising principle: even with the building blocks have been successfully churned out there is no sign of foresight, however limited it might be. Aleatority, it seems, must first be summoned in the set of possible events. A year earlier I am in London talking to the head of flood risk (i11) in the very same catastrophe modelling company:

> ***[akm]*** *So I suppose you would need some data to decide how to footprint these scenarios – how is that done?*
>
> ***[i11]*** *That might take a little longer to explain. How much do you know about statistics?*

The response of my informant is prompt and the awkward feeling that we might have reached the limits of what can be explained in the course of an interview sneaks up. I try to be honest:

> ***[akm]*** *Not a lot.*
>
> ***[i11]*** *That will take some time then, because the standard of catastrophe modelling is about understanding return periods.*

At this point in my fieldwork I am still very much tuned in on the hydrologic aspects of flood modelling and it takes me slightly by surprise that statistics and return periods, rather than the intricacies of some shallow water equation, should constitute what needs to be understood about catastrophe modelling. I have come to talk to a flood specialist, but judging from his preoccupation with statistics he does not really fit my bill of what a flood specialist should be like. I have heard about return periods before, but I have never thought about them as complicated or problematic. One of the first things I did when I came to Oxford was to feed my postcode to the Environment Agency's online flood map (see figure 1.2) to see the extent of the 1 in 100 and a 1 in 1,000 year flood zone. What I got, in other words, was return periods. Each year there is a certain chance of experiencing a flood, or in more professional terms taken from the Flood Estimation Handbook: 'The *return period T* of a flood is a measure of its rarity, defined as the average interval between occurrences of floods that exceed it' (Robson, Reed 1999, p.64). It seems relatively straightforward and I am not quite sure why he is laying this out as a complicated statistical problem that will take some time to explain. As we continue our conversation it becomes clearer what it is I need to understand about these seemingly straightforward average intervals and their limitations:

> ***[i11]*** *If you look at the EA maps they just give you the 100 or 200 year flood zone for example, it's not going to tell you anything, it's not going to flood a 100 year everywhere at the same time.*
>
> ***[akm]*** *I am trying to fit two ends here. When I talk to insurers or the ABI about modelling, what they say is not that different from what you could find on the EA website for example: they talk about return periods as well…*
>
> ***[i11]*** *But that's quite different, right? (…) The EA flood maps, which are largely derived from modelling, what do they really tell you? They tell you, for each location, whether you're in or outside of a flood zone with a certain return period. (…) It tells you statistically the average waiting time between two years that I will be flooded with any flood height. It could be 5m, it could be 10cm, it could be 1 mm. (…) Second thing: the EA flood maps don't give you information about the correlation of two different houses. So if you have two*

> *different houses in one river basin and they are, let's say, 10 km apart, what is the probability that both of them will flood at the same time? Because, as an insurer, you need to know that.*

The last point is the key here: *as an insurer*. From the homeowner's perspective the flood height might be of interest but the correlation is certainly not. Indeed it does not really matter whether it floods everywhere at the same time or not, the important thing is whether or not there is flood water in the living room. The space-time of the gamble is in other words markedly different, and that difference can be measured in pounds: the homeowner risks the value of the property; the insurer risks the value of the entire insured portfolio. Catastrophe modelling is a way of taking this difference into account. And to do that flooding must answer a more aggregate and multiplex question of likelihood than the spatiotemporally simple return period. My informant goes on to exemplify:

> ***[i11]*** *Let's say you have three hurricanes on average per year, that doesn't tell you exactly how many hurricanes you have in any given year. All you can say is: what's my distribution of hurricanes in let's say 100 years, and then you just go through it and say what's my probability of having zero hurricanes? What's my probability of having 1,2,3,4,5 up to whatever, 20, and when you do that analysis you find out that they are approximately Poisson distributed, that's if they're independent. Then you can argue, with hurricanes for example, that if the sea surface temperature in the Atlantic is higher, then there's a higher probability, so they cluster more. So if you have a year when they are higher they are actually much higher, and if you have a year when they are lower they are actually much lower. Then you get a slightly different distribution that's called for example a negative binomial distribution. That's a Poisson distribution with a rate that's Gamma distributed. So there are all these distributions around that, which you need to understand in order to come up with event sets that you put finally in the software.*

Indeed, the same debate about independence is valid for flooding where the 2007 events showed evidence that the first inundations left the ground so saturated that the later ones were much more prone to happen. But whether the distribution ends up looking like the

Poisson or the negative binomial is in principle less important here. What is vital to the aleatority of event-sets is the fact that these distributions *look like floods*. I am thus back at the curve drawn in my field notes by my informant at the FSA (figure 5.1) and the way in which it brings something to the table, something which is known about future floods even when nothing else is. In this case, a lot of other things are in fact known since a whole event set has been produced by the catastrophe modelling company, but a similar curve is still mobilised to deliver what all this available knowledge cannot: the spatiotemporal matrix needed to make flooding answer to the aggregate question of likelihood acutely important to the transaction of risk between insurers and reinsurers. It forges the simple averages of return periods into a much more complex consideration of likelihood.

The Poisson is the most commonly used derivation of the binomial distribution for exploring natural hazards in catastrophe modelling. It was first noticed by the insurance community in the 1940s when a series of papers on its potential use were presented to the Institute of Actuaries (Seal 1943, Lidstone 1943, Clarke 1946) and it is telling that they had absolutely no relation to floods whatsoever.

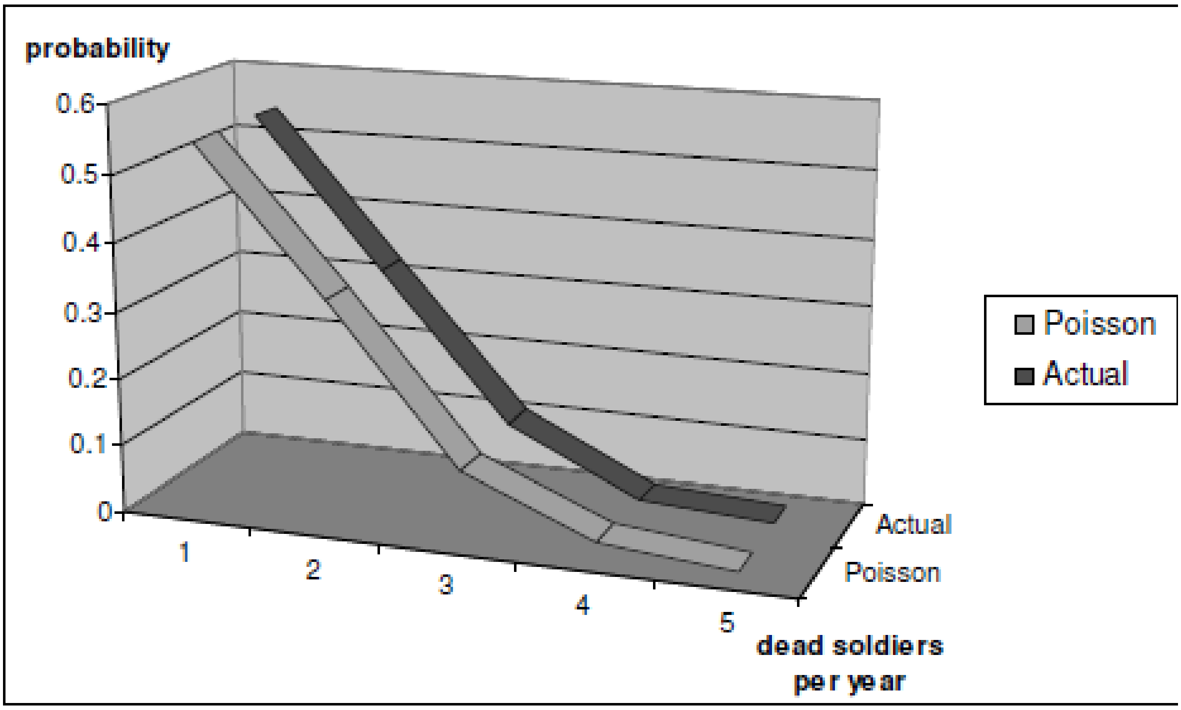
Number of flying bombs per square	Expected number of squares following the Poisson distribution	Actual number of squares
0	226.74	229
1	211.39	211
2	98.54	93
3	30.62	35
4	7.14	7
5 or more	1.57	1

5.3 Clustering of flying bombs (VI and VII rockets) hitting London during WWII (Clarke 1946). The question here is whether or not the Germans had the ability to accurately target particular areas or not. The Poisson distribution is mobilised to show how the pattern of impacts would like if the bombings were a game of chance (i.e. indeterminable and thus not aimed). Comparing actual number of squares hit by 0, 1, 2, 3, 4 or >5 bombs clearly shows that the impacts have dice-like properties.

One paper for instance demonstrated how the Poisson was used by military intelligence during the war to determine whether or not the Germans were able to hit anything with their V1 and V2 rockets (Clarke 1946). A map grid of London revealed differences in the concentration of impacts, with a few limited areas being hit by flying bombs three times or more, while the overwhelming majority of the remaining areas were hit only once or not at all. Would that suggest that the enemy was targeting something? Since there was no way of positively confirming that the Germans were in fact able to aim their rockets, it would have to be demonstrated that the opposite was the case. And the opposite of aiming would be to leave the impact to some sort of random process. It was in other words assumed that the course of the rockets was either predetermined or a game of chance. As mentioned, the Poisson distribution is derived from the binomial distribution and thus works as a series of trials with two possible outcomes (hence the name binomial). Binomial questions could take the form: what are the odds that a flood will occur within a given number of weeks? Or in the native setting of gambling: what are the odds that x rolls with a die will produce a six? Each outcome has a probability (a six or not a six) and a series of trials can thus answer questions about the probability of having particular combinations of outcomes in a particular number of trials. What distinguishes the Poisson from the binomial distribution, however, is that the number of trials is preset to approach infinity. If a flood has a return period of 1 in 100 years, then it has a 0.01% chance of happening in any given year. But what about the month after it has happened? Or the next day? The return period remains the same and the chance is still 0.01%, so what is the chance of having 5 floods in the same year? By chopping up time or space into infinitely small bits and carrying out trials for each of them the Poisson distribution becomes very well suited to answer questions about the probability of very unlikely events happening in any given quantity, and in any given area or period of time, since the number of trials is no less infinite for a year, a minute, a postcode or a country. It is also relatively easy to handle since the only input needed is the average frequency, the mean (normally written as λ in the Poisson), which in the case of flooding translates into the return period. The resulting distribution can be seen as an expression of aleatority: what the distribution of events would be like, that is, if these events were instances of a game of chance. Figure 5.3 shows quite clearly that the clustering of impacts from German flying bombs was indeed very dice-like and that there was thus no basis for concluding that the enemy was successfully taking aim. The characteristic shared by rocket impacts and floods is rarity. It is this, rather than any particular knowledge about the characteristics of a weapons system or the nature of an inundation, that makes them coincide with the Poisson distribution. Poisson himself published the function in a book about jurisprudence (Poisson 1837) while the perhaps best known example of its application was published by Ludwig von Bortkiewicz (Bortkiewicz 1898) applied to the case of Prussian army officers killed after being kicked by a horse.

Number of dead soldiers from kicks by horses per year in a Prussian army corps	Occurrences in 200 years (mean=0.61)	Probability	Poisson for λ=0.61	Expected number of occurrences
0	109	0.545	0.543	109
1	65	0.325	0.331	66
2	22	0.110	0.101	20
3	3	0.015	0.021	4
4	1	0.005	0.003	1

5.4 Death by the kick of a horse I (Bortkiewicz 1898). The second and third column shows the data for the actual occurrences and their respective probabilities. The question is this: what is the probability of having 0, 1, 2, 3 or 4 dead officers in a Prussian army corps any given year, if we know that in 200 years it has happened in x number of years? From this it can be derived that the average frequency is 0.61 dead officers a year, and if that mean is fed to a Poisson function it is possible to calculate what the probabilities and the expected number of dead soldiers would be if their accidents were chance dependent.



5.5 A plot of the data from figure 5.4 visualises very clearly how the Poisson distribution (with λ = 0.61) *looks like* the number of Prussian army officers killed after being kicked by a horse.

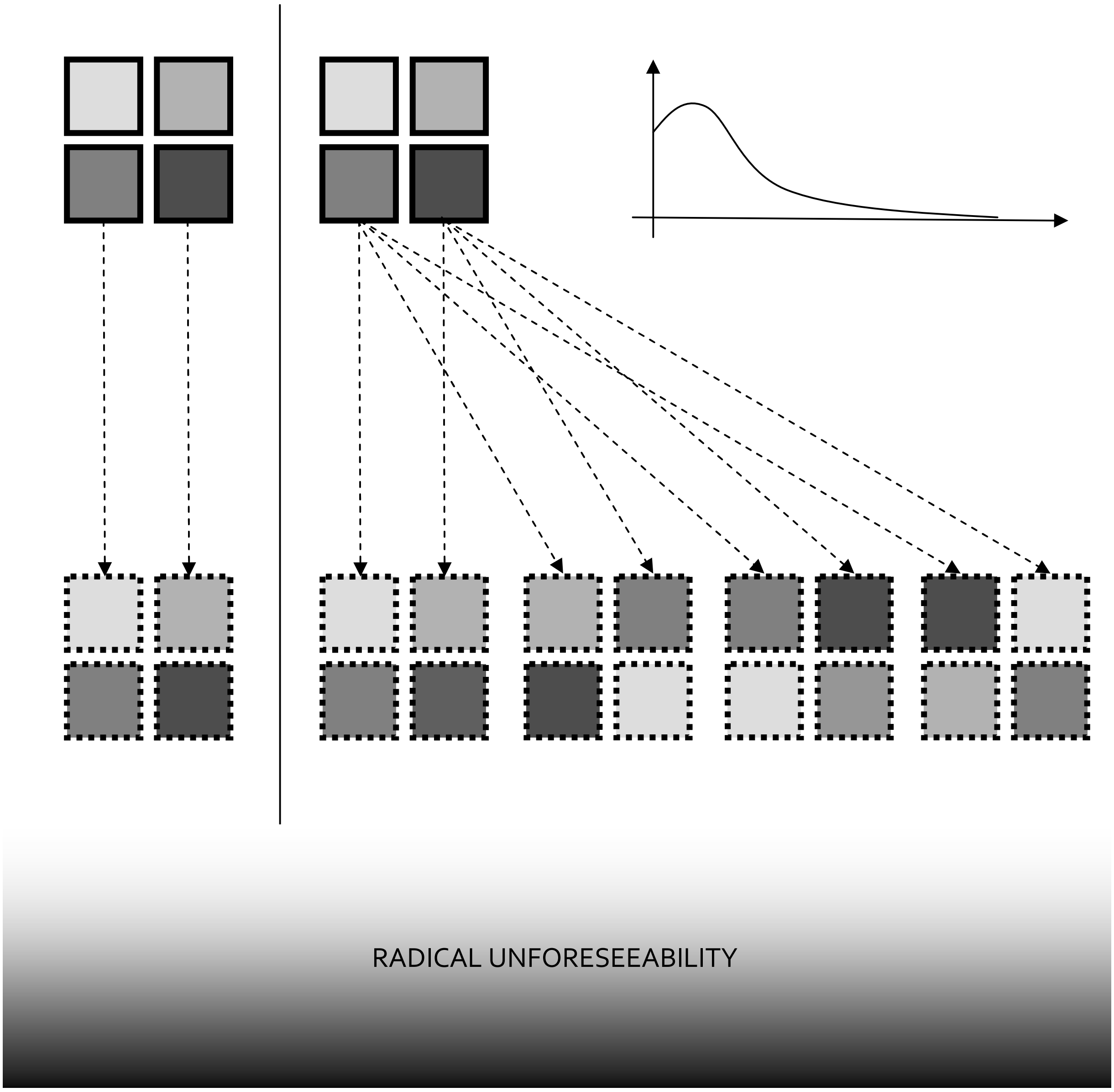
As long as events are deemed to happen extremely rarely, as long as the average frequency is low (like a 1 in 75 year return period flood zone for example), the specifics, that which lends itself to being deterministically known, play a secondary and somewhat arbitrary role. Figures 5.4 and 5.5 show Bortkiewitcz's data on the number of officers in a Prussian army corps killed each year by horse kicks. They essentially compare two ways of knowing this phenomenon. The columns on the left side of figure 5.4 are populated with what has determinably taken place, while the columns on the right display what could be expected if these accidents were understood to be rare outcomes of a fundamentally indeterminable game. The point is that these data tables could just as well have been displaying information about floods or any other rare event. They assert that aleatory uncertainty is a property of the future, a spatiotemporal characteristic that can be recognized and explored. Knowing more about the way in which floods happen, the way in which Prussian officers work alongside their horses, or the way in which the Luftwaffe tries to guide their flying bombs across the Channel, will not make this fundamental element of chance go away. Hence, knowing what shape a flood distribution might have is tantamount to enacting an indeterminable yet somewhat ordered and intelligible space-time in which a multiplicity of possible futures is recognized as being irreducibly there. Risk, of course, must involve some sort of speculation towards the future, but in a crucially indeterminable way. In the case of catastrophe modelling this indeterminacy is orchestrated by the Poisson distribution as it enacts a spatiotemporal matrix for thinking about future floods as the possible outcomes of a game of chance. Although the eventual result cannot be predicted, the nature of the game and its strategic challenges can still be considered. In combination, the types of modelling explored in chapter 3, 4 and 5 aids the becoming of dice-like constructions; large sets of possible future flood events, some of them incorporating tens of thousands of possible outcomes; randomizers which can be used to contemplate the game play of an indeterminable future.

Is this the cartography of things to come?

> *Reality flows; we flow with it; and we call true any affirmation which, in guiding us through moving reality, gives us a grip upon it and places us under more favorable conditions for acting. (Bergson 1946, p.255)*

> *There are two paradigms that govern the manner in which the multiple is thought, as Deleuze's texts indicate from very early on: the 'vital' (or 'animal') paradigm of open multiplicities (in the Bergsonian filiation) and the mathematical paradigm of sets, which can also be qualified as 'stellar' in Mallarmé's sense of the word. (Badiou 2000, p.3)*

I am now in the potentially paradoxical and somewhat ironic situation that the three chapters I have singled out as reminiscent of a long since obsolete mode of inquiry seem to have delivered on my 'geographical impulse to contemplate the kind of space needed for [an] indeterminable, though far from intangible, futurity to take place' (to quote my own introductory paragraphs). It may be that the outputs of flow simulations and catastrophe models are not very well understood as practiced versions of flood risk (the object), but how do they fare with my pledge to 'restore flood risk as a way of doing other things, rather than as an object of other doings'? After becoming attentive, in chapters 3 and 4, to the ability of deterministic flood models to not so much determine facts (if that was their sole point they would indeed be awkwardly stuck between theory and experiment) as to imagine possibilities – and after exploring, in this chapter, how the spatiotemporal machinery of a probability distribution like the Poisson enacts these possibilities into a plural, though far from unintelligible, futurity (reinforced against the 'topsy-turvy reign' of chaos (James 1943a, p.153)) – the question must be asked: is this the cartography of things to come? If the answer is yes, then figure 5.6 might provide a principle sketch for how that cartographic operation would proceed. On the left, the mobility and immutability of the flood scenarios crafted through hydraulic modelling is recognized as being temporal as well as spatial. What has been invented is not only the ability to claim correspondence with what has observably taken place, but to claim that something else could happen. Towards the end of chapter 4 I termed this the fictitious capacity of flood modelling. On the right, indeterminacy is added with the introduction of probability. In effect, that is a way of imposing some sort of order. To be immutably mobile in time is not necessarily the same as being predictive – a 1962 example of the term 'model' from the Journal of the Royal Statistical Society asserts that 'in order to obtain complete predictive accuracy the model would be no simpler than what was being modelled, and would not be a model' (quoted in the Oxford English Dictionary) – and that places the possible futures churned out by imaginative model-modellers right in the middle of the dilemma of determinism. Either these techniques are seen as predictive (which they can never be) or they serve to exacerbate unintelligibility by fueling speculations and leaving more, rather than less, to be reigned by chaos. Thus, catastrophe modeling and its ability to turn these possibilities into outcomes in a game of chance can be seen as a way of reintroducing order, a dice-like order, in which the totality of possible outcomes is known, but the actual course of events is left open. Is that the concoction of actual fact and credible possibility that I am looking for? Is this the way in which indeterminacy takes place, goes live and makes a difference? And if that is the case, then what is the point in opening the event of flood risk to a wider political ecology than the one unfolding over the pages of the past three chapters? In chapter 2, before narrowing my focus and reverting to an ant-like trot in my engagements with expertise, I suggested that floods instil a nascent kind of out-of-placeness by transgressing a wide range of the demarcations on which the bicameral nature-society collective relies. My point was to argue that this opened up a very wide playing field for thinking about the risking of floods, but if figure 5.6 is really the cartography of things to come, it leaves that kind of broader thinking somewhat pointless.



5.6 Is this the cartography of things to come? On the left the immutable mobility is recognised as a temporal as well as a spatial property. On the right side the introduction of distributed probability allows the future to be thought of as a game of chance. In this version the eventual becomes a set of eventualities, possible outcomes of the same game. This enhanced model, however, presume an indeterminable backdrop of radical Bergsonian unforeseeability. Being, as it is, unrealised, it seems that knowing everything there is to know about the future – this is the contention of the square measure underneath curve: there is always a 1:1 chance that one of several discrete possibilities will come to pass – contradicts futurity.

It seems useful, then, to first try and clarify whether or not this is indeed the cartography of things to come. How would one know? In the introduction I suggested that risking and mapping must share a creative capacity. As James Corner pointed out in a Deleuzian vein of thought, there is a distinct difference between mere tracings of 'things which are already known' and proper maps which 'discover new worlds within past and present ones' (p. 214). One way of approaching figure 5.6 could be to ask, if this criterion has been observed? Where is the novelty? In this chapter I have tried to follow Bergson in asserting that any *foreseeable* future must be made up of immutable mobiles (1944); that it must be combined into being using the established elements of the past. In the case of flooding these elements are the products of hydraulic knowledge practices capable, through modelling, of creating fictive scenarios that 'could happen'. And in the case of the spatiotemporal machinery embedded in catastrophe models, the rules of the game of chance, derived from coin tossing and card gambling, are known to apply to 19th century horse kicks and WWII flying bombs alike. Despite its ability to concoct an indeterminable futurity, figure 5.6 is constructed entirely using well known elements of the past. But something more has been made of them. What used to be elements of the past has been turned into elements of the future. This has required work; this is what models do; this is the difference they make. But figure 5.6 is also an expression of neatness which has become temporarily possible only over the course of chapters 3, 4, and 5. It is hard to deny that it does exemplify a world view made 'partly of facts and partly of possibilities' (James p.183); a world view in which room can be left for chance without abandoning all sense of order to perplexing disarray. And it could thus be argued that figure

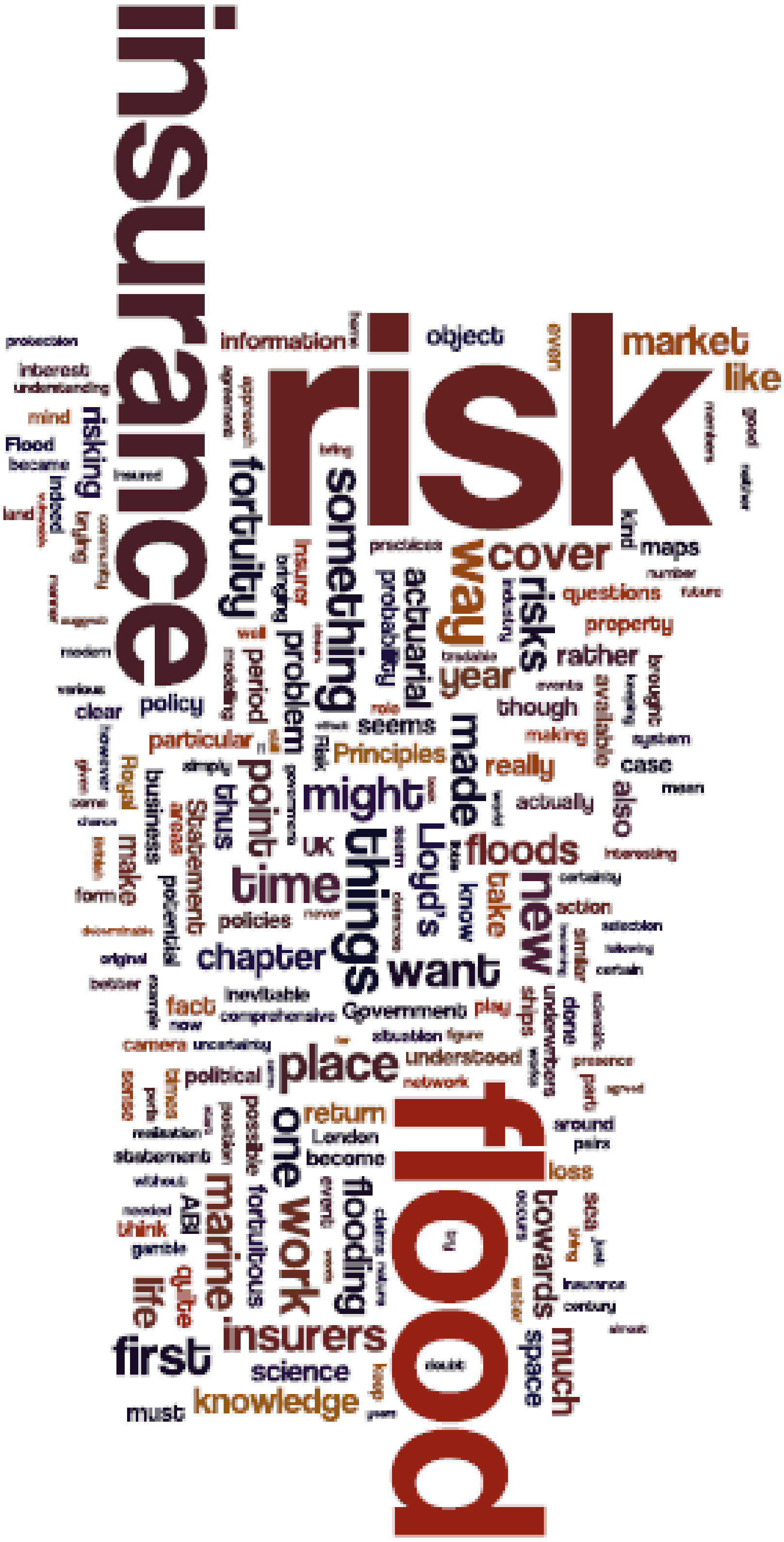
5.6 actually does demonstrate how things which have yet to take place (or not) can be accorded a geography despite their inherently unrealised character. However, this would neither be fair to the issue of flood risk, the broader ecology of which would be rendered more or less detached and inert, nor to Bergson and James, which would have their thinking gravely misrepresented in such a setup.

To say that any foreseeable future must be made out of immutable mobiles is implicitly hinting at the other half of Bergson's argument which I have conveniently omitted above, namely the existence of a future characterized by the 'continuous creation of unforeseeable novelty' (Bergson 1946, p.107); a future which leaves room for creativity, for unexpected things to happen, and for the possibility of bringing something entirely new into the world. This radical unforeseeability hinges on a conception of time not simply as a fourth dimension of space, the kind of time inherent in figure 5.6 and the kind of time which engenders set multiplicities of the kind Badious calls 'stellar', but as a creative force:

> *Time is something. Therefore it acts. What can it be doing? Plain common sense answered: time is what hinders everything from being at once. It retards, or rather it is retardation. It must therefore, be elaboration. Would it not then be a vehicle of creation and of choice? Would not the existence of time prove that there is indetermination in things? Would not time be that indetermination itself? (Bergson 1946, pp.109-110)*

What became clear in chapter 2, and what I will explore further in the next chapter, is that this unforeseeability not only poses a real problem to figure 5.6 – a future made from what has already taken place will necessarily have trouble accommodating creativity – but is in fact vital to the very possibility of risk. Flooding proper, the nascent out-of-place kind, is as much part of the risking as the modelling efforts which must constantly absorb its novelty in order to reclaim that 'this could happen'. Although it is somewhat tempting to settle the enquiry here and claim that, in principle form, figure 5.6 provides a sketch of what it means to be risking the flood, surely, it should be rewired into the 'relatively unnamed stages' of 'thickness, concreteness, and individuality of experience' (James 1987, p.758) which sustains flooding as a matter of public concern?

There is something about cartographic machineries, something which I have touched upon a couple of times now and which seems to grant them a peculiar affinity with processes of risking: they work by resemblance. 'How is it possible, and, indeed, why is it necessary,' asks Chrisitan Jacob, 'to depict and to make visible something invisible, something that does not exist as such in front of the human eyes until an analogical rendering has been achieved?' The interesting point, of course, is that a map is not simply an analogy, not simply a resemblance, but that it works through analogy to bring something hitherto unavailable and completely irresemblable into being. 'Those who look at it and who share the scientific, semiological keys to its understanding are assumed to concur that they look beyond the drawing itself. As an optical as well as an intellectual prosthesis, maps allow a new level of reality' (Jacob 1999, pp.24-25). This thesis is full of examples of such prostheses, not least the facts and possibilities populating figure 5.6, and I want to argue that whereas they are no doubt part of the cartographic techniques involved in risking the flood, they are always absorbed by far more unpredictable, retarding and open-ended space-times in which they must conjure up the concurrence that they conjecture 'beyond the drawing itself'.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6. Towards more eventful questions

To conclude…

London, October 2008: The atmosphere in the City is unusually meek and unassuming. Half way through the turbulent weeks of the worst financial meltdown since the great depression, an ominous wariness hangs like a thick fog between the glassy high-rises. The man in front of me (i18) is the science advisor to one of the major re-insurance brokers. He is an expert on expertise, so to speak, in an industry renowned for its scientific rigour in quantifying risk and uncertainty. Yet, though there is something unmistakeably panoptic about the showcased flood maps, the actuaries computing away at their desks and the sweeping view of the Thames Estuary from the 16th floor office, the conversation we are having is not exactly boasting with the assertive statements of fact one might have expected. No incontrovertible truths, no detached perspectives. The network of researchers he is managing, he tells me, 'isn't [t]here to be a panacea.' He talks about differing views and interpretations, about complexity and endless sources of uncertainty. He does not see it as his job to draw conclusions or make assumptions about what is wanted or needed, so he emphasizes communication:

> ***[i18]*** *I always think, you know Monty Python in Life of Brian, where Brian… some people say follow the god, no follow the shoe, we all have the same concerns but people have differing views of risk (…) And even though every insurer or re-insurer will have a similar concern about quantification of the frequency and severity of flood risk, ultimately, they will have different idiosyncrasies about how they want that to be dealt with and understood. So the Research Network, why does it exist? Simple: it's there to improve or to increase our market's or our clients' comfort when dealing with incomplete, inconsistent knowledge on complex risk assessment problems, flood being probably the biggest*

> *complex risk problem that we would deal with in the natural perils side of that. And the network isn't there to be a panacea. It couldn't be. What it does do, I think, is focus the good work that academics do in the generic risk areas on to some very specific questions and challenges that the insurers generally have. And a huge percent of that is communication between the parties. So it's really a facility to develop research based on conversations and dialogues between people at both ends rather than assumptions to be made about what people want, which I think is not explicit.*

How to conclude? How to shut things up (*con claudere*) when I want to make the case that the preceding chapters have to some extent led me into a dead end? I began my exploration of catastrophe modelling by suggesting that their spatiotemporal machineries are at work to perform a market for flood risk. I never followed that suggestion through, but I want to use it now as a vehicle for making clear why I think there is a need for more eventful questions when it comes to the issue of flood risk. In the previous chapter I explored how possible flooded futures, deterministically worked out to optimise mobility and immutability, attained futurity through the spatiotemporal intervention of probability theory. I thus speculated that catastrophe modelling brought about the necessary space time for trading flood risk and could be understood performatively in relation to such a market. In his recent book on financial models Donald MacKenzie (2008) realigns Milton Friedman's metaphorical framing of such devices as 'engines' rather than 'cameras' with Michel Callon's (1998) performative agenda: economic models do not simply record processes of the market (camera), they bring them into being (engine). When I framed catastrophe models as space engines and time machines I was tentatively alluding to something similar, namely that they bring together the constituent parts of tradable flood risk by enacting a spatiotemporal canvas on which modeled futures can be contemplated as potential outcomes of a game of chance. That resulted in a quite neat model of how to map eventualities (figure 5.6), which (un)fortunately came with the (dis)advantage of being sketched out on the disturbing backdrop of Bergsonian unforeseeability (Bergson 1944). Rather than bringing a conclusion to the main questions of this thesis, namely what it might mean to be risking the flood, and what kind of mappings would offer eventualities presence before they come about, figure 5.6 actualized a nagging doubt about the conditions needed for such a future-as-dice-game to work. I want to nourish that doubt and try to unmask the neatness of the model a little further.

So, I return to the political ecology of flood risk that began to take shape in chapter 2 to try and reconnect figure 5.6 to more expansive 'territories of instruction' (Thrift 2008, p.154) than the ones which suffused it with its neatness and coherence. I want to make the point that an understanding of the cartographic operations involved in mapping eventuality hinges on more eventful questions than the ones which conceived of chapter 3, 4 and 5. I am in other words tying up the ends from chapter 1 and instead of 'plunging in' I will try to pull myself out of the mess I have made and find a place to dry up. The challenge is to argue that it makes more sense to investigate how floods are risked than what flood risk is. This is my ticket to dry land and I begin my pursuit of it by revisiting the Statement of Principles.

A Statement of Principles (revisited)

> ***[i13]*** *The fundamental principle of insurance is that you cover a fortuitous risk. The risk of floods was in some areas getting to a point where it had almost become inevitable. As soon as the rains came down it was fingers and toes crossed. (i13 is the property development manager of a major UK primary insurer)*

From October to December 2000 England was hit by severe and consecutive river flooding. The events spawned the usual jumble of human-nature constellations: the rainfall was extraordinary, the highest on record, but how much of it was natural and how much of it was manmade (i.e. climate change)? In any case the rains were not to take the blame on their own. In East Sussex flood hit towns like Lewes, Uckfield and Keighly showcased how new property developments in vulnerable areas had made matters worse than they would otherwise have been. Poorly designed structural defences trapped floodwater and prevented its retreat while misplaced buildings increased the velocity of the incoming flow. In close by Bevendean farmers had been cultivating the hillsides of the catchment, causing a muddy runoff which overwhelmed the sewer system. In West Sussex, the town of Partridge Green was immediately inundated by the downpour due to poorly maintained, clogged and overgrown drains (Kellman 2001). As I noted in the introduction it was also the first flood disaster in the UK to exceed the hitherto magical £1 billion limit for insured losses. In a report published just days before the first floods in October the ABI had indeed warned that future losses of this magnitude were to be expected if appropriate action was not taken by Government. They were particularly worried about plans to build 3 million new homes before 2016 – mainly in densely populated South East England where vulnerable but affordable floodplain land would be tempting to developers – and highlighted flood defence spending and better dissemination of data and research in the fields of climate science and flood estimation as urgent priorities (ABI 2000).

In the wake of the floods it quickly became clear that insurers were not prepared to continue offering cover by default, as they had done since the 1960s, but the ABI agreed to a preliminary continuation of status quo until the end of 2002. That two year period was used by both sides (insurers and Government) to test out what might be the shape of a future agreement. In 2001 the ABI used the terminology of a 'partnership approach' (ABI 2001a) for the first time. They did so responding to one of DEFRA's own flood risk appraisals (DEFRA 2001) and thus played to the idea that insurers and Government had a common interest in providing adequate flood protection for vulnerable homes. At the same time DEFRA issued a new planning policy guidance (PPG25 (Communities and Local Government 2001)) which for the first time mentioned that flood risk should be considered as part of a planning application (although no statutory responsibilities or mandates were given). Leading up to the expiration of the preliminary agreement in December 2002, several insurers made clear that they did not see it as their responsibility to provide cover for new properties built at severe risk of flooding. In autumn the ABI thus announced that they would not be renewing the agreement and that a Statement of Principles setting out the responsibilities of the Government and insurers respectively would have to be negotiated. A browse through the online archives of the ABI gives a very clear picture of how the flood issue radically changed shape and presence in the insurance community following the autumn 2000 floods. In the four years from 1997 to 2000 the Association released 9 publications which contained 'flooding' as a key word; in 2001 alone that number was 10; in 2002 it was 31; and in 2007 it was 47. And it was not only the amount but also the kind of attention that changed.

6.1 – Tag cloud comparing published press material on 'flooding' from the ABI online archive. The red word pairs at the top are from 1997 and 1998 (5 publications in total) while the blue pairs at the bottom are from 2002 (31 publications in total). The size of the word pairs is relative to the number of times they occur in their respective datasets. Thus 'flood defences' occurs 48 times in the 2002 data, while 'coastal defence' occurs 13 times. Likewise 'cold weather' occurs 12 and 'burst pipes' 6 times in the 1997/1998 data.

Figure 6.1 compares all flood related press releases from 1997/1998 and 2002 respectively (the quantity is so sparse in the late 1990s that two consecutive years had to be chosen). The pairs in the middle section are the ones which occur in both datasets and it is noteworthy that pairs like 'environment agency', 'British insurers' and 'flood risk' have an almost identical prominence in both sets. Thus, 'environment agency' occurs 14 times in 2002 and only 4 times in 1997/1998, but in relative terms that translates to 0.22% and 0.19% of the text respectively. Pairs like 'flood cover', 'flood defences' and 'flood vulnerable', on the other hand, appear much stronger in 2002 which was the year when the first Statement of Principles was eventually signed in September following a long standoff between Government and the industry. The online insurer E-sure, for example, announced that it would no longer write new business in flood prone areas (which prompted a strong reaction from parliament and a storm of questions in the media), the ABI accused DEFRA of understating the benefits of flood defences in their 'Flood & Coastal Defence Funding Review', and they took every opportunity to remind the general public that the continued provision of broadly available and affordable flood cover hinged on the political will to back words with action and improve defences in vulnerable areas. These issues are echoed in the word pairs particular to the 2002 dataset where 'government action', 'provide cover', 'defence funding' and 'flood insurance' are among the high rankers. In the small print, pairs like 'premiums charged', 'urgently needed' and 'repeated flooding' contribute to the picture of an industry acutely aware of the potential threat to its business. This is sharply contrasted in the 1997/1998 dataset where flooding seems to be mostly a matter of 'burst pipes' and 'freezing weather', a problem which tellingly is sought mitigated through 'simple straightforward advice'. The number '75' also occurs for the first time in 2002; it is not to be the last.

Is it possible, now, to come to a better understanding of what all this is about? The reason for revisiting the Statement of Principles at this progressed state of thesis writing is to use it as a litmus test for judging whether or not my efforts have made a difference. So what is going on? Political negotiations to secure certain standards of physical protection in return for certain standards of financial protection? When I interviewed the property development manager of one of the major UK primary insurers (i13) as the latest round of negotiations for a revised statement were about to start in February 2008, we talked about what motivated the talks with Government in the first place. What he told me I had already heard again and again from insurance professionals throughout my fieldwork: 'Flood (...) should be covered by the insurance industry wherever possible'. Logically so, that is how insurers make a profit. However, the autumn 2000 floods had been a wakeup call and successive events in the following years really brought home the point that 'the risk of floods was in some areas getting to a point where it had almost become inevitable.' What was at stake was one of the fundamental precepts for insurance: fortuity. Tradable risk requires a certain measure of uncertainty about what is going to happen, the notion that particular futures are precisely not inevitable. Too much certitude kills of the gamble; a premise valid for both parties in a transaction: clients have no more interest in purchasing cover against something which they do not believe will happen, than insurers have in providing it against something that they know is going to take place. What is thought provoking is that the absence/presence machineries deployed by insurers to represent/produce (camera/engine) flood risk were starting to narrow down this fortuitous space. The rains did not account for the ensuing crisis and ultimate breakdown of the 40 year old Gentlemen's Agreement alone. Flood modeling was at the time beginning to yield results which suggested that this kind of disaster could be a regular occurrence. When the insurance community did not regard the 2000 events as a one off, but as a signal that flooding in some areas had become inevitable, it was very much driven by the devices which I have just singled out as performing the space-time needed to transact insurance. The fact is that by 2001 these knowledge practices had become a hazard to fortuity and, with that, the gamble vital to any insurance contract. As the actuaries chewed through the loss data and as hydraulic modellers started to project flood maps, some areas of the UK were becoming uninsurable as risk was turning into inevitability. Rather than performing a market, these knowledge practices were dismantling it. Some companies, like Norwich Union, managed to reduce the number of uninsurable properties significantly by commissioning more detailed flood maps projecting the risk at address instead of postcode level, but the general trend remained: as patterns emerged in the loss records, and as flood zones were mapped out, the market was becoming smaller. I want to argue that the Statement of Principles can be understood as a way of countering that process. By committing the government to spending money on flood protection in return for promises of continued cover, fortuity could be reinstated.

What does that make of all the modelled futures, the aggregate probabilities, the flood maps and the risk assessments? All the possibilities populating the spatiotemporal machinery of figure 5.6? In June 2007 I meet members of the ABI negotiating team for the first time:

> ***[AKM]*** *I suppose that somewhere in developing the original Statement of Principles, or in devising it, you would have a position on… I mean this 1 in 75 year limit for example, how did that come about? It does, I suppose, in some way reflect your position on when insurance should be available?*
>
> ***[i2]*** *No [laughs]*
>
> ***[i1]*** *Well [laughs]*
>
> ***[i2]*** *Actually no, what happened with the statement of principles is that the 1 in 75 return period is the Government's minimum for defending urban areas. So we just took that as a line because the government had a minimum. That was a convenient take off point.*
>
> ***[i1]*** *It's not something that was based on…*
>
> ***[i2]*** *It's not science… more politics really*
>
> ***[AKM]*** *right, I thought it was…*
>
> ***[i1]*** *Well, I mean at some point there might have been some science behind it…*

[i2] *You thought we'd measured it!*

[AKM] *well… [laughs]*

[i2] *nono…*

[i1] *And it's the question that's still up to be… you know, whether or not that's the right standard, and, you know, there are various questions.. and you know I really.. the Statement of Principles is really a tool for the insurance industry, but it's only, obviously only, a useful tool if you can use it to your advantage, and sometimes there is obviously the risk that it might swing the other way, you know? That's why we need to be quite careful in how we play it and there's, you know, there's a lot of tactics.*

The camera/engine metaphor is no doubt appealing when working with risk in a market context. The problem is that risk cameras – what could potentially be reinterpreted as risk engines – are only part of a broader story. Even though the actuarial ethos holding sway over much of the modern discourse on risk promotes the idea that risk is objectively out there waiting to be recognised (the camera approach), it seems that insurance practitioners engage with risk in a much more direct way. Tellingly, their job is to risk. It is a doing, not a thing. That might sound a bit like the engine approach, but it is not. At least not in the sense that what was thought to be passively representing risk is shown to be actively bringing it into being. This is not to say that risk is not being made. Risk is indeed coming into being, but it is through a variety of converging practices irreducible to cameras-turned-engines. These practices seem to be brought together by what insurers actually do: risking. Below I want to work through that paradox in two moves. The first examines the actuarial ethos of science and precision in a comparison between two contenders for the title as the primogeniture among the different branches of insurance, life versus marine. The second returns to the provision of flood Insurance to make the case for more eventful questions.

Life vs. Marine

> *Guano: The handling of guano calls for great care as it throws off a fine powder which, together with the ammoniacal odour, affects the respiratory tract. (...) Mortadelle: A large Italian sausage. Subject to loss in weight due to shrinkage. (...) Noodles: Usually packed in cartons which, to travel in good condition, should be packed in cases lined with tin and welded. (From the handbook issued to Lloyd's surveyors in foreign ports (Cooper 1956, pp.126-149))*

> *The history of the investigations on the laws of mortality and of the calculations of life insurances is sufficiently important and extensive to demand a separate work; these subjects were originally connected with the Theory of Probability but may now be considered to form an independent kingdom in mathematical science. (Todhunter 1865, p.37)*

The first application of the probability calculus to a world outside mathematics (and gambling) was made by actuaries. Johann de Witt used life tables to price the annuities sold by the Dutch state in 1671 (Hacking 1975) and a century later Richard Price was able to construct a law of mortality upon being consulted by the world's first life insurance company, the Equitable (Hacking 1990, MacKenzie 1981). The actuarial ethos of an arch modern kind of science applied (full of examples which lend themselves easily to the camera/engine metaphor) has a tendency to speak on behalf of the practice of insurance. But to what extent, with the exception of life cover, do insurance markets actually spring into being when actuarial type practices engage in representing (camera)/producing (engine) new kinds of risk?

Scientific publications such as the Journal of the Institute of Actuaries convey the clear impression that actuarial science is almost synonymic with life cover and pension schemes. These themes attract the attention of the overwhelming majority (sometimes all) of the papers published here. The actuarial profession honor founding fathers such as the trader's son John

Graunt who was elected into the Royal Society in 1662 after successfully estimating the life expectancy for the population of London (Renn 1962), or the Newtonian mathematician Benjamin Gompertz who in 1825 'introduced the idea that l_x [life expectancy of x] was a function connected by a mathematical relationship with a continuously operating force of mortality' (Hooker 1965, p.203). Indeed, many members of the Royal Society, including the astronomer Edmond Halley (Raynes 1960), took on the study of life expectancy alongside other scientific problems. However, as the scientists proper of the insurance community, actuaries do not seem to have had the same appetite for/success with other types of risk. It is for example telling that in his 68 page research paper on 'Landmarks in the History of Actuarial Science' Steven Haberman splits his discussion into ten general themes in order to 'to simplify the presentation' (1996, p.4):

> *Life Table and Survival Model; Life Insurance Mathematics; Life Insurance; Pensions; Investment; Risk Theory and Non-Life Insurance; Multiple Decrement and Multiple State Models; Health and Sickness Insurance; Experience Studies and Estimation Rates; Graduation of Decremental Rates*

The term 'non-life' in itself says something about the location of the actuarial centre of gravity. What makes for such a compelling case of science-performing-markets is the fact that known attempts to make life insurance work (in the UK) date back to the late 1500s, but it was not before actuarial science took flight in the early 18th century that a profitable business with long term policies as we know them today began to develop (Raynes 1960). On this backdrop of clear minded, and highly performative, mathematical science it is interesting to contemplate the story of the other founding branch of the industry, namely marine insurance. Contrary to life expectancy there has, as far as I have been able to find out, been no examples of Royal

Society members committed to discovering the laws behind wrecks and losses at sea. This is not to say that the business is devoid of information, but simply that no scientific method is available to calculate the average risk on a policy. Brokers have bought and sold marine policies at the Lloyd's marketplace since the late 17th century. The founder, Edward Lloyd, was the owner of a coffee house conveniently located between the docks and the commercial district so as to become a meeting place for seafaring tradesmen (looking to insure their ships and cargoes) and rich sedentary merchants (looking for ways of investing their money). Lloyd made the most of the opportunity and started to service his new coffee drinking clientele by gathering and publishing maritime intelligence. On October 15th 1696 it was thus possible to read in 'Lloyd's News' that 7 English ships had taken refuge in Amsterdam from French men of war patrolling near Scotland; that doubtful rumours were circulating that a hurricane had wreaked havoc in the Caribbean; and that 10 ships had arrived safely in Plymouth from Barbados under the convoy of HMS Childs-Play. On December 8th the same year it was reported that an inbound Spanish ship had been cast away on the Isle of Wight and that the seamen rescued brought news that a fleet of galleons from the West Indies were not expected in Cadiz that year out of fears for a French ambush; that 800 bales of pepper were en-route to England on a ship from Bombay; and that several Paris based merchants had gone bankrupt[24]. As noted by the Lloyd's member D.E.W. Gibb (Gibb 1957) the war with France must have generated an acute need in the marine insurance market for information about the movements of convoys and war ships up and down the channel, a need which could actually be

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[24] Issues 20 and 43 respectively. They are listed as published by 'Edward Lloyd (Coffee-Man) in Lombard-Street'.

catered for by Lloyd given the relatively short time in which news could travel from the English channel ports to London. Reports from overseas are on the other hand unlikely to have been of much practical use to the underwriters as they would initially have been both very scattered and out of date before they made it home. But this gradually changed. As the Lloyd's market grew bigger so did the systematic collection of maritime intelligence from all over the world – first by the aid of dedicated shipmasters who agreed to send home information as they came across it in foreign ports, and by the beginning of the 19th century through an established corps of Lloyd's agents permanently stationed abroad to keep an eye out for casualties at sea. With the invention of the telegraph this network became a highly efficient way of procuring information and by the turn of the 20th century more than 1,400 agents provided the Lloyd's market in London with more than 64,000 telegrams and 42,000 letters a year (Hozier, Puttock 1901). The British coast guard reported directly to the underwriters, so did its commonwealth counterparts and so indeed did many foreign governments.

The quality of the information available in The Room was such that the marine insurance centres in Hamburg, Paris, Genoa, Melbourne and New York wrote business based on the news they got wired back out from London. Lloyd's even became the preferred place for the families of missing seamen to inquire about the fate of their loved ones. In 1960, a leaflet aimed at introducing the youth to the insurance profession made the following remark about the differences between life and marine lines of business:

> *In life insurance the boy who finds arithmetic especially difficult isn't likely to be happy with the fundamentals of compound interest when seeking a professional qualification in this branch of work. And the boy who was advised to drop geography in his fourth form*

out of sheer lack of interest could probably do better in a branch of insurance other than marine. (Smurthwaite 1960, p.34)

There is no doubt that marine insurance works, and that this system makes it work, nut the camera-cum-engine metaphor is somehow poorly suited to grasp it because the things that make marine insurance tick do not really present themselves as cameras in the first place. The same introductory leaflet cites some of the questions used for the marine part of the 1959 Associateship and Fellowship examinations of the Council of the Chartered Insurance Institute, and it is worth noticing that the knowledge exacted from the candidates has got nothing to do with representing the risk in a camera-like fashion. Rather it pertains to circumstances surrounding the objects insured:

What is the provision in the Institute Cargo Clauses with reference to the seaworthiness of ships, and why is it inserted?

Describe the harbour and salvage facilities at three of the ports on the west coast of North America.

What are the provisions of the Institute Clauses for Shipments of Frozen Mutton, etc. (lettered A), concerning: condition of interest; period of cooling and/or freezing chambers prior to shipment; rail or other land conveyances; transhipment; adjustment fees; interest condemned on or after arrival?

Explain Briefly the recent decision in the case of G.H. Renton & Co. Ltd. v. Palmyra Trading Corporation 1956 (Caspiana case), with particular reference to the effect on cargo owners.

A ship is inclined from the vertical: Explain, with the aid of a diagram, how the forces of weight and buoyancy tend to restore the ship to its original position. Explain the difference between a 'stiff' and a 'tender' ship.

What are the dangers of a cargo which shifts its position?

One has here to keep in mind the actuarial understanding of life expectancy as a 'function connected by a mathematical relationship with a continuously operating force of mortality' and then imagine the marine insurer trying to evaluate the risk of insuring a particular cargo as it crosses a particular stretch of ocean at a particular time of year. Whereas the risk of dying can be traded as a piece of statistical information, the dangers of sea travel must be risked in a very different kind of interplay with a very different type of information.

I want to recall the conversation I had at the outset of this chapter with my informant (i17) in a City-based reinsurance broker. As a flood specialist he did not see it as the role of his research network to be a panacea. The problems facing both insurers and reinsurers dealing with natural catastrophes, he believed, were simply too complicated to be sorted out in such a manner. That, however, did not mean that a research network was irrelevant, on the contrary, but from the perspective of the broker trying to facilitate transactions of risk between insurers and reinsurers, the point in making flood related knowledge available was to instil comfort with the clients. Even though it is agreed that there is no proper actuarial method available for calculating what is being traded, even though there is no camera capable of capturing what is being traded, there is still a role to be played by knowledge. I want to suggest that knowing something about the properties of a cargo under the conditions of sea travel, or trying to construct a game of chance in which possible future floods can be contemplated, are movements aimed not at representing 'the risk', but at keeping open a fortuitous space. This is a work which oscillates between determinability and chaos, both of which are antithetical positions to fortuity.

A distinct feature of the Lloyd's trading floor is a peculiar rostrum with the recovered ship's bell of the HMS Lutine, a Royal Navy frigate lost off the Dutch coast in 1799 while carrying £1,200,000 in gold to distressed banks in Hamburg. The cargo was insured by underwriters at Lloyd's, who became the lawful owners of it after paying out the claim and consequently made numerous attempts to salvage it. Unfortunately, the bell was one of the only things they managed to retrieve from the silting wreck. It rang until recently to alert the underwriters of incoming news about missing ships and is perhaps the most visible testimony in the Room to the host of devices at work to keep this place fortuitously suspended between play safe certainties and their deterring absence. It is a precondition for insurance that hazards are perceived neither as inevitable, nor impossible, but as chance dependant, enabling the potentially profitable gamble of taking on a risk. It simultaneously assumes an inability to pinpoint with any exactitude when or where losses will occur and a capability to advance various legitimate speculations towards it regardless. Thus, insurance must take place in the middle, not only in the sense of where underwriters meet their clients, but in the sense of a phenomenal halfway point where recognised eventualities have yet to eventuate. It might thus be that Lloyd's is no longer the buzzing coffee house it used to be, but the features that made such a place a suitable incubator for the world's leading marine insurance market are nonetheless intact. Rumours from the seven seas now share the fuss with a mix of other knowledge claims – flood maps and disaster scenarios, for example – but the comforting effect this fuss has on the clientele is unchanged. Lloyd's is not an insurance company, it is a meeting place. A place in the middle (between docks and commerce; between brokers and underwriters; and between certainty and its antipode), and thus a place in which insurance becomes possible. In 1901 the then Secretary of the corporation, Colonel Henry M. Hozier, delivered a series of lectures at the Royal Naval College in Greenwich titled 'Our Commerce in

Maritime War' in which he warned that it would not be without consequences for the Royal Navy to neglect the necessity of keeping the ships of the empire on the seas in case of war:

> *It is evident that our own country – the United Kingdom – which is the head and heart of the Imperial, social, governmental and most important of all the financial system of the Empire, can only, being islands, communicate with the various colonies and possessions by sea; and these can communicate with each other also only by sea.*
>
> *Our social system has become so complex, that for some time – and more markedly than ever previously, during the last few years – we have been compelled to depend to a very large extent for the supplies necessary to feed our population, on sea-borne transport. It is estimated that thirteen millions more are dependent on somewhat higher wages, and if we lost the command of the sea would be to an almost equal extent affected, so that we would have 20,000,000 bordering on starvation; and should have to expect bread riots, bakers' shops looted, warehouses stormed, sickness and mortality, and civil disorder.*
>
> *This danger is one of the great dangers that our Government would have to face in case of interruption of the wheat supply. (Hozier, Puttock 1901, p.xxi)*

What was the Secretary of the world's leading marine insurance market doing here apart from being patriotically concerned for the well being of the empire? My contention would be that, in a manner of striking similarity to the negotiations around the Statement of Principles 100 years later, he was *tending to fortuity*. By making the protection of the merchant fleet a matter of vital public concern (or by playing to the notion that it was) the establishment of a fortuitous middle ground for the conduct of marine insurance was no longer solely in the hands of the intelligence network around the world and the underwriters in the room, but a work engaged (in the military sense of the word) by the Royal Navy. Similarly, a lot of work is done through the Statement of Principles to make flooding risky as opposed to inevitable. Crucially, however, it is not camera-like acts of knowing 'the risk' which constitutes the main part of that work. Rather, the work is to risk. From an insurance perspective, turning a flood hazard into tradable flood risk is not reducible to the process of ascribing frequencies and severities to it; it might include that, but the goal is always, by whatever means possible, to keep open a space of fortuity in which flood risk is actually possible. Could it be, then, that all this information, and the work involved in bringing it about, is more adequately understood as ways in which a space of fortuity is continuously suspended between certainty (which kills of the gamble) and its antipode (which scares of the gambler)?

Tending to fortuity

Be it the flood footprint for a Realistic Disaster Scenario or the aggregate probability calculated by a piece of catastrophe modelling software, a problematic dilemma seems to crop up between the ability of these phenomena to assert their presence and the role they play in the risking of floods. Or rather, the problem is not that they strive towards self-containment and disentanglement in order to present themselves as phenomena, the problem is how to reconcile that mechanism with the unrealised and open-ended character of fortuity? There can be little doubt, keeping in mind the multivarious professional usages of the label 'risk' (Holyoake, Weipers 1999), that a reinsurer might very well treat a client's annual exceedence probability – the likelihood, that is, that a primary insurer will face a bankrupting amount of claims in any given fiscal year – as an *expression* of 'the risk' involved in insuring that particular portfolio. In a similar manner, although with slightly different conceptual bearings (this time referring not a hazard instead of a likelihood), the Lloyd's underwriter considering the footprint for an extreme flood event in the Thames catchment is likely to treat that information as pertaining to 'the risk' of flooding. Potentially that is in itself really interesting because it exemplifies with great clarity how things which have yet to take place come to have an impact prior to their possible realisation through some very tangible and all but unrealised phenomena. It would simply not make sense to pursue a cartographic understanding of what it might mean to be risking the flood without according things like aggregate probabilities or flood footprints a central role in that enterprise. But what role, exactly, should they be accorded?

If it is to be accepted (for the sake of argument) that they express 'the risk', that they are in fact present concretisations (differently assembled to suit different purposive communities of practice) of some indeterminable future possibility, then the dilemma must be addressed: how can something which prescribes open-endedness and non-realisation be expressed through entities which tend towards closure and work by dint of reduced complexity? The dilemma is nicely captured in Joost van Loon's attempt to frame risk as a 'virtual object' (following Law 1995, Mol 1998):

> *The problem with risk is that it does not exist without representation. By definition there is no unmediated risk (...). Its presence is thus always necessarily deferred. Risk is a potential coming-into-being, a becoming-real. Hence the 'presence' of a risk can never be completely objective but has to be mediated in 'some form. (van Loon 2002, p.54)*

And he thus goes on to assert that:

> *Whereas we can only speculate on the reality of risks beyond their articulation in (resistance to) trials, it is hard to deny that risks exist, if only because actants actualize them in everyday settings. (...) By their very nature, risks cannot be 'real,' for they would cease to be risks if they were more than a potential of becoming. (p.63).*

This paradoxical notion of deferred presence is, I think, beautifully capturing the inherent tension which makes risk a fascinating topic. But it also occurs to me that part of the ensuing conceptual headache could be avoided if the default assumption of risk as a designated 'it' could be abandoned. This is effectively a matter of language and it is for this purpose that risk must be restored to its verbal etymological origin. The dilemma which Van Loon tries to bridge with the compromise of the virtual object has some affinity with Whitehead's example of the Great Pyramid as an event in that it confuses the object for the real (unreal, virtual) element:

> *The whole subject is invested with an unmerited air of subtlety by the fact that when the event is the situation of a well-marked object, we have no language to distinguish the event from the object. In the case of the Great Pyramid, the object is the perceived unit entity which as perceived remains self-identical throughout the ages; while the whole dance of molecules and the shifting play of the electromagnetic field are ingredients of the event. An object is in a sense out of time. It is only derivatively in time by reason of its having the relation to events which I term 'situation'. (Whitehead 2004, pp.77-78)*

Asserting in a similar fashion that risk must be understood as an event, and that 'the risk' is a derived abstraction from this more fundamental practice, opens up some possibilities. First of all it allows the framing of all the realisations I have encountered in chapters 3, 4 and 5 as being part of risk-the-event rather than contenders for the status of risk-the-object. A return period is best understood as a return period, rather than an enacted version of flood risk (noun). So is a rain depth. And so is an estimated loss. But what role should they be accorded in the risking of floods? Now that it no longer collides with the unrealised peculiarity of risk, their tendency towards closure offers itself as an asset in the constant (re)construction of fortuity. It provides fixture and adjustment towards certainty, which helps to counter balance the upsetting play of water out of place. Secondly, but perhaps more importantly, under the sign of the event risk can be adequately framed as a productive situation from which a host of objects/knowledge claims exude.

The Statement of Principles is essentially a way of making sure that floods are still potential eventualities and not predictable certainties; even though insurers are demanding better defences and more restrictive planning policies, what they are effectively asking for is more uncertainty and thus a reinstatement of fortuity. The 1 in 75 year return period becomes a vehicle for that reinstatement, rather than a way of pinpointing an acceptable level of flood risk. This is the root of the first challenge presented by radical unforeseeability to figure 5.6: if the realisations that are in there are seen as performing flood risk, then they are systematically suspending the vital indeterminability of the concept. If, on the other hand, they are seen as movements in a broader process of risking which takes as its goal to tend to the fundamental element of fortuity, then perhaps this play of radical unforeseeability will become an asset rather than a problem.

To understand how that might be the case I want to recall the notion of flooding as water out of place developed in chapter 2. Risk and its prerequisite fortuity require a balance between the determinable and the chaotic. Crucially, however, risk is absolutely antithetical to both these positions and cannot revert to any of them without obstructing its own possibility. That is effectively what makes the substantive definition of risk as an object hugely problematic: any realisation of such an object will tend to push it towards the determinable. Nonetheless, objects of that sort are constantly realised and distinctively labelled 'risk'. In fact, they are better understood for what they are: a probability, a flood depth, a cost, a sentiment, a map, an asset, a postcode, a game. What I want to suggest is that these becomings can be fruitfully re-imagined as ways of adjusting towards the determinable, while other processes, like the Statement of Principles or the betrayal of placeness committed by floods, adjust towards its antipode. The underlying notion of radical unforeseeability is crucial here because it prevents the realisation of flood maps, return periods, exceedence probabilities or loss estimates from pushing a fragile fortuity too far towards play-safe certainty.

Chapter 2 offers a very concrete example of how this prevention takes place. In disrespecting territoriality, in transgressing the established divide between environed and environment, in betraying the bicameral nature-culture collective (Latour 2004), flooding instils a fundamental kind of creativity which forestalls the hegemony of a future made up of well known elements of the past. In the words of Serres 'floods take the world back to disorder, to primal chaos, to time zero, right back to nature, in the sense of things about to be born, in a nascent state' (1995, p.51), and it is from this fertile chaos that unforeseeability profuse. By adopting web crawls as a symmetrical mapping tool, a 'Lippmanian' (Marres 2007) device which does not take as its starting point a predefined political entity or social group, it became possible to tease out the volatile and composite morphology of a public constantly forming around the UK flood issue. Water out of place seems to spark a changing range of becomings: new constellations of environed and environment constantly implicating new material geographies such as those arising from surface water, urban drainage or heavy rainfall.

The political ecology of flood risk is in other words quite irreconcilable with the idea of the immutable mobile; changes are not merely 'changes of position' and it is indeed a 'theoretical absurdity' to imagine that 'things are restored to their place'; on the contrary, flooding does create 'an original situation' which is not 'given before it is actually produced' (Bergson 1944, p.33). The really interesting thing is that it is not only the institutional collective tasked with keeping water in place that is caught up in, and transformed through, this original situation, but a much broader list of implicated parties and practices, including those churning out the immutable mobiles making up figure 5.6. As I showed in chapter 1, the 2007 floods redefined the way in which a disaster scenario could claim to be 'realistic' and exacted a new approach to flood modelling that could circulate reference between a flood footprint and a hinterland packed with surface water issues, changing weather patterns and the effects of rainfall runoff. In a similar manner the catastrophe modelling company that I visited in chapter 5 had been prompted by the summer floods to consider changing the rules of flooding (the dice game) from those of the Poisson distribution to those of the negative binomial, in which the probabilities of particular outcomes are not independent (the second or third flood in a year is more likely to happen than the first).

I would like to propose that risking proceeds by continuous and paradoxical movements between stability and chaos. It is a precondition for insurance that hazards are neither inevitable, nor impossible, but fortuitous: possible, chance dependant. This element of chance, vital to the potentially profitable gamble of taking on risk, depends on an inability to pinpoint with any exactitude when or where hazards will eventuate and a simultaneous capability to advance various legitimate speculations towards it regardless. The standard formats of substantive risk – measures of probability and magnitude, maps showing extent and vulnerability, visualised statistical information – originate in a far more verbal version of the concept, the practice of risking. What risking brings about, however, is not risk as such but a range of other things – territories, futures, publics, objects – needed in the continuous paradoxical enactment of fortuitous space. This version of risk as a way of doing other things calls for re-imagined constructivist vocabularies to capture its modus operandi not as a thing done, but as a particular type of doing capable of leaving things permanently poised between primordial ontological ooze and realisation, neither pure potentiality, nor indisputable being, inconclusive, yet tangible and effective. Such a vocabulary, I suggest, could be fruitfully adopted from cartography. Risks seem to share the enabling capacity of maps; they make otherwise unavailable worlds available to us; they hint towards possibilities and function as a kind of forward operations base in the absence of more solid kinds of knowledge. The UK flood issue makes it quite clear that, however much their substantive formats might be framed as events in becoming which never take place (van Loon 2002), risks have geographies; that they come with a spatiality and affect territorialities (November 2002, 2008, November, Campacho-Humber et al. 2010); and that the mappings which bring these geographies into being (Corner 1999, Thrift 1996) are processes with very real and material consequences. In commenting on John Wilford's grand cartographic history of 'The Mapmakers' (2002) Patrick McHaffie notes that:

> *Perhaps the 'frightened Africans' who once 'threw spears at an Aero Service aircraft' or the 'suspicious moonshiners in Appacachia' who 'took a few rifle shots' at aerial mappers did so not because the intentions of the mappers were 'not always understood', but because those intentions, and the powerful forces behind them, were understood only to well. (McHaffie 1995, p.122)*

There are striking similarities to the controversies arising around flood science and its application in the insurance sector, where a new aerial survey could potentially mean not only a loss of insurance cover, but of equity. On the other hand, as Eilean Hooper-Greenhill notes, 'to be 'on the map' is to be acknowledged, given a position, accorded an existence or an importance' (Hooper-Greenhill 2000, p.17). And what I want to suggest is that 'to be risked' means exactly that for a great many things: to be given a position and accorded an existence; to be hardwired into the public domain. To investigate flood controversies lends itself too easily to a social critique of risk where 'avoidance imperatives dominate' but 'the expansion and heightening of the intention of control ultimately ends up producing the opposite' (Beck 1994, p.9). But risk is not an object to be managed or mismanaged; it is not reducible to a scientised politics (Barrry 2002). If we confuse risk for barren abstractions like frequencies and severities then the cartographic component is truly missed. Risk is enabling, it is creative, and it brings new geographies into being. The managerial ethos of risk as a measure and a measurable might thrive, become contested or end up discredited within those geographies, but it is not to be mistaken for them. Risk commands a wider political ecology in which these claims to knowledge grow and become controversial: 'other flowers could just as well have grown there if the wind had brought other seeds' (Bergson 1946, p.256). If flood risk is to be further explored as an object of controversy then there is no need to look with sadness or concern on the flowers which never grew to properly represent it. That was never the point. Rather, flood risk is the spawn of this proliferate and monstrous fauna; it is the fertilizer which prompts a cocktail of fact and possibility to germinate outside the botanized reserves of science proper; and the question which must be asked of these heterogeneous cartographies of things to come is how? How are floods risked?


ash
controversy
now
think
point
risk
make
things
flood
back
research
becoming
risking
days
come
airlines
GMT
cloud
going
politics
might
way
maps
problem
airspace
something
different
time
see
Risk
started
new
frame
took
really
much
attentive
onboard
creative
first
light
coming
clear
like
along
instruments
work
thing
know
writing
means
sites
opening
materials
telling
need
scientised
anyone
bring
attempts
Institute
questions
wind
Norwegian
Maps
Boulogne
put
simply
fly
left
truth
model
political
hand
Office
brought
order
Bergson
MET
follow
situated
finally
better
taken
anxieties
fly-zone
areas
James
looking
good
Europe
little
beginning
weeks
map
extent
spewing
doubt
difference
kind
meant
look
geographies
go
couple
seems
ethnographic
field
reading
never
chapters
ask
flight
rather
news
material
seen
ago
terms
find
words
pieces
cartographies
plane
airport
try
part
past
well
life
actually
just
want
consider
ways
jet
went
managed
three
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cartography
extension
Airport
mean
exactly
ground
Danish
moments
Marcus
affected
amount
ironically
thesis
flooding
quite
particular
knowledge
volcano
place
although
came
Oxford
papers
important
changed
openness
hours
jeopardized
productive
world
somewhere
Denmark
space
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likely
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Cartesian
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Alps
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dealing
anxious
risked
change
objects
got
mapping
similar
contention

7. Out of the Ash Cloud

Afterthoughts

4:37pm (GMT +1), airport train, Copenhagen: For the past two weeks I have been stuck in Denmark, unable to hand in this thesis. Since the Icelandic volcano Eyjafjallajökull started spewing ash into the atmosphere and up until a few days ago, the airspace over Northern Europe has been hermetically closed and all flights cancelled. I write this in one go as I return to Oxford; I have left the books behind along with increasingly disorganised stacks of field notes and papers; the wifi is dead; I am on my own. The time is now 4:44pm and I have 3 hours and 49 minutes of battery left unless I find a place to recharge.

So, I have learned to ask a different question. This is my contention. But why does that matter? What difference would it make to anyone that a substantive 'what is flood risk?' has been replaced by a more eventful 'how are floods risked?' Who will be affected by the restoration of risk to its etymological origin as a way doing other things, rather than as an object of other doings? To be honest, the answer has been anything but clear to me. And that, I think, has to do with the way in which flood risk was never really my problem. This project was a bounded assignment when I took it on. 'Understanding Environmental Knowledge Controversies: Flood Risk Mapping, Insurance Zoning and the Politics of Rural Property' was a good title to work from, but it was not mine. I had to find other ways of becoming interested. Ironically, now, for the first time, I feel properly implicated by a knowledge controversy. It took an ash cloud from Iceland, not a flood, to accomplish it.

5:55pm (GMT +1), gate D103, Kastrup Airport: I have of course been arguing that all the chapters in this thesis attempts to jeopardise something, and I think that the result speaks of that. It would have been easier to stick with the research agenda that I originally devised; go through the motions of tracing out the multiple 'what's of flood risk, the object; arguing that multiplicity is the source of controversy. Instead I have ended up challenging that way of imagining the field. So far, so good in terms of putting things at risk. But this ash cloud somehow puts things in perspective.

It started out as other people's problem. The airport was going to be closed for a couple of hours. There was no way this was going to affect my flight three days later. But I was soon implicated anyway. Maps began to appear on the news with overlays showing the predicted extent of the ash cloud. Denmark, and in particular the UK, was well within it. Then pieces of information: the wind would have to change for the problem to go away; there was no prospect that it would; or the volcano would have to stop spewing ash; and the last time that happened (which was sometime in the 19th century) it took well over a year.

I changed my plane tickets; and then I changed them again. I called the proctors office in Oxford to apply for an extension; I was not the only one. And then the controversy took flight (everything else was grounded!). As the last bits of capital evaporated from the coffers of the already hard pressed airlines, questions were raised: Where did these maps come from? The Danish Meteorological Institute would not be held responsible; they got their data from the MET Office in London. The MET Office? Could they be trusted? Very much so, they employed the best expertise available. So did anyone actually see this cloud? What did it look like? Apparently a Swiss Air Force jet had photographed it somewhere over the Alps. The Alps? Had nobody seen it over Scandinavia? No. The maps were based on model predictions. Ironically, that settled things for a couple of days.

Meanwhile I was waiting for my extension. Anxiously. There was no way that I was going to make it back in time to hand in. The trains and buses through Europe were sold out and the ferry to Harwich was going through its yearly makeover in a dry dock somewhere in Jutland (a rare coincidence and most likely Poisson distributed!). Someone told me that it was possible to get onboard the Channel ferries in Boulogne after midnight. There was no news on how to get to Boulogne. However, it did make the news that a taxi to Istanbul currently went for £5,000. My supervisor sent me an e-mail telling me to calm down and rest assured that Examination Schools would have to come up with some kind of contingency plan. It seemed rational, but the calming effect was negligible.

Then came the next round of questions: Was it really that dangerous to fly through volcanic ash? Several airlines were willing to try it out. Not with passengers, of course, but with experts. A Lufthansa jet zigzagged its way from Hamburg to Stockholm cramped with recording equipment and scientists from the Max Planck Institute, but came back empty handed. The engines were checked for sand particles melted into glass sediment in their inlets. No luck. The readings from the instruments were no better: there was no trace of ash in Danish airspace. Instead of looking at the maps, people started to look up, into the sky, asking themselves if anything was really up there. These were some clear sunny days in spring.

6:47pm (GMT +1), Norwegian flight DY 3514, airborne: Politicians were quick to get involved. A new system was put in place based on three different fly-zones. Or rather: instead of a fly-zone and a no fly-zone there is now an additional fly-if-you-want-zone where the ash is 'light'. I am of course happy that the airspace has reopened – I got the extension and it seems that I will make it back – but as a concerned member of the public I am not quite sure how to interpret this 'light', knowing only that whatever it means, it is likely to be based on the same computer simulations which are now contested (yesterday British Airways went as far as to say that the cloud was never there at all). Being onboard a plane puts that slight uncertainty to the point. I know that Norwegian deemed it safe to fly through 'light' ash quite a bit earlier than other airlines. I also know that pilots are now advised to turn around and land if they smell ash in the cockpit (that actually happened three days ago, but it turned out to be a blown fuse). I cannot help but look out the window once in a while or listen for a change of pitch in the noise from the engines.

Over the past three years I have extended my researching self in all sorts of ways in order to become attentive to the issue I was dealing with. I have still had little use for the waterproof hiking boots, but I think my interactions with web crawlers, flood models, audio recorders, databases, papers, humans and the words you are reading have been productive nonetheless. At least they have thoroughly jeopardized my preconceptions and opened up a new 'space of thoughtfulness' (Thrift 2003, p.115). Still, none of these experiences really compare with being onboard this plane trying to fit the pieces of the immense amount of material which has been brought into being during the past few weeks of fertile dispute: *How* *badly do these airlines need to get back in business? What pressure were the politicians under when they came up with this re-zoning of European airspace? If those maps are wrong…*

It seems so infinitely more acute and engaging to speculate like this 10km above the North Sea than it could ever have done if the stakes were lower, and although my situation is of course completely incomparable to that of potential flood victims, I think I am finally beginning to understand what Bergson meant when he wrote that 'we invent the truth to utilize reality' and that 'realities are only the ground in which truth grows (…) other flowers could just as well have grown there if the wind had brought other seeds' (Bergson 1946, p.256); I think I am beginning to appreciate why James encouraged us to 'fall back on raw unverbalized life' although it might mean 'putting off our proud maturity of mind and becoming again as foolish little children in the eyes of reason' (James 1987, p.755). I think I am finally becoming attentive to controversy.

8:15pm (GMT), en route from Gatwick to Oxford: Throughout this thesis I have flirted with the idea that risking and mapping has something in common. In Dennis Cosgrove's words 'acts of mapping are creative, sometimes anxious, moments in coming to knowledge of the world' (Cosgrove 1999, p.2), and I think it does make sense to say that acts of risking are equally creative and arguably more anxious moments in coming to that kind of knowledge. We were never paralyzed by that ash cloud. The planes stood still, true. Life changed, for a moment. But the anxiously productive activities of coming to knowledge of the world flourished. As an implicate of this controversy I have not for one minute felt that being able to pinpoint a substantive measure of the risk would have settled anything. I did, however, feel a strong urge to know what was going on. That might be a rather banal point, but it is the point I want to make. Risking the cloud allowed us, for a moment, to bring a veritable plethora of situated materials into the same productive event. Materials which alluded to no higher order and suggested no common denominator, but the issue still accorded them a place in the same cartographic enterprise; posited them as constituents of the same futurity and as collaborators towards the same fortuity. It would have been more honest to acknowledge them in this way, to ask what they were doing, how the cloud was being risked, instead of avoiding them, mistaking their creative potentials for dangerous uncertainty, and regressing to the modern angst that follows from being led down by the impossible promise of certainty. This is it, Queens Lane, Oxford. If I had come out of the ash cloud three years ago when I first got off the bus at this stop, perhaps this thesis would have been different.

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Appendix: list of recorded interviews

Date	Location	Activity	Informant(s)
26 March 2007	Oxford	Interview (phone)	Financial modeler, British reinsurance broker (i5)
21 May 2007	London	Interview	Head of Policy, Association of British Insurers (i1)
17 October 2007	London	Interview	Head of policy, Association of British Insurers (i1); senior underwriter, major UK primary insurer (i2)
17 October 2007	London	Interview	Financial modeler, British reinsurance broker (i5)
17 October 2007	London	Interview	Lead researcher, Lloyd's Exposure Management (i3)
21 January 2008	London	Interview	Senior underwriter, major UK primary insurer (i2)
25 January 2008	Oxford	Interview (phone)	Visiting Professor, Benfield Hazard Research Centre (i27)
4 February 2008	London	Interview	Senior underwriter, major UK primary insurer (i13)
4 February 2008	London	Interview	Post doctoral research fellow, Kings College (i14)
6 February 2008	Oxford	Interview (phone)	Chief cat manager, major German Reinsurer (i10)
11 February 2008	London	Interview	Chief research officer, cat modeling consultancy (i16)
11 February 2008	London	Interview	Head of flood risk, cat modeling consultancy (i11)
28 February 2008	Oxford	Interview (phone)	Technical Director, flood modeling consultancy (i19)
11 March 2008	Oxford	Interview (phone)	Flood manager, DEFRA (i21)
19 March 2008	Oxford	Interview (phone)	Head of Policy, Association of British Insurers (i1)
20 March 2008	Skipton	Interview	Technical Director, flood modeling consultancy (i19)
20 March 2008	Skipton	Interview and observation	Modeler, flood modeling consultancy (i22)
20 March 2008	Skipton	Interview and observation	Modeler, flood modeling consultancy (i23)
20 March 2008	Skipton	Interview and	Modeler, flood modeling consultancy (i24)

		observation	
4 April 2008	London	Interview	Solvency specialist, FSA (i17)
11 September 2008	London	Interview	Head of Policy, Association of British Insurers (i1)
11 September 2008	London	Interview	Director of research, UK reinsurance broker (i18)
27 October 2008	Skipton	Interview	Technical Director, flood modeling consultancy (i19); modeler, flood modeling consultancy (i23)
27 October 2008	Skipton	Interview and observation	Modeler, flood modeling consultancy (i25)
27 October 2008	Skipton	Interview and observation	Modeler, flood modeling consultancy (i26)
23 February 2009	London	Interview	Visualization specialist and post doctoral research fellow, UK reinsurance broker (i28)