Landscapes of Prehistoric Northwest Sichuan: From Early Agriculture to Pastoralist Lifestyles

Jade d'Alpoim Guedes and Anke Hein

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Abstract: We describe a preliminary survey of the relatively unknown part of the eastern Himalayas (Northwest Sichuan). This survey revealed that three primary phases of occupation are represented across the landscape. Large settlements with dense remains characterize the landscape during the Neolithic (3400-2000 cal. BC). Following a hiatus in occupation, stone-cist graves characterize the region during the Bronze Age (1450-800 cal. BC). We argue that the lack of settlement remains from this period indicates that mobile pastoralism may have increased in importance. Between AD 500-1500, dense scatters of ceramic that extend over a wide altitudinal corresponds to the fragmentation in Tibetan history when local warlords that challenged the power of other nomadic groups on China's frontiers established themselves in the region. While some changes in occupation and subsistence practices appear to be linked to changes in climate, others relate more closely to changes in sphere of political power across Eastern Tibet. We argue that further intensive survey work is needed to expand our understanding of past land use and the development of pastoralist practices in this region.

Keywords: Tibet, Survey, Sichuan, China, Millet agriculture, Pastoralism

1. Introduction

The Tibetan Plateau is far from being a homogeneous environment. How humans adapted to the diversity of high-altitude environments on the Tibetan Plateau (over 2500 meters above sea level, or masl) has become a topic of renewed interest in recent years (Aldenderfer 2007; 2011; Chen et al. 2015; d'Alpoim Guedes et al. 2015a; Lu 2016; Madsen 2016; Rhode 2016). However, a lack of systematic survey has meant that most descriptions of prehistoric human activity on the Plateau generalize about the manner in which humans occupied this landscape. Detailed studies of human settlement on different parts of the Plateau are necessary to improve our understanding of how humans adapted their subsistence and settlement patterns to the "roof of the world".

The role that mobile groups, particularly pastoral nomads, have played in shaping prehistoric settlement patterns has become an increasingly important topic of archaeological research around the world (Barnard and Wendrich 2008; Cribb 1991; Frachetti 2008b; Wright, et al. 2009), however, in western China and Eastern Tibet such groups have received hardly any attention. Despite the wide range of variation in the types of pastoralism seen in the Tibetan economy today and their importance to Tibetan history, archaeologists working on the Tibetan plateau have not focused on revealing the presence of pastoralists in the archaeological record.

In this paper, we present the results of a survey of the Jiaomuzu and Chabao Rivers in Ma'erkang (Barkam), Aba (Ngawa) Tibetan and Qiang Autonomous Prefecture, Northwest Sichuan (Kham).

This part of the Eastern Tibetan Plateau has been demonstrated to be an important conduit for the spread of agriculture to the Tibetan Plateau (d'Alpoim Guedes 2015) as well for exchange of cultural material between northern and southern China, both through trade and down-the-line exchange and movement of people (Hein 2014a and 2015; Miyamoto 2015).

We argue that during the third millennium BC settled farmers occupied the river valleys of Kham, but following the second millennium BC, these valleys were largely abandoned. Material from the subsequent phase of occupation (1700 BC -AD 500) is found only in graves, suggesting that a mobile lifestyle characterized the region during this period of time. From AD 500-1500 surface scatters of ceramics without associated building remains or occupation layers cover mountain slopes, higher-level terraces, and even mountain ridges suggesting that this non-sedentary or possibly pastoral lifestyle may have continued, albeit with higher densities of ceramic scatter compared to earlier periods of time.

2. Geographic and Environmental Background

Situated at the intersection of the Qinghai-Tibet and the Yunnan-Guizhou Plateau and bordering on the Sichuan Basin, Eastern Tibet (Kham) differs considerably from other areas that have been the focus of studies of early pastoralism in Eastern and Central Asia. Several major river valleys transverse a series of northwest-southeast oriented mountain chains. A first cordillera of mountains that rises between 1000-2000 masl encircles the Chengdu Plain, following which elevation rises precipitously to between 2000-4000 masl in the second cordillera. The high altitude plateau of Ruo'ergai (Zoigê) flanks these mountain river valleys to the north and the high altitude Tibetan Plateau flanks this area to the west (**Figures 1 and 2**). The area chosen for our survey, the Jiaomuzu and Chabao Rivers, which are tributaries of the Upper Dadu River, are situated in this second cordillera mountain range.

The Jiaomuzu and Chaobao rivers are characterized by an extremely steep and vertically defined geography. This creates considerable micro-climatic differences along the mountain slopes, with temperatures decreasing by 0.57 ºC roughly every 100 meters in altitude (Fan 2009). Vast differences in sunshine hours, rainfall, and winds between windward and leeward or the sun-facing and sun-opposing sides of the same mountain can lead to different vegetation even on opposing slopes.

Cool temperate forest likely filled the river valleys prior to the movement of farmers in this area. Today these river valleys are composed primary of agricultural fields. High alpine forest can be found on lower lying mountains and half-way up the slope; and elevations above 3500 masl are dominated by steppe composed of grasses, sedges and dominated by *Kobresia* sp. shrubs. In the Dadu River Valley, the upper elevation steppe is currently exploited by vertically transhumant pastoralists. Nomadic pastoralists exploit the steppe in the higher altitude and wider area surrounding Ruo'ergai. The boundaries of these different niches are highly sensitive to climate change and likely shifted considerably in prehistory (see review of paleoclimate sources for the region in d'Alpoim Guedes 2015).

3. The Archaeology of Northwest Sichuan

Archaeological evidence indicates a history of human occupation on the eastern Tibetan Plateau that is closely linked to developments in Gansu and Qinghai in Northwestern China China (e.g.

Chen and Chen 2006; Li 2011). In fact, finds from all prehistoric periods reflect close exchanges between these two areas. We provide a brief review of these finds below.

The history of archaeological research in Northwest Sichuan is relatively short and very little is known about pre-agricultural settlement in the region although recent (and still unpublished) finds of ephemeral camps containing microliths that date to between the fifth to second millennium BC indicate that foragers may have exploited the upper elevation reaches of Western Sichuan (see summary in d'Alpoim Guedes 2016). Prehistoric settlement sites have only recently been targeted for excavation (Aba et al. 2008; Chen 2009; Chengdushi et al. 2002; Lü et al. 2010). Surveys and trial excavations mostly have been conducted in the first cordillera of the Upper Min River Valley (**Figure 1**). Consequently, the number of sites known from the lower elevation Mao County in eastern Tibet largely exceeds those reported from the high-altitude areas further west.

Systematic application of radiocarbon dating has not yet been applied to the region and as a result much of the local chronology discussed below is based on ceramic typology and comparison with finds from other regions. Conventionally, finds in this region are classified in two key phases (**Figure 3**).

Neolithic (3400-2000 cal. BC): In 2000, excavations conducted at Yingpanshan demonstrated that Neolithic settlers who showed strong connections to the Yangshao Culture of northern China had arrived in this region (Chengdushi et al. 2002).

Pottery from early, Miaodigou phases of the Yangshao culture (4000-3500 cal. BC) has come to light at four settlement sites in the first cordillera of Western Sichuan: Boxi and Yingpanshan, Jiangweichen,and Gongnaruo (Chen and He 2007) (**Figure 1**). Coarse wear at sites in Western Sichuan are characterized by a combination of reddish high-polished fine-paste wares and coarse grey or brown pottery with gravel inclusions and corded-ware impressions as well as some black-slipped ceramics that share similarities with those of the Majiayao core culture zone (see, for example, Jianping Phase III remains [He 2011; Beijing and Gansusheng 2000]). Rarer finds of painted pottery are dead ringers for vessels manufactured in Qinghai and Gansu, suggesting that they were likely brought into this region via trade: something that has been confirmed by chemical analysis on pottery (Hong et al. 2011; Hung 2011). Unfortunately, no radiocarbon dates are available for any of these sites, making the lower limit of this region's occupation unclear.

With the transition to the Majiayao Phase (c. 3300-2600 cal. BC), evidence for human occupation becomes more widely spread across Western Sichuan (Aba et al. 2008). Sites of this period show clear cultural affinities with the Majiayao heartland in Gansu both in terms of housing structures and ceramic typology. In particular, remains from Yingpanshan are strikingly similar to material from the Majiayao-culture sites of Linjia and Dali Jiaping in Gansu (He 2011) (**Figure 3**). The earliest sites in our survey area, Haxiu and Konglong (Barkam) (Aba et al. 2007; Chen and He 2007; Chengdushi et al. 2007) belong to this period (Supplementary Information (**SI Table 1**).

Majiayao phase pottery in Western Sichuan consists of painted ceramics in the form of vases, ewers, and closed bowls. Spouted vessels, lids, open bowls, high-footed vessels and deep-bodied jars also appear, reflecting an increasingly close connection with Gansu. In addition to fine painted ware, ceramics for daily use such as large coarse jars with net pattern and corded ware design also show strong connections to the Majiayao heartland **(Figure 3).**

Migration of settlers from northern China has been argued to be the major contributor of the appearance of this pottery on the margins of the Tibetan Plateau (Chen and Wang 2004; He 2011; Jiang 2004). However, there could also have been interaction and trade in technology between the two regions without actual migration (He 2011).

Archaeobotanical analysis at Yingpanshan indicates that much like their contemporaries in northwest China, the inhabitants of early agricultural sites in Western Sichuan relied on foxtail millet (*Setaria italica*) and broomcorn millet (*Panicum miliaceum*) (Zhao and Chen 2011). Zooarchaeological analysis conducted on material from Yingpanshan suggests that the inhabitants were heavily reliant on domesticated pig, while in higher elevation sites like Haxiu, hunted animals formed a larger component of the diet (Chen and He 2007; He and Chen 2009).

No C-14 dates fall into the time period between 2000 and 1700 cal. BC, suggesting that the mountains of Northwest Sichuan were either abandoned or occupied in a way that did not leave noticeable traces in the archaeological record. A period of documented climatic cooling (Marcott et al. 2013) that reduced the available niche for millet agriculture has been argued to be responsible for the sparse occupation of the region during this period of time (d'Alpoim Guedes 2013, 2015; d'Alpoim Guedes et al. 2015a; d'Alpoim Guedes et al. 2015b).

Bronze Age (1500-800 cal. BC): During this period, archaeologically visible occupation recommences, albeit not in the form of settlements but stone-cist graves. Similar types of graves appear throughout the mountains of Southwest China (Aba and Chengdu 2009; Chen 1996; Li and Li 1986; Luo 1992; Luo 2012; Tong 1987). The characteristic objects contained in these graves, including double-handled jars made of black or yellow-brown coarse ware, often with ram's head decoration, steppe-style weapons and personal ornaments (e.g., ring-pommel knives, arch-backed knives, double-circle headed daggers, and ornaments depicting horses), suggest that the inhabitants of Western Sichuan shared connections to mobile pastoralists inhabiting the Northern Steppe (d'Alpoim Guedes 2015; Hein 2014b; Li 2011).

Radiocarbon dates from Galazong/Yan'erlong (Sichuansheng et al. 2013), Kasha Lake (Sichuansheng and Ganzi 1991), Nagu in Yunnan (Yunnansheng 1983), Yan'erlong (Sichuansheng et al. 2013), and Han'eyi (Sichuansheng and Ganzi 1998) show that these graves appear in the region starting at roughly 1500 cal. BC and characterize burials in the area until the first centuries AD. Until recently, no habitation sites dating to this period of time were known, but in the last five years, three sites have been discovered: Shidaqiu (Chen Jian: Personal communication 2013), Mu'erxi (Aba et al. 2007), and Ashaonao (Lü et al. 2010, d'Alpoim Guedes et al. 2015b). Otherwise, small scatters of pottery thought to be associated with this phase have been reported from non-systematic surveys across the region. This low-fired reddish coarse ware that is very different from ceramics found in earlier settlement sites – have generally been attributed to the Qin/Han period (4^{th} c. BC to AD 2^{nd} c.) and are seen as contemporaneous with stone-cist graves. The lack of diagnostic traits and the fact that none of these ceramics were derived from excavated contexts, means that the widely accepted association between these ceramics and the late Bronze Age-Han Dynasty is questionable. We thus paid particular attention to the distribution and dating of these ceramics during our survey.

The change in settlement patterns from deeply layered sites in the Neolithic to hardly any finds aside from graves in the Bronze Age suggests that the way in which humans occupied the landscape during this period changed dramatically.

The Bronze Age represents a key transitional period in the prehistory of Eastern Tibet, where farmers who subsisted on millet and pig husbandry shifted to a lifestyle that is possibly associated with pastoralism (d'Alpoim Guedes et al. 2016). While extensively employed in other parts of the Eurasian Steppe, systematic zooarchaeology is only beginning in the region and as a result we barely understand the roles played by animals such as horses, sheep, goat and cattle in Eastern Tibet (let alone in China) following their introduction sometime during the second millennium BC. We know that at some point the yak became an important part of subsistence regimes in this area: however almost nothing is known about how this process took place. Finds of horse heads and hoofs in Eastern Tibet (Hein 2015; Hein 2017:145) and potentially domesticated sheep in Central Tibet (Xizang 1989; Zhongguo and Xizang 1999) as well as object types and burial customs shared with Qijia, Xindian, Siwa and Kayue material where sheep bones have been found (Flad, et al. 2007) suggest that the inhabitants of the area *may* have practiced animal husbandry. The custom of depositing horse heads and hoofs is known from the Bronze and Iron Age Eurasian steppe (Allard and Erdenebaatar 2005; Fitzhugh 2003; Martin 2001; Wright 2014), reaffirming the northern connection of the inhabitants of these sites in southwest China.

Our understanding of subsistence patterns based on plants is somewhat better as systematic archaeobotany has begun to be carried out in Eastern Tibet and surrounding regions. Wheat (*Triticum* spp.) and barley (*Hordeum* spp.) arrive in Western Sichuan at roughly 1700 cal. BC and completely replace millets (d'Alpoim Guedes et al. 2015a, b).

While we have begun to form a picture of early lifestyles on the Tibetan Plateau, several key questions remain open to investigation:

1.) To what extent did the observed hiatus in material culture between the Neolithic and the Bronze Age result from an abandonment of the region?

2.) Did the switch between millet agriculture and between wheat and barley agriculture take place through a process of population replacement and migration or rather a continuation in habitation of the area?

3.) Finally, how and when did pastoral animals become part of subsistence economies in the area? Did their introduction change how humans inhabited this landscape?

Below, we describe the results from a systematic pedestrian survey of the Jiaomuzu and Chabao River valleys in Ma'erkang (Barkam), Aba (Ngawa) Tibetan and Qiang Autonomous Prefecture, Northwest Sichuan that contributes to making progress toward finding answers to these questions.

4. Methods

In September 2014, we conducted a systematic survey focusing on the Jiaomuzu River and the eastern part of the Chabao River, one of the smaller branches of the Upper Dadu River of approximately 20 km length (**Figure 2**). We chose our survey area because it represented the widest river valley in the second cordillera of the eastern Tibetan highlands, one where both Neolithic settlements and stone-cist graves were already known.

Intensive survey methods have been used to recover evidence for pastoralists in other areas of the world (i.e., Honeychurch and Makarewicz 2016; Houle 2015; Seitsonen, et al. 2014; Ur and Hammer 2009; Wright, et al. 2009). Unlike other areas of China where systematic pedestrian and sub-surface surveys have become increasingly common (e.g., Chengdu 2010; Chifeng 2011;

Drennan, et al. 2014; Linduff, et al. 2002; Underhill, et al. 1998), survey work in Western Sichuan is still largely unsystematic. Sites are identified either through word of mouth from villagers or non-full coverage quick pedestrian surveys. The main focus of research in Western Sichuan has been on graves that are looted and become the focus of emergency excavations. In addition, survey in the area has been largely limited to the valley bottoms with proximity to roads, ignoring high terraces and ridgetops. It is also worth noting that the recent closure of Tibet Autonomous Region as well as parts of Western Sichuan, Yunnan and Qinghai to foreigners has introduced impediments to foreign collaborative archaeological projects, including our own. Our long history of work in the region meant that we were granted an exceptional permit to carry out an exploratory 10-day survey. Since carrying out our work, this region has been completely closed, so follow-up research in the same river valley is impossible at present.

Eastern Tibet's deeply incised and highly orographically defined environment makes survey archaeology here challenging. Distances of only 1 km can quickly turn into a full day trek and some areas of the landscape are characterized by steep rock faces: areas where humans are unlikely to have spent extensive amounts of time. In order to take these geographic challenges into account, we classified a DEM of the area into three different slope categories based on natural breaks (**Figure 2**). The 1-11° slopes are terraces at the bottom of the river valleys that cover approximately 2.6 km^2. Slopes of 11-27° (c. 15.4 km^2) include the lower parts of the hills, areas along the main river valley, and some high plateau and saddles. Both of these areas were easily accessible with some exceptions described below. Slopes between 27-54 °were generally not accessible terrain: these were either rock face or covered in thick *Artemisia* brush and high bushes.

We were not able to target all of the 11-27° and higher elevation areas (between 3300-4500 masl) despite original plans to do so. These areas were likely of great importance to pastoral societies in the past as pasture-lands much like they are today because of the presence of forage grasses that can be consumed by animals. However, we were not allowed to survey in some of these areas for several reasons: 1.) Concerns with accessibility (several roads leading to these areas were washed out by monsoonal rain; 2.) Alternative routes would have taken us through areas we were not permitted to enter as foreigners given recent tensions among pastoral Tibetans; 3.) We also encountered initial resistance from our colleagues who felt that it was unlikely that we would find sites in areas of high altitude; 4.) Safety concerns: our one day-long foray into a higher altitude area resulted in altitude sickness for two of the team members.

We were however able to target a few high altitude areas. In addition to the area we had originally planned to target, we were also able to carry out surveys in two additional areas farther up the Chabao River. In our fieldwork, we thus included some second- and third-level terraces on elevations up to 3400 masl, areas that previously were deemed unsuitable for human occupation and thus had not been targets of archaeological investigation.

With a team of five people, we intensively surveyed all of the areas outlined in **Figure 2**, covering all accessible areas of slopes up to 27° as well as a few steeper areas in between: a total of about 20 km^2. Surveyors were spaced at distances of 10-15 meters, where possible: sometimes the presence of a mountain ridge meant that surveyors became separated into two narrow valleys. When this occurred, surveyors walked across their area in a zig-zag fashion. Surveyors recorded and collected all worked stones and ceramic sherds as well as the occasional metal item found on the surface regardless of their apparent date. Slopes with natural or man-made profiles were

investigated particularly carefully. Ceramic finds were labeled with a name that corresponded to their present-day administrative unit in addition to taking GPS coordinates for artifacts found.

In our survey, we distinguish between true "sites" areas with visible cultural layers and clear boundaries around the extent of ceramic scatters and between "ceramic scatters" that may have be explained by a number of phenomena. While a few Neolithic sites in our survey were well stratified, and corresponded to the definition of a site, very few of the post-Neolithic find areas furnished any cultural layers or clear boundaries around the extent of ceramic scatters; instead, thinly distributed surface scatters covered large areas. We thus do not consider all areas of ceramic scatter encountered on the survey a "site". Rather we argue that these finds either show evidence of short durations of human activity or in areas of high slope and low density of ceramics, it is possible that these finds represent deposition through natural movement of archaeological material downhill.

We took soil samples from identifiable cultural layers in naturally occurring terrace cuts or trash pits at the sites of Baishe, Konglong, Haxiu, Puzhi, and Pa'erba. We paused our survey and took samples from identifiable layers whenever these were encountered to collect soil for flotation and radiocarbon samples. We conducted analysis on the archaeobotanical remains in the laboratories at the Sichuan Provincial Institute of Archaeology. We also obtained twenty radiocarbon dates from archaeobotanical remains that were analyzed at Peking University. Ten TL dates from ceramic sherds at eight sites were analyzed by James Feathers at the University of Washington.

5. Survey Results

Prior to our survey, it was assumed that prehistoric occupations and other activities were restricted to the immediate river valleys or at most on the second-level terraces at elevations of up to 2500-2700 masl. To test this assumption, our survey team covered higher altitudes and steeper slopes where possible, discovering that ceramic surface scatters extended to areas over 3300 masl. Ceramics were found across slopes of up to 7° inclination and not just the flat, low-elevation terraces that had been the focus of previous surveys.

Overall, we were able to observe 23 areas of dense ceramic scatter, 12 of them previously unknown (**Figures 2, 4, 5, and 6**). Two of these areas (Konglong and Pa'erba) held stone-cist graves; all others were settlement sites or surface scatters of ceramic material that were not associated with stratigraphic layers. Our finds mostly consist of ceramic sherds, few stone tools as well as animal bones from profiles at a small number of sites.

5.1 Ceramic typology

We distinguished three groups of pottery (**Figure 7; SI Tables 2-4**) (Numbers discussed below represent total number of sherds):

Group 1: Neolithic ceramics that were composed of either: burnished or slipped vessels in various colors and types of ware including all of the painted vessels (Ia; 17 sherds); or an inhomogeneous group (208 sherds) comprising (Ib) hand-formed or wheel-shaped grey sand-tempered or fine ware mostly decorated with corded ware, line incisions, net pattern, and/or appliqué bands (126 sherds), (Ic) hand-formed brown sand-tempered or fine ware always decorated with corded ware or net pattern (35 sherds), and (Id) hand-formed red or red-brown sand-tempered ceramics, mostly decorated with cord marks, net pattern, basket impressions, or line incisions (47 sherds). These are very similar to middle Neolithic Majiayao ceramics found in Gansu, Qinghai, but also other parts

of Northwest Sichuan and conventionally dated to 3300-2000 BC based on ceramic typology and radiocarbon dating.

Group 2: A yellow-grey group of medium fired hand formed sandy tempered ceramics associated with the stone-cist graves. One sherd was decorated with a flower composed of grain impressions (3 sherds).

Group 3: Ceramics of unclear date (previously ascribed to the Qin/Han period by scholars working in the region): sand-tempered, hand-formed ceramics of a color ranging from red (IIIa) to light brown (IIId) or dark brown (IIIb), only rarely decorated with a few line incisions (IIIc) (947 sherds).

5.2 Site distribution

Previous work in the region has assumed that sites should be exclusively located on first- or second-level terraces at low altitudes in close vicinity to the rivers as only these would be suitable for agriculture. As a result, survey at higher elevations was not carried out.

The results of our survey show that ceramic scatters can be found at altitudes of over 3300 masl (**Table 1**). Throughout our survey area, we uncovered ceramics between altitudes of 2431-3328 masl, but only on slopes of an inclination of less than 7°. Slope thus seems to have been a more significant limitation to human activities than altitude; however, there are differences by type of ceramic material and date.

Group 1 Ceramics

The Group 1 painted ceramic finds were largely restricted to the sites of Baishe, Haxiu, and Konglong: all true “sites” with clear stratigraphy. A few sites (Konglong Sanzu, Puzhi) furnished single Neolithic ceramics, a few more held a small number of ceramics that may belong to the Neolithic period (Baishacun, Jiaomuzu, Pushikoucun, Shashicun, Shijiangzui) (**Figure 4**).

It was unclear if these represented true Neolithic occupations of if these find locales represented movement of sherds from Haxiu, Konglong and Baishe. To establish if these ceramics are signs of an actual Neolithic occupation or if they reached their place by chance through soil or water movement, we created slope, flow direction, and flow accumulation as surface arrows in ArcGIS (**Figure 8**). These analyses showed that moving water could have resulted in the movement of sherds from Baishe to Baishecun and from Konglong to Jiaomuzu and Shijiangzui. However, sherds and Konglong Sanzu, Shashicun and at Puzhi could not be explained by moving water, suggesting either that there was a genuine Neolithic occupation at these sites, or that they were moved there via another means such as anthropogenic movement of fertile alluvial soil from the riverbed.

Several possibilities emerge for the nature of settlement in this area: It is possible individuals were organized into a few centralized villages located at Baishe, Konglong and Haxiu and that ceramics moved from these sites to the less dense find locations across our landscape either by natural processes or by people transferring soil for manuring, terrace building or house construction. It is also possible, that individual houses were scattered across the landscape and contiguous to fields in a non-centralized settlement pattern. Sub-surface probing and test excavations should aim to clarify these hypotheses.

All Neolithic ceramic scatters were observed on first- or second-level terraces in the river valleys at altitudes of 2458-2535 masl in the Jiaomuzu River Valley and 2780-2783 masl in the Chabao River Valley. In all cases, the ceramic scatters are located on flat or slightly sloped ground (**SI Figure 4**). Unlike the stepper slopes (some of which are constituted of bare rock) these valleys contain deep loess deposits and rich agricultural soils. Our survey found material on every available terrace in the survey area. There was no clear preference for bank of the river and availability of agricultural soil appears to have determined placement and not direction (**See Table 1**).

At Baishe, a large portion of the site was damaged due to dormitory construction at the local monastery. Although the local political situation did not allow us to halt this destruction, we were able to sample ceramics and take float samples from a construction excavation unit that was being dug into the site (**SI Figure 1**).

Group 2 Ceramics

Group 2 ceramics were only found at a single locale: inside stone-cist graves (**Figure 5**). No other ceramics resembling these were found on our survey. The two cemeteries in our survey area, Konglong (2600 masl) and Pa'erba (2900 masl), were severely disturbed by modern grave looters, and at the time of our survey Konglong was been largely destroyed. None of the graves at either site were properly excavated or recorded by the local archaeology service. Visible graves at both sites consisted of stone-cists made of stone slates of 3-5 cm thickness. Graves were 1.5-2 m long and roughly 40-50 cm wide. The graves contained one primary extended-supine interment accompanied by a small number of ceramic vessels, many of them with one or two handles. During our survey, we could observe that the graves at Pa'erba were densely spaced with 0.8 to 6 m between them, mostly oriented toward the southeast (100-140°). We counted 45 graves in one cluster at an altitude of 2884-2920 masl (**SI Figure 5**). We retrieved two small double-handled jars (ca. 15 cm height) from one grave (M1); some ceramic sherds from another (M2), and a human human clavicle from a third (M3).

Group 3 Ceramics

We found Group 3 ceramic scatters at elevations of up to 3328 masl. Lower numbers of ceramics were found between 2600 and 3000 masl: possibly due to the steepness of slope in this area (**SI Figure 4; Table 1**). It is also likely that the small number of ceramics found at these altitudes might have been transported by downhill by rainfall or by humans moving soil.

Only a few features relating to this phase were discovered during the course of the survey. At a locale called Puzhi, where otherwise only ephemeral surface scatters were present, very faint cultural layering was visible inside a modern trash pit (**SI Figure 6 E**). Finally, a potential pastoralist enclosure or stones that supported a tent of unclear date was located near the modern locale of Pushikoucun (**SI Figure 2**).

5.3 Tool assemblages

Tools made of stone or bone were found at a limited number of sites, mainly at those associated with Group 1 ceramic assemblages. These finds largely consisted of small quartz and more rarely granite fragments that showed removal scars from knapping and that may have been used as tools possibly axes or insets in threshing, harvest or hunting tools. Further analysis is necessary to ascertain if the marks on these stones are actual traces of use wear. Baishe furnished a half-moon-

shaped perforated stone knife; Haxiu held several clearly identifiable cutters, choppers, knife-like objects, as well as ring- and disk-shaped stone items of unclear function; at Konglong, stone cutters and choppers were found on the surface (Aba et al. 2006: Fig. 2). During our survey, we found a single undecorated bronze blade near Washeng at an elevation of nearly 3000 m. We suspect that it may be of recent date, possibly a scythe fragment, but further analyses are needed to clarify this point.

5.4 Insight into subsistence practices: Archaeobotanical remains

To gain insights into early subsistence practices along the upper Dadu River, we collected soil samples where possible (**See SI text 1.A for methods**).

Both foxtail (*Setaria italica)* and broomcorn millet (*Panicum miliaceum*) are present in the samples taken from the Neolithic sites of Baishe, Konglong and Haxiu (**SI Figure 3 A and B**). There is a slightly higher proportion of foxtail millet than broomcorn millet.

The proportion of *Chenopodium* sp. (which may have been either a weed or potential food crop) was also high, constituting over 30% of the assemblage (**SI Figure 3 C**).

A few other plant taxa were found at Baishe: mallow (*Malva* sp.) (**SI Figure 3 D**) a plant consumed as a popular vegetable in the Middle Ages across Eurasia, (Gasparetto, et al. 2012) and still consumed as a vegetable in soups in the region (Wu, et al. 2006). Specimens of wild strawberry (*Fragaria* sp.) (**SI Figure 3 E**) were unearthed at both Haxiu and Baishe. Baishe also yielded pieces of nutshell likely. *P. mume* or *P. armeniaca* (**SI Figure 3 F**). A series of common weeds were also present (**SI Figure 3 G-Q**).

Samples were also taken from a variety of post-Neolithic contexts. The sample from Puzhi South Terrace yielded a considerable diversity in taxa, but was modern in date, therefore we do not discuss it further here (see **SI text 1**). In addition, a total of three samples were taken from the walls of the modern trash pit at Puzhi in a contiguous column where previous surveys had discovered pottery. These samples yielded wood charcoal and *Chenopodium* sp. A final sample was taken at Pa'erbacun, however no carbonized material was unearthed from this sample aside from four tiny pieces of wood charcoal.

5.5 Dates

We targeted short-lived plants and bone for our radiocarbon dates where possible. Where no other material was available wood charcoal was employed. As the majority of collection areas did not have any identifiable settlement layers from which radiocarbon samples could be derived, we submitted seven ceramic sherds for thermoluminescence dating to the University of Washington's Luminescence Dating Laboratory (**SI Table 5**).

These dates showed the following patterns:

I. A series of C-14 dates from Konglong, Baishe and Haxiu fell solidly into a known period of occupation for the Neolithic in this region (3400-2500 cal. BC). Within the Neolithic, two clear phases of occupation are discernible: Konglong and Haxiu fall into an earlier phase of occupation (3400-2900 cal. BC), while Baishe was occupied slightly later (2900-2000 cal. BC). A thermoluminescence date on Group 1 ceramics from Baishe ranges from 2370+-220 cal. BC, a finding slightly later than the C-14 dates (**Figure 9**).

II. A human bone from the Pa'erba stone cist graves yielded a date 1000-850 cal. BC. Thermoluminescence dates obtained from ceramics from another tomb (M6) yielded a similar but slightly earlier result (1250+-220 cal. BC).

III.) Very few features (and hence datable material) were associated with the Group 3 ceramics that were scattered across the survey area. A number of these ceramics were thus submitted for TL dating. These dates on Group 3 ceramics ranged from 970+-60 to 1450+-40 cal. AD (**Figure 9**). Samples from the walls of the modern trash pit at Puzhi also fell into this time frame. A sample taken at 90 cm below the surface in the column dated to 500-600 cal. AD (wood charcoal). A sample above this at 65 cm below the surface dated to 1400 cal. AD (wood charcoal). Samples from what appeared to be a feature in a wall at Haxiu also fell within this range.

6. Discussion

Our survey revealed that prehistoric activity across the region took place over a range of altitude from 2431-3328 masl, contradicting the widely-held assumption that prehistoric activity only took place in the river valleys. A combination of ceramic analysis, radiocarbon and thermoluminescence dating has furthermore revealed that instead of the previously postulated two phases of occupation (Neolithic and Bronze Age/Qin Han) there are at least three:

Phase I (3400- 2000 cal. BC), represented by multi-layered settlement sites in the river valleys, and associated with Group 1- Neolithic ceramics. During this first phase, large settlements are present in select river valley terraces. These terraces tend to be large areas that contain sufficient land for farming. Archaeobotanical samples taken at the Neolithic sites demonstrate that the inhabitants of this area consumed millet. Almost no material relating to this earlier period of time was found in areas of high elevation. Pottery is also densely concentrated in these settlements making sites highly visible and suggesting higher population densities that were relatively sedentary. Features related to this period were often visible in terrace cuts.

Phase II (1450-800 cal. BC); Phase II is characterized by a complete lack of observable settlement remains, however, large cemeteries with stone-cist graves containing a completely different ceramic assemblage (Group 2) appear. These cemeteries occur on mountain slopes between 2600 and 2900 masl.

Phase III (500-1500 cal. AD), represented by widely distributed Group 3 ceramics but low-density surface scatters on mountain slopes on elevations of up to 3400 masl . This phase is also characterized by a lack of graves but also a lack of identifiable settlement layers: aside from faint layer in a unit at Puzhi. Despite the lack of clearly observable layers, a number of radiocarbon dates fall into this period, indicating that burning (anthropogenic or otherwise) took place throughout the valley during this period of time.

The disappearance of Neolithic settlement sites in the region following the second millennium BC appears to be closely synchronized with a contemporaneous decline in temperature. Our previous work has hypothesized that this decline in temperature made it impossible for locals to continue to grow millet in this area. It was only following the introduction of wheat and barley to this area that the inhabitants were once again able to establish an agricultural system (d'Alpoim Guedes et al. 2015; d'Alpoim Guedes and Butler 2014; d'Alpoim Guedes et al. 2015a). However, the results from our survey indicate that wheat and barley farming might not have immediately spread throughout the region. During Phase II, wheat and barley farming may have been limited to select

river valleys such as the lower elevations of the first cordillera of Western Sichuan. It is possible that sedentary farmers may not have subsequently occupied the higher elevation Dadu and Chabao Rivers until substantially later in time (following AD 500). Indeed, between 2000 BC-AD 500, the type of settlement pattern we observed appears to correspond to one that is not that of sedentary farmers but rather a more mobile form of occupying the landscape. No visible features dotted this area aside from graves and domestic ceramics were recovered during Phase II and the subsequent hiatus between the end of this phase and AD 500.

While our archaeobotanical results from Neolithic sites confirm that the early inhabitants of this area consumed millet, we found no evidence that the inhabitants of this area grew wheat and barley locally between 2000 BC and AD 500 in the valleys that we surveyed. No house remains, pits, trash pits or other features containing grains that are typically associated with farmers were found throughout our survey area that date to this period of time. Given that Neolithic sites are so well represented and visible throughout the region, it seems unlikely that, if present, features associated with later farmers would be not have been recovered during the course of our survey.

However, finds of wheat and barley in stone-cist tombs in other areas of Western Sichuan such as Yan'erlong (Sichuansheng et al. 2012) indicate that the builders of these tombs were knowledgeable of the existence of these crops. Several possibilities emerge: They either grew these crops themselves and sites might be located exclusively underneath modern villages and as result not visible to us. Alternatively, they may have engaged in trade with individuals in lower lying elevations. It is also possible that the Chabao and Dadu River valleys formed part of a larger scale settlement pattern and could have functioned as the herding hinterland of farmers who occupied the lower and warmer valleys of the first cordillera of the Eastern Himalayas. Mobile pastoralists who exploited a much larger territory might also have used the Chabao and Dadu River valleys as areas for grazing animals and may have interacted with farmers in lower elevations to engage in trade in grain.

Our record, however, may be biased: recovering evidence of ephemeral herding sites in the river valleys of the Upper Dadu is complicated by the fact that high rates of erosion and slumping from mountain deposits may have damaged these already difficult to detect sites. Therefore, the sherd scatters observed through pedestrian surface survey may not provide a completely accurate picture of past human occupation.

If the TL dates we carried out on ceramics are correct, this region becomes re-occupied with renewed intensity between 900-1500 cal. AD: a period which corresponds to the fragmentation of the Tibetan Empire during the 9th-11th century AD. Prior to this period, and starting around AD 600, Central Tibetans organized a number of campaigns into Western Sichuan conquering other groups that previously inhabited this area. For instance, the town of Songpan located near our survey area, was invaded by Songtsän Gampo in 641 (Beckwith 1993:17; Schaeffer 2013:12). Following political fragmentation in Central Tibet, local warlords flourished, particularly in Kham (Shakabpa 2010). This also corresponds to a period of time where in other parts of the Steppe, the construction of strongholds, and structures related to taxation and fortifications were underway that may have been the result of central organizational demands on pastoralists, as Wright (2015) argues in the case of Mongolia. This period may also correspond to the period in which many of the stone houses and possibly defensive towers dotting the present-day landscape were built (**Figure 10**). A series of radiocarbon dates obtained from wooden beams from defensive towers across the region date to the 10th-15th century (d'Arragon 2009): dates that align with our TL

dates. While we were not able to carry out dating of historic buildings during our survey, future research on these buildings may indicate that settlements dating to phase 3 have continued to be used up until the present day: thus explaining the apparent lack of large settlements encountered for Phase III on our survey.

The radiocarbon dates derived from our survey revealed several gaps in the occupation of the region: One between 1800-1500 cal. BC and a second between 1000-500 cal. AD. More survey, combined with excavation and systematic radiocarbon dating campaigns are necessary to test if these observed gaps are the result of sampling bias or true patterns in the occupation history of the region.

Our short survey revealed tantalizing evidence for what might be the impacts of a shift to a subsistence and settlement mode based on some form of pastoralism during the second millennium BC. However, much more work is necessary in this region in order to fully understand these dynamics. We were not, for instance, able to retrieve direct evidence of wheat and barley agriculture (in the form of charred seeds) or of the exploitation of pastoral animals (in the form of animal bones) over the course of this survey. Future research in this area should adapt survey methods with an aim of revealing how changes in subsistence impacted the way in which humans occupied the landscape and should aim to document if the changes we describe in this survey were indeed associated with prehistoric herding practice. Systematic surveys should be carried out in the full altitudinal range of this area (i.e., up to 5000 masl) and subsurface probing should be employed to assist with identifying ephemeral sites. Likewise, future research in this area should also focus on dating historic buildings and on documenting the post AD 500 occupation of this area. Research in these areas will allow us to expand our understanding of broader trends of past land use and explore the development of modern pastoralist practices. This will eventually help us understand the timing and causes behind the development of the complementary models of vertical transhumance combined with farming and nomadic pastoralism practiced by different segments of the current inhabitants of the region.

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Figures

Figure 1. Main locations mentioned in the text: Sichuan Province: 1. Ashanao, 2. Baishe, 3. Boxi, 4. Chengdu, 5. Gongnaruo, 6. Han'eyi, 7. Haxium 8. Jiangweichen, 9. Kangding, 10. Karuo, 11.

Kasha Lake, 12. Konglong, 13. Laolongtou, 14. Ma'erkang, 15. Mu'erxi, 16. Pujiaoding, 17. Ruo'ergai, 18. Sijiaba, 19. Siwa, 20. Yan'erlong/Galazong, 21. Yingpanshan, 38. Anxiang; Yunnan: 22. Haimenkou, 23. Nagu, 24. Yenong; Gansu: 25. Bailongjiang, 26. Dadiwan, 27. Jianping, 28. Linjia, 29. Longxizhai, 30. Majiayao, 31. Qijiaping, 32. Xindian, 33. Kayue, 34. Banpo, 35. Jiangzhai, 36. Miaodigou, 37. Yangshao.

Figure 2. Map of the survey area with previously known sites and new find locations in the survey area. 1. Konglong stone-cist graves, 2. Haxiu, 3. Guanzhai, 4. Diegezhai, 5. Dazangxiang, 6. Konglong Yizu, 7. Nanmuzu, 8. Danbuluozhai, 9. Puzhi, 10. Pa'erba, 11. Qiesike, 12. Pushikoucun, 13. Konglong Sanzu, 14. Baishe, 15. Baishacun, 16. Baishacun Erzu Bapuli, 17. Zheru, 18. Washeng, 19. Jiaomuzu, 20. Shijiangzui, 21. Mu'erduomo, 22. Puzhi Dengdan, 23. Shashicun, 24. Sha'erzong. Areas within red lines represent the areas we were able to survey. The area has been divided into a series of slope classes as noted in the legend. The area between 0-11% is represented in green. Between 11-27% slope is represented in orange. Finally the area that had a slope higher than 27% is represented in light beige. We were not able to survey areas above 27% as they represented either rock face or very steep slopes covered in Artemisia bushes. Slope analysis was carried out by Joshua Wright. The average altitude for the whole area is 2500 m asl. The sub-regions denoted in black frames refer to areas displayed separately in Figures 4 and 9.

Figure 3. Typical ceramics of three phases conventionally distinguished for prehistoric material from northwest Sichuan: 1-4 Neolithic Phase (Yingpanshan finds; after He 2011: Fig. 6); 6-9 Bronze Age Phase (6. Cuoji BM30 (after Xie and Jiang 2002: Figure 3), 7-8 Cuoji BM32 (after Xie and Jiang 2002: Figure 5), and 9 Yingpanshan 02M45 (after Zhao and Chen 2011); 10-13 Late Phase (after Chen and He 2007: Fig. 4-5).

Figure 4. Distribution of ceramics across the survey area by ceramic group and sub-region. Group 1 Ceramics. The precise location of the sub-regions can be found in Figure 2.

Figure 5. Distribution of ceramics across the survey area by ceramic group and sub-region. Group 2 Ceramics. The precise location of the sub-regions can be found in Figure 2.

Figure 6. Distribution of ceramics across the survey area by ceramic group and sub-region. Group 3 Ceramics. The precise location of the sub-regions can be found in Figure 2.

Figure 7. Typical ceramics found during the survey by date. Phase I. Neolithic Ceramics; Phase II. Ceramics associated with stone cist tombs; Phase III. Later Phase ceramics.

Figure 8. Flow Accumulation Diagram. Neolithic sherds represent areas where Neolithic ceramics were found. Other ceramic finds represent other types of ceramics found on the survey. **A**: slope and flow direction arrow map of the central part of the research area; **B**: flow accumulation map of the central part of the research area. NASA SRTM Data was employed for the Digital Elevation Model (USGS 2004).

Figure 9. Radiocarbon and thermoluminescence dates derived materials obtained from the survey. Red bars represent the age range of thermoluminescence dates. Age for radiocarbon dates are represented in grey. Radiocarbon dates represent the 2σ probability intercepts with the calibration curve (from IntCal09 [Reimer et al. 2009]). Dates are in order of uncalibrated radiocarbon determination (see Table SI-6 for uncalibrated dates). Measurements at Puzhi correspond to depth in meters.

Figure 10. Stone towers on the Baishe terraces. These are associated with historic buildings of unclear date, many of which are still in use today. Some of these may be as early as the 10th century AD.

Table 1. Find locations and site sizes. Elevations over 3000 masl are set in bold print.