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Mobilising hydrosocial power: Climate perception, migration and the small scale geography of water in Cambodia

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A B S T R A C T

As successive reports have predicted tens or even hundreds of millions of people displaced by climate change in the coming decades, the politics of climate migration has moved to the forefront of contemporary public discourse. In particular, those least able to adapt and most vulnerable to exploitation have garnered media and policy attention. Nevertheless, analysis of this phenomenon is inhibited by the large scale, predominantly unidirectional nature of the phenomenon's social scientific analysis, leaving the power laden nature of resource and infrastructure persistently underplayed. In particular, how the geography of natural resources produces different patterns of (im)mobility in response to environmental change, even within the same community, remains poorly understood.

Drawing on data gleaned from a multi-sited study of rural and migrant livelihoods in Cambodia, this paper highlights how the small scale, power-laden geography of water resources and irrigation shapes migration in response to the changing climate. Using brick workers as a case study of 'hyper-precarious' migrant labour, it uses quantitative, qualitative and spatial data to show how the socio-economically situated geography of water influences both perception of the climate, and mobility in response to it. Viewing this resource landscape as a form of hydrosocial power, the paper overarchingly makes a case for enhanced communication between the climate migration and hydrosocial power literatures, in order to better conceptualise the role of power in articulating the linkages between water geographies and climate mobility.

1. Introduction

How people respond to climate change is one of the key questions of our era. Millions of people are subject to ongoing shocks to their livelihoods as a result of its effects, often inducing them to move elsewhere to earn money or seek safety. Consequently, climate migration is adopting an increasingly central place in public discourse. Scientific journals and the quality press alike proclaim a coming 'wave of climate migration' (Scientific American, 23/03/ 2018: 1) and that 'climate change will create the world's biggest refugee crisis' (The Guardian, 2017), whilst advocacy groups proclaim 'a growing global crisis' (Arcanjol, 2018, p. 1) in which 'every second, one person is displaced by disaster' (IDMC, 2017).

Indeed, so global has the discourse of climate migration become, that smaller scale lenses on its manifestation have tended to be marginalised in the literature. Relatively few studies have explored how community scale resource geographies structure the (im)mobility in response to the climate and fewer still have considered these processes through the lens of power. Drawing on the experiences of rural people subject to high level of environmental vulnerability, this paper argues that a smaller scale, geographically embedded, perspective needs to be taken on the drivers of climate migration.

As shown here, changes to the climate are not experienced directly, but via the articulated geography of livelihoods and resources. To understand both what motivates and what results from climate migration, therefore, it is necessary to adjust the scale at which it is perceived. Rather than viewing climate response as a global, national, or regional phenomenon, this paper shows it to be rooted in both small scale resource geographies and the wider structures of power in which they are situated.

Moreover, by analysing rural conditions associated with entry to various occupations, it is shown here that this socio-economically and geographically embedded perspective on climate migration is necessary to understand not only the drivers, but also the outcomes of climate migration. Specifically, the paper uses a detailed focus on bonded labour in the brick industry as an example of how entry to hyper-precarious migrant labour (Lewis, Dwyer, Hodkinson, & Waite, 2015) may be engendered by the articulated experience of the climate. Finally, by framing these processes from the perspective of hydrosocial power (Boelens, 2014; Meehan, 2014; Uson et al., 2017), this paper explores how the spatial, institutional and economic conditions that structure climate migration are rooted both in the specifics of local geography and wider process of development.

This paper therefore makes three contributions. First, it uses quantitative, qualitative and spatial data to show how the perception of the climate is influenced by the usage of, and geographic positioning in

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relation to, irrigation. Secondly, it highlights the efficacy of these socio-geographically articulated climate *perceptions* in determining migration incidence at the community scale. Finally, it highlights the combined role of irrigation and climate perception in shaping the outcomes of migration, taking a detailed analysis of hyper-precarious brick worker rural livelihoods as a lens through which to interpret the conditions shaping entry to the worst forms of migrant labour.

In elucidating these points, the paper will begin by framing the concept of hydrosocial power within the wider literature on climate migration. Subsequently, sections on methodology and contextual framing will precede two empirical sections. The first of these, section 5, examines the small scale geography of climate change perception, highlighting how it manifests at intra-village scale and through the lens of livelihoods. Section 6 then considers how the use and accessibility of irrigation structures migratory decision making in relation to the climate, before bringing these perspectives together, to consider how the community scale geography of irrigation structures migration outcomes, in some cases promulgating entry to brick work, a hyper-precarious form of migrant labour.

2. Linking climate migration and hydrosocial power

That climate change is driving water scarcity in parts of the world is well established (Bates, Kundzewicz, & Wu, 2008; Mekonnen and Hoekstra, 2016), yet views differ as to the human response to these changing conditions. Adaptation scholars have emphasised the ability of communities to manage such risks and scarcities, whilst proponents of climate conflict models have pointed to the role of water in fuelling current conflicts (Gleick, 2014; Swain, 2004) and warned of the mounting potential for future ones (Carius, 2006; Conca, 2006; Gleick, 1993). Nevertheless, each viewpoint has limitations. Both the adaptation (Hulme, 2011) and water conflict (Lipschutz, 1997) literatures have been accused of deterministic reasoning, with a more structural (Böhmelt et al., 2014; McDonald et al., 2014), translocal (Greiner & Sakdapolrak, 2013) and multi-scalar (Selby and Hoffmann, 2014) analysis of climate response having been called for in each case. Space and power are, in other words, underplayed in the climate migration literature.

Historically, this has been true also of the literature on resources more generally. Indeed, though described in 2004 as being 'at the top of the global agenda' (Khagram, 2004), the study of water nevertheless remains 'a rather dispersed field of research, organised in strongly regionally and sector-wise defined clusters, apart from being disciplinarily divided' (Mollinga, 2009, p. 8). Each has its own characteristic approaches, but a consistent influence in the literature has been Thomas Homer-Dixon's seminal work on environmental scarcity and violence (1991; 1994; Homer-Dixon, Boutwell, & Rathjens, 1993), which has 'received considerable attention since at least the late 1990s' (Ide, 2015, p. 61).

This perspective has given rise to a sub-set of the literature focusing specifically on the institutional management of water in regions characterised by physical, but especially armed, conflict. Key country and area focused studies have in recent years been undertaken in Syria by Gleick (2014), the Middle East by Zeitoun (2008) and Selby (2003) and – more broadly – "Asia, Africa and the Middle East" by Swain (2004), whilst an additional area of literature has begun to explore in more detail the institutional conditions that engender and mediate conflict. Pahl-Wostl and Kneiper (2014), for example, have explored the efficacy of polycentric governance surrounding international water management, whilst McDonald et al. (2014), Zografos et al. (2014), and Azhoni, Holman, and Jude (2017), have considered it in relation to infrastructural development and state led climate adaptation respectively.

Nevertheless, recent trends within adaptation scholarship have begun to see it bring power more centrally into the analysis of climate response, raising the possibility of a productive analytical nexus. Just as the adaptation literature has begun to consider how institutions and power relations structure responses to climate change (Adger, 2001; Adger, Huq, Brown, Conway, & Hulme, 2003; Kelly and Adger 2000; O'Brien et al., 2007; Ribot 2011) and posit means by which those systems might be transformed to facilitate desired outcomes (Eriksen, Nightingale, & Eakin, 2015; Pelling 2011), culture and power have become a feature of water conflict study (Böhmelt et al., 2014; Ide, 2015).

From this position, a steady stream of papers, beginning with Budds in 2004 and continuing with Goldman (2007) and Bonsch et al. (2015), have critiqued the neoliberal, self-interested 'hydrocracies' that govern water at a macroeconomic scale (Molle et al., 2009, p. 341). Viewed thus, the history and geography of water infrastructure are therefore also the history of the development of the state, a longitudinal perspective on power posited most famously by Eric Swyngedouw (2015, pp. 1898–2010; 1997), but later developed by a range of authors (Suhardiman, 2018; Taylor and Trentmann, 2011; Zografos et al., 2014) seeking to understand how the 'social character of water' (Castro, 2006, p. 11) is co-opted into the 'organised encroachment of the powerful' (Hackenbroch & Hossain, 2012, p. 417), via both state sized and also household scale (Adams, 2018; Barnes, 2014; Delgado & Zwarteveen, 2007) geographies.

By tracing the state's extension and emergence in this way, scholars of hydrosocial power have therefore sought to disrupt the dualism between its human and physical dimensions by moving 'away from thinking of water as a discrete resource or utility' (Allon & Sofoulis, 2006) towards the idea of water as a field of power and tool of dominance (Khagram, 2004). By reinserting the 'polis' into water politics (Menga, 2017), they argue, contemporary water management frameworks are an exertion of control over the hydrosocial cycle (Boelens, 2014; Joshi, 2015), but meet and conflict with existing hydrosocial frameworks, creating tensions which manifest across humans and landscape (Koehler et al., 2018).

Such approaches have added much needed subtlety to the analysis of how water, land and power interact and co-produce each other. Nevertheless, they have remained generally static, engaging relatively little with the recent literature on climate migration (e.g. Ahmed et al., 2019; Ingham, 2019; Kelman et al., 2019; Parsons, 2019; Porst and Sakdapolrak, 2018; Suliman, 2019, pp. 1–21; Tuitjer, 2019; Zander et al., 2019) despite growing calls by scholars to engage with power in a similar manner. This relatively untested nexus therefore offers an opportunity to move away from the climate migration field's traditional dominance by large scale mono-factoral models (Gómez, 2013), which have tended to adopt a binary (move/doesn't move), and administratively defined conceptions of mobility (see e.g. Smith, 2001; Henry et al., 2003; Barrios, Bertinelli, & Strobl, 2006; Van der Geest, 2010; Kniveton et al., 2012 for examples of studies on rainfall and migration).

This is a longstanding issue. Indeed, as commentators on climate migration (e.g. Baldwin et al., 2014; Bettini, 2013) have argued, this binary approach to field is rooted in the historic distinction between minimalist and maximalist approaches to the issue (Suhrke, 1994). Yet it is one subject to growing scrutiny in recent years, as a wave of new social science research has begun to explore the political (Cresswell, 2010) and cultural (Adger, Barnett, Brown, Marshall, & O'brien, 2013) dimensions of climate migration. From this perspective, not only are 'the lived experiences [of climate change] … extremely diverse' (Abbott & Wilson, 2015, p. 1), but mobility itself is 'a resource that is differentially accessed' (Cresswell, 2010, p. 21), rooting climate migration firmly within multi-scalar geographies of power.

In conceptual terms, what this demonstrates is that mobility does not occur in direct response to the aggregated geophysical phenomena by which climate change is measured, but rather local weather events, as they are socially, culturally and economically articulated in place. In a manner increasingly familiar to human geographers, therefore, environmental phenomena are being reconceptualised as 'experienced by the actors involved' (Long, 2008, p. 39), rather than predetermined

geographic ontologies. This is a perspective which has spawned key practical innovations. Recent years have seen a growing focus on risk perception as an intermediary factor in mobility (Adger, 2010; Blaikie, Cannon, Davis, & Wisner, 2014; Brouwer, Akter, Brander, & Haque, 2007; Johnson and Covello, 2012; Pidgeon et al., 2003) and translocal studies have worked similarly to interrogate and reformulate 'orthodox views of space as bounded and coherent territory' (Collins, 2012, p. 318).

What renders this perspective especially relevant is its ability to conceptualise linkages between the impact of the climate – as articulated via social, and local physical geographies – and the outcomes of this impact in terms of migration. This is a task that has often been undertaken in manner that fails to account for the complexity of climate migration outcomes (Middleton et al., 2018). Moreover, it has tended to be undertaken in a depoliticised manner, eliding the role of structural and multi-scalar inequalities in shaping these outcomes (Cote & Nightingale, 2012; Nightingale, 2017). By exploring how the small scale social and physical geography of the community shapes distinct migrant outcomes, therefore – including the 'extreme forms of migrant labour exploitation' described as 'hyper-precarious' by Lewis et al. (2015: 582) and exemplified here through brick work – the aim here is draw closer conceptual linkages in this respect.

Overarchingly, the aim of this paper is therefore to highlight how small scale geographies of water shape mobility in response to the environment. In doing so, it will first demonstrate how migration in response to the environment is undergirded by climate perception – essentially the climate as it is articulated within a milieu of assets, livelihoods and social structures – rather than the direct manifestation of the climate itself. Secondly, it will demonstrate the undergirding role played by the geography of water in shaping climate perceptions. Finally, it will demonstrate the role played by water geography in shaping the incidence and outcomes and migration.

3. Methodology

This paper constitutes part of a wider project examining how climate change impacts on migrant worker livelihoods in Cambodia. Via a contextual focus on bonded labour in the brick industry, the project addresses how the debts accrued as a result of Cambodia's increasingly unpredictable climate induce former and current smallholding farmers to migrate from rural villages to work in debt bondage in Cambodia's brick kilns (Brickell et al., 2018). In addition, it seeks to explore how the sender side conditions leading hyper-precarious migrants such as brick workers to migrate differ from those promulgating migration into alternative occupations.

Seeking to provide linked data on origin and destination conditions, the data presented here were collected using a two-stage research method. First, a set of 51 semi-structured interviews were undertaken with brick workers, alongside 31 with kiln owners, union leaders, former kiln workers, neighbours, and Buddhist monks. This first phase collected data on the lived experience of brick work and the conditions that induce people to enter it, whilst also compiling a list of candidate villages in which to conduct rural research. From a shortlist of seven sender villages, each reporting high out migration to the brick kilns, three were selected for further analysis in phase two.

During this second phase, a total of 308 quantitative surveys were conducted in three sender villages. Village A: Svay, is located in Kampong Cham province, around 50 km from the centre of Phnom Penh and around 20 km from the brick production sites visited in phase one. Village B, Cheik, and Village C: Poum, are in Prey Veng province, located between 80 and 100 km from Phnom Penh and the brick production sites.

In each village, all households with members working in the brick industry, and a randomised sample of those without, were surveyed on livelihoods, assets, and the experience of the climate. A spatial dimension, in which the location of surveyed households was recorded and that of any agricultural land established using a gridded map and landmark method in which enumerators were trained, was also included. These data were subsequently plotted and GPS data recorded. These GPS coordinates and the survey data with which they are associated were subsequently analysed using ArcGIS to produce the maps included here.

Finally, further qualitative work with farmers and local officials was undertaken to ground survey data in qualitative accounts. Throughout the research process, qualitative interviews were conducted in Khmer and transcribed into English, whilst quantitative data were collected and recorded in Khmer by a trained native speaking research team.

4. Climate change, development and hydrology in Cambodia

Cambodia has in recent years been much lauded for achieving rapid economic growth in the course of its transition from a closed, state controlled economy under the People's Republic of Kampuchea to one of the most open economies in one of the world's most open regions (TRAC, 2013). Driven by a two hundredfold expansion of the garment industry since the early 1990s (ILO, 2015), the Kingdom's GDP is almost ten times larger today than in 1993 (World Bank, 2018).

Nevertheless, these spectacular figures have come at a cost. Cambodia has one of the fastest rates of deforestation in the world, driven in large part by the unfettered provision of government land concessions since the late 1990s (Scurrah and Hirsch, 2015), which have 'decimated' (Lawreniuk, 2017) vast swaths of the country's forestry and agricultural livelihoods through deforestation and land use change on a vast scale (Davis, Yu, Rulli, Pichdara, & D'Odorico, 2015; Global Witness, 2015). Nevertheless, even amidst the enormous scale of these processes, a closer focus is necessary. Alongside major land concessions, an equally important process of land redistribution has resulted from the agglomerative effects of far smaller scale economic processes.

Indeed, from an initial position in which land redistributions undertaken by the People's Republic of Kampuchea during the 1980s left the country with an unusually equitable distribution of agricultural smallholdings, Cambodia's development has proved its own land grabber. Market forces, spatially embedded in the landscape via the mass labour migration that has transformed national livelihoods, have engendered land redistribution, land use change, and ecological degradation on an enormous scale. Debt, in particular, has underpinned this process. Microfinance has boomed, contributing to a mean household debt ten times larger than it was only a decade ago (Bateman, 2017) and remittances – predicated on high levels of migration to the modern sector (UNESCO, 2018) have transformed the rural economy, tripling rural wages (IBRD and World Bank, 2015) and resulting in a nationwide shift towards capital intensive, debt funded agriculture (Liese et al., 2014).

Alongside these political economic and environmental changes, Cambodia's recent development has been intertwined with one of the world's highest levels of climate change vulnerability (Kreft et al., 2016). Now routinely described as 'a major threat' to the economy and society of Cambodia (Khut, 2017), climate change is increasingly central to questions of inequality, poverty and development in the Kingdom (Halsnaes et al., 2018). Moreover, as well as greater unpredictability, historical records indicate a shift away from the traditional bi-modal distribution of rainfall since the 1920s, towards a single rainfall peak centred on October (Diepart et al., 2015), substantially shifting the amenability of the environment to smallholder agriculture.

Faced with these changing conditions, the idea of adaptation has been enthusiastically adopted by the Cambodian government (RGC, 2013) as an essential strategy for rural Cambodians (Nang et al., 2014). Nevertheless, the weather data necessary to interpret the climactic changes underway in Cambodia have been acknowledged by the World Bank and others to be 'lagging behind' (UNISDR, 2010, p. 5) others in the region. In general, 'rainfall is only rarely recorded, even on days

with heavy thunderstorms' (The Phnom Penh Post, 2015: 1), thereby providing a picture of climate change at odds with farmers' reported experiences (Touch et al., 2017). Moreover, it is a picture rooted firmly in existing structures of power (Nightingale, 2017), with the only properly maintained weather stations usually positioned in close proximity either to the geographic or urban centre of each province.

As a result of challenges in both data and administrative capacity, the RGC has adopted an explicitly laissez faire approach to the challenges posed to Cambodia's farmers (Chea, Nang, Whitehead, Hirsch, & Thompson, 2011). Yet despite the absence of functional state led systems of water management (CEDAC, 2009), community led adaptation has been widespread in recent years. In little more than a decade, the country has transitioned from the traditional transplanting method of farming – wherein seedlings are raised in a nursery plot before replanting – to a system of broadcasting, in which seeds are scattered directly onto larger plots (Shrestha et al., 2018). As a result, the labour-intensive transplanting method, requiring around 30 labour days per hectare, has been replaced by a broadcasting system requiring only one fifteenth of the labour, but a great deal more capital (Liese et al., 2014).

Notwithstanding government efforts to encourage more capital intensive farming, farmers' accounts of their transition demonstrate considerable agency in the process of agricultural decision making. In their own words, 'no one told us [to change]. We did it ourselves because growing long-term rice takes too much time, and growing short-term rice takes only 3 months so we can cultivate it faster' (Farming Focus Group, Cheik, 22/02/2018). Yet examining farmers' motives in greater detail reveals the influence of changing community hydrology. As informants across all three villagers explained, mirroring wider nationwide findings by Thomas et al. (2013), the unpredictability of rainfall in recent years had played a significant role in the need for greater flexibility in the dates of cultivation, engendering a preference for the three month growing period of short grain rice over the six month growing period of long grain rice:

> 'When I was a child the weather was comfortable. In the past time, rain came only in the rainy season, but nowadays rain also comes in the dry season. It's difficult doing rice farming [now], because whenever we need a lot of water for the rice field, there is no rain, and when we don't need water, there is a lot of rain. For example, after transplanting we needed water to keep the seedlings alive, but there was no rain' (Mother of Brick Workers, Svay, 08/02/2018)

The resultant transition from the labour intensive transplanting method of farming to the capital intensive broadcasting method requires only 1/15th of the labour investment, but a great deal more capital, in the form of fertilisers, pesticides and seeds. Moreover, it requires water in large quantities, engendering a shift mirrored across Asia more broadly whereby 'large centrally managed schemes are giving way to individually managed small-scale pumping from canals, river, aquifers and on-farm ponds' (Johnston et al., 2013). This 'water scavenging economy' (Johnston et al., 2013, p. 4) is made possible by the availability and affordability of small portable pumps (Molden, 2007), but it is also predicated on the presence of existing water infrastructure to be repurposed for private use, thereby allotting ageing Khmer Rouge infrastructure a key role in the process of small scale agricultural intensification in many sites.

Cheik, Poum and Svay are three examples of such repurposing. Located in the highly populated Mekong floodplains to the south of Cambodia, the soil type, water resources and topography led Khmer Rouge governors to plan paddy extension and intensification in the area surrounding each site. Contrary to much scholarship on the issue, these projects were not homogenously designed, but tailored to the geography of each site (Tyner et al., 2018). Reflecting their slight elevation and thus relatively low propensity to flooding, therefore, the areas in which these three sites are situated were subject to vast irrigation projects such as the one shown in Fig. 1, originally intended to be pump fed and centrally powered by a generator whose concrete casing still exists on the outskirts of the village. However, by the time the Khmer Regime collapsed in 1979, the irrigation projects were mostly not completed and during the 1980s and 1990s those which had been finished were poorly maintained and began to degrade as villagers struggled to rebuild their lives after the war.

As a result, these vast interconected irrigation systems have in large part been repurposed as rainwater storage in either nominally or formally private hands. In Cheik, once centrally powered by a pumping station drawing water from a neighbouring lake, a short lived farmer's water user community [FWUC][1] has given way to private management by a handful of villagers. In Poum, once at the edge of a similar centrally powered irrigation grid, only the main canal (see Fig. 2) remains connected to a lake beyond the village, leaving the small number of villagers whose land is close by to organise pumping directly to their farms where necessary. In Svay, once the hub of a large centrally powered irrigation project intended to pump water from the adjacent Mekong river to neighbouring villages, the derelict canal system is now used as rainwater storage for a brief period after the rainy season.

Moreover, seeking to supplement or supplant the water access provided by these canals, bore wells have sprung up in recent years in ever greater numbers. These wells draw on the local aquifer at an averge of depth of 40–60 m, depending on petrol powered pumps to raise large quantitities of water to the surface, in addition to the horizontal distance to reach individual plots of land. Although officially discouraged by the Cambodian government (RGC, 2019), using bore wells for agricultural purposes in this way is increasingly common across the country as a means for farmers to cope with unpredictable rainfall. Unlike canals, they do not depend directly on recent rainfall. Nevertheless, using them comes at a considerably higher cost than the average $1-200 annual cost of surface irrigation, often necessitating high levels of advance credit to faciliate.

Thus, despite the local character of its geography, local experiences of, and responses to, the climate are inseparable from Cambodia's wider economic development. The rapidly expanding availability of microfinance and remittances from migrant workers has increased rural capital to the extent that private water provision is possible. In turn, these same processes of water of management have fed back to the uptake of loans and the undertaking of migrations, both of which have increased rapidly in volume in recent years (Bylander, 2015). As a result, this nexus of migration and debt has resulted in growing entry to some of the Kingdom's worst and most precarious forms of migrant labour, as exemplified in particular by brick workers: the key focus of this paper.

Indeed, unlike other migrants, brick workers predominantly work under conditions of debt bondage, following their accrual of unmanageable debts outside of the kilns. Rooted in a desire to avoid a formal default, those who enter the brick industry therefore do so on the basis that a single loan from a brick kiln owner will clear all of their existing debts, leaving them both a consolidated debt figure and the means, in theory, to meet it. On this basis, prospective brick workers therefore agree a contract with the kiln owner to continue to work until their debt is cleared, a situation usually leading to long term bondage in the industry. On average, brick workers spend almost 8 years working in brick kilns, but many have done so for much longer, often running into decades and incorporating widespread intergenerational bondage (Brickell et al., 2018).

In rural discourse, those who find themselves in this position are routinely referred to as unlucky. Yet as what follows aims to show, this is a process with little to do with luck. The economic pressures that

[1] Farmer's water user communities are an initiative encouraged by the Cambodian government to promote shared management of common water resources. However, they are rarely put in place and even more rarely functional. Out of a total of 2525 irrigation schemes nationwide, only 230 – around 6% – have an FWUC in place, of which only four – 0.16% of the total – are functioning properly (CEDAC, 2009).

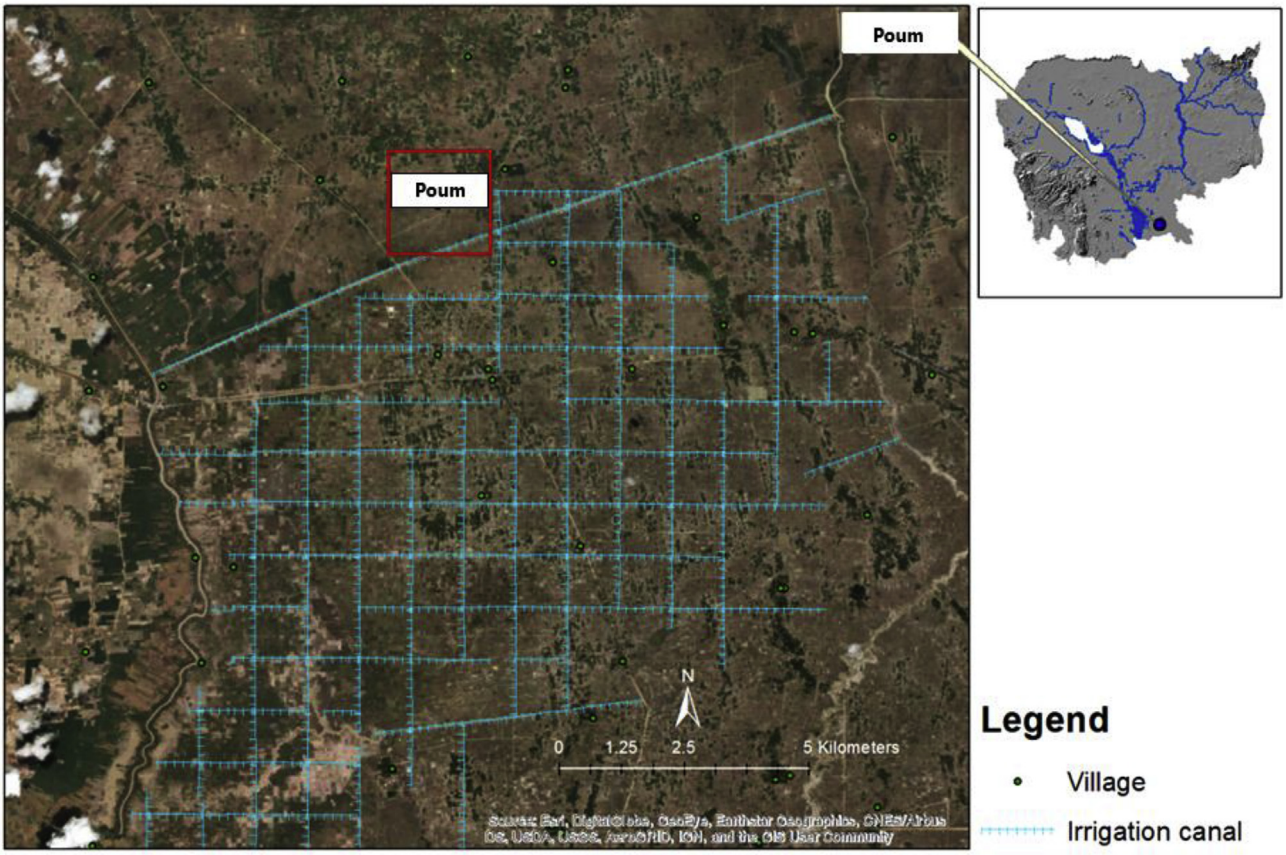

Fig. 1. Predominantly Khmer Rouge irrigation system around Poum (Open Development Cambodia, 2016).

Fig. 2. A Khmer Rouge era canal in Poum. Photograph: Sopheak Chann, 2018.

have transformed Cambodia's rural areas have increased precarity not at random, but according to specific geographically and socially articulated endowments of land, hydrology and capital. Who loses their land as a result of this process, and who retains or gains it, is thus no accident, but the result of these endowments being expressed amidst novel rural social and physical circumstances. Indeed, as this paper shows, it is paramount that neither the social nor the physical dimensions of this process are underplayed. Neither wells nor canals emerge by accident, yet they are key components in the hydrosocial politics of space, intertwining with both livelihoods and mobility in a fundamental manner.

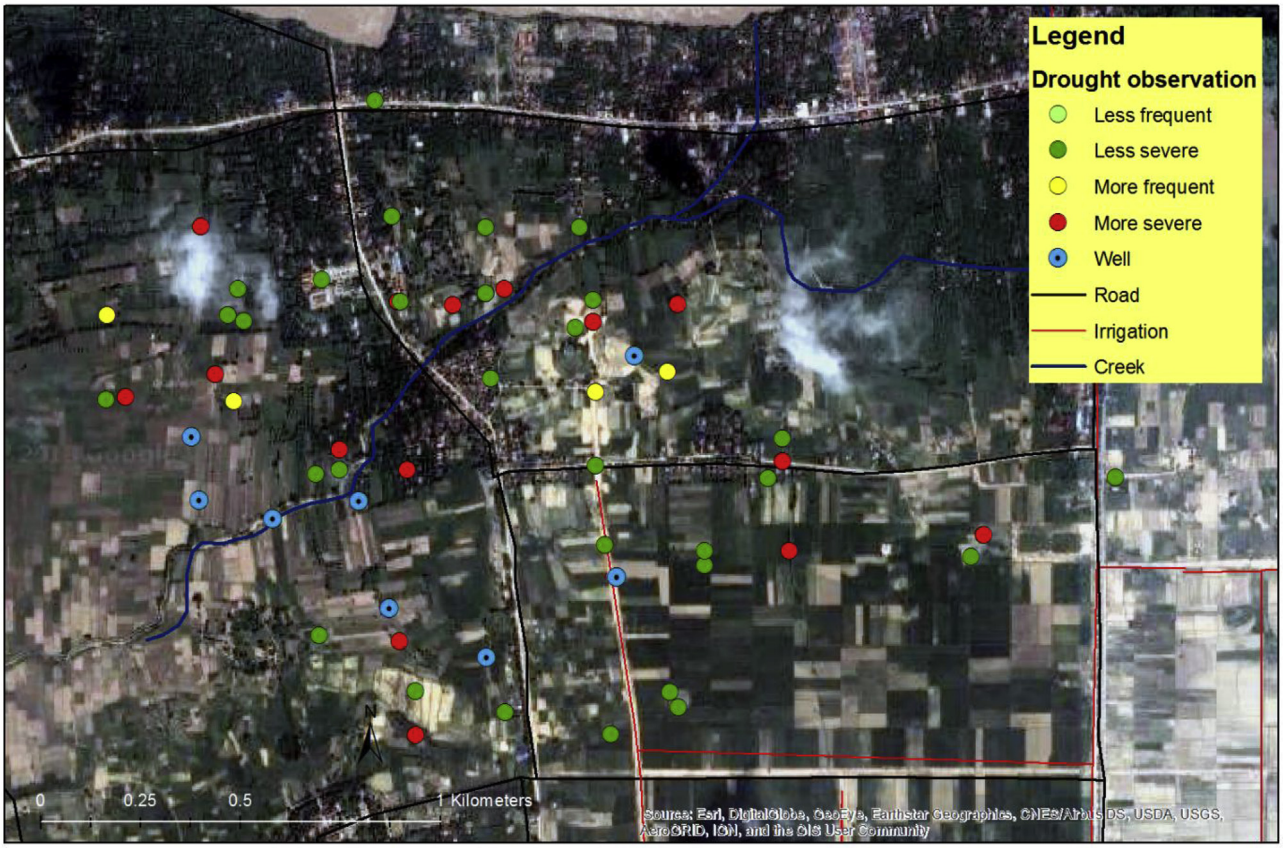

Fig. 3. Drought perception mapped against house location in Svay.

5. Hydrosocial power in situ: irrigation, space and debt

Where the politics of water are concerned, space and scale are key. Despite the broadly homogeneous picture of changing water regimes and adaptation across the Kingdom as a whole, a household perspective, as exemplified in Fig. 3, reveals a far more diverse set of accounts. Indeed, rather than indicating the geographical distribution of climate perception that might be expected according to such a method – with droughts perceived more by those living further from natural water sources, for example – the spatial data indicates no clear pattern to the perception of drought. Rather, as the figure shows, diametrically opposed reports of drought trends co-exist within a few metres of each other, suggesting that drought perception on this scale is neither homogeneous, nor related in a direct manner to residential land.

A logical response to this finding might be to hypothesize that it is the positioning of agricultural, rather than house land that drives drought perception. Indeed, given that access to drinking water was not presented as a challenge by either informant villagers or local officials or during the course of the research, the distance between water sources and agricultural land might be expected to influence the perception of drought more than the distance from residential land. However, mapping drought perception against agricultural land locations, as undertaken in Fig. 4, produces an equally diffuse picture of its experience. In both cases, therefore, it is not so much that there is no clear relationship, but the extent of the non-relationship that is key here. Far from demonstrating any clear spatial coherence, diametrically opposed perceptions of drought trends again co-exist within a few metres of one another.

Nevertheless, although space does not appear to play a direct role in shaping climate change perceptions, the data support Niles and Mueller's (2016) claim that water geography plays a role in shaping perceptions of the changing climate. Specifically, respondents' irrigation use correlates significantly with their perception of changes in the last five years to wind (Spearman's = 0.296; p = 0.000; insect infestation (Spearman's = −0.503; p = 0.000); new pest species, (Spearman's = 0.225; p = 0.002); floods, (Spearman's = −0.19; p = 0.009); and new plant species/weeds (Spearman's = −0.162; p = 0.027).

Supporting this relationship, informants' testimonies suggest that space, irrigation and climate work in combination to shape water availability on a household basis. As those in Cheik explained, the ability to farm is dependent on capital investment, with irrigation increasingly key to achieving a successful harvest. However, whilst 'some people have money to drill wells; people who don't have enough money have to watch their rice goes bad' (Farming Focus Group, 22/02/2018). Those wishing to make use of a well belonging to somebody else are therefore required to pay on credit for the service. Specifically:

> 'They charge 250,000 Riel [62.5 USD] per hectare. And the harvest fee is the same so in total it's already 500,000 Riel [125 USD], not including the rice delivery. If the farmlands are near, they charge 500 Riel [0.125 USD] per haversack and 1000 Riel [0.25 USD] if they are far. For example, if the land is 1 ha, it costs 100,000 riels [25 USD] and the harvest fee is 600,000 riel [150 USD], but there is also the expense of delivery and fertilizers. One hectare of rice paddy can yield up to 6–7 tons of rice to sell.[2] It costs up to 4 million Riel [1000 USD] for one time and all [of this is] bought on credit. We can't earn much profit because sometimes the rice gets infected when there's no rain. Fertilizers, oil [petrol] and well water are not

[2] N.B. The farmer here is citing this figure as a potential maximum. Mean reported yields in the study sites are in reality far lower. In Cheik, yields average the highest, at around 3 tonnes per hectare, whilst in Svay the figure is under 2 and in Poum, only 0.5.

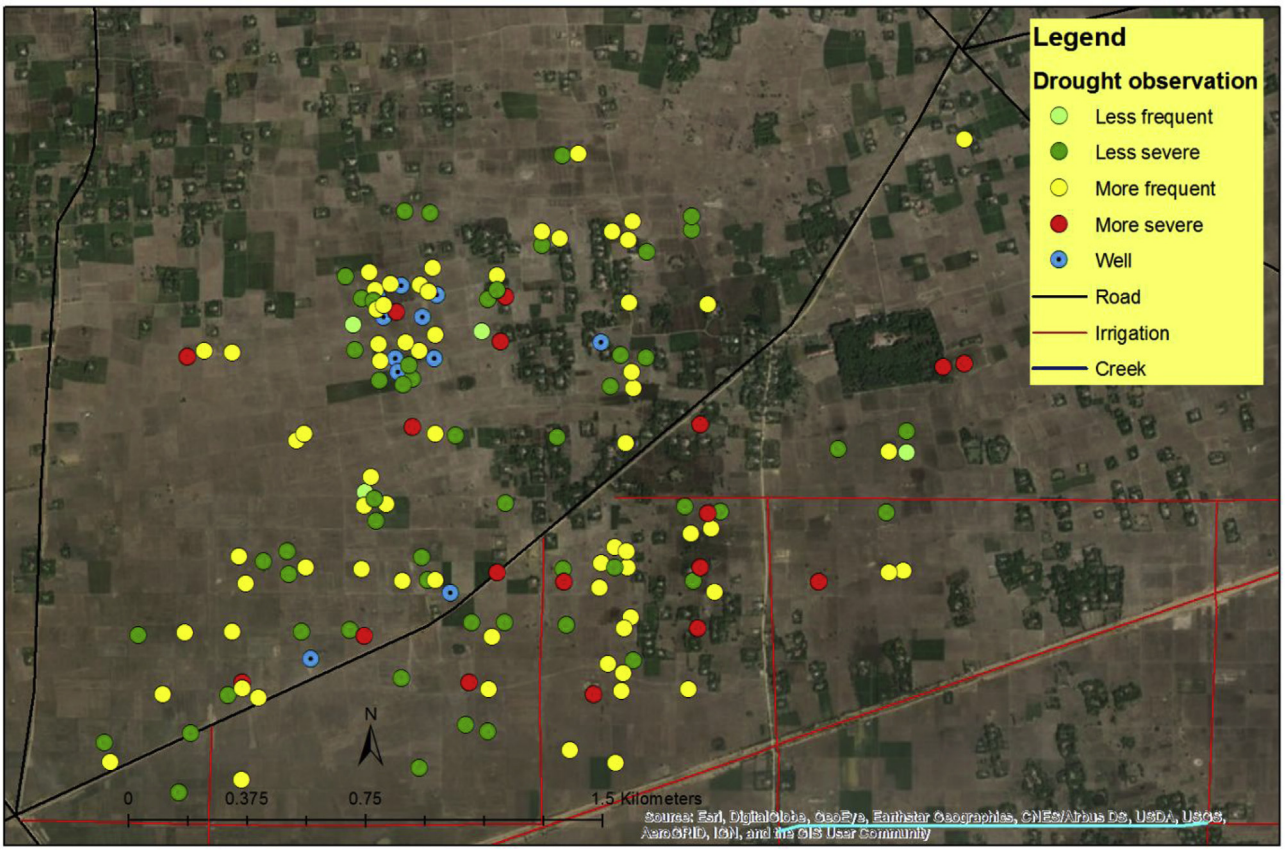

Fig. 4. Drought perception mapped against agricultural land in Poum.

enough [to make profit from] one hectare of farmland' (Farming Focus Group, 22/02/2018)

The fine margins that farmers in Cheik refer to mean that relatively small differences in distance from a water source can make a big difference to the profitability of an agricultural plot. Thus, whilst owning a well is not necessarily a prerequisite to a successful harvest, easy spatial and economic access to irrigation often is. Nevertheless, even when water is available, the cost of pumping is significant. For those whose land is located near to a canal, it entails two separate charges: 250 Kg of rice per hectare – or approximately 50 USD – to the water supplier (who pumps water from the main canal to smaller canals) in addition to 60 L of diesel, amounting to a total of 100 USD per hectare. Moreover, as a second farmer (Bol, 22/02/2018) explained, to receive water from a more distant canal costs 300 000 Riel [75USD] per hectare to the water supplier in addition to another 90-150 L of diesel to transport, costing between 72 and 120 USD. The total cost of water therefore amounts to between 150USD and 200USD per hectare per season, against average yields of under 2000 kg per hectare, or 500 USD at market value.

Although more reliable during periods of peak demand, the cost of pumping from wells is higher still, adding the cost of bringing the water to the surface to that of pumping it from the well to a farmer's agricultural land. In addition, well owners often levy further charges on well users, most commonly in the region of 2.50 USD per hour. Usually paid on credit, this renders the use of wells yet more costly and prohibitively expensive for those whose land is more distant from the well itself.

Viewed in this context, the close association shown in Fig. 5 between household debt and irrigation – reflected also in a correlation of 0.441 (Spearman's, $p = 0.000$) – is unsurprising. By driving and distributing debts, the geography of water shapes local livelihoods in rural areas. Nevertheless, the influence of irrigation is not confined to the spatial vicinity of the agriculture it sustains. Rather, as the following section will demonstrate, local hydrology continues to influence behaviour and livelihoods outside of the village itself by shaping the success or failure of translocal livelihoods, as well as the cost of sustaining them. By considering linkages between agricultural failure, migration, and entrapment in debt bondage, the following section will examine this scenario in further detail.

6. Mobilising hydrosocial power: irrigation, perception and precarious migrant labour

As section 5 demonstrates, perceptions of the changing climate are rooted, in part, in local environmental endowments. Yet climate perceptions are also a driver of mobility. Migrant livelihoods in the construction, garment and a number of informal industries are structured by the translocal experience of sender household assets and liabilities (see Parsons, 2017; 2016). Climate is perceived via the intermediary factors of assets and livelihoods, often earned or possessed many miles from the perceiver, thereby allowing the influence of hydrology to transcend local spaces and embroiling it in complex and spatially dislocated migrant livelihoods.

Indeed, as shown in Figs. 6 and 7, perceptions of climactic changes, even in the relatively recent past, are a key factor in the likelihood of migration, with both drought (Spearman's = 0.117; $p = 0.041$) and rainfall (Spearman's = 0.204; $p = 0.00$) significantly correlating with the presence of migrants in the household. This highlights the importance of climate perception – essentially the climate as articulated within a multi-scalar, power-laden milieu of assets, livelihoods and economic structures – in shaping migration decisions. Moreover, given that the minimum scale of data available in relation to both drought and rainfall patterns is in general (and certainly in Cambodia) far larger than size of a single village (Touch et al., 2017), it also highlights the scalar shortcomings of utilising climate data as an independent variable

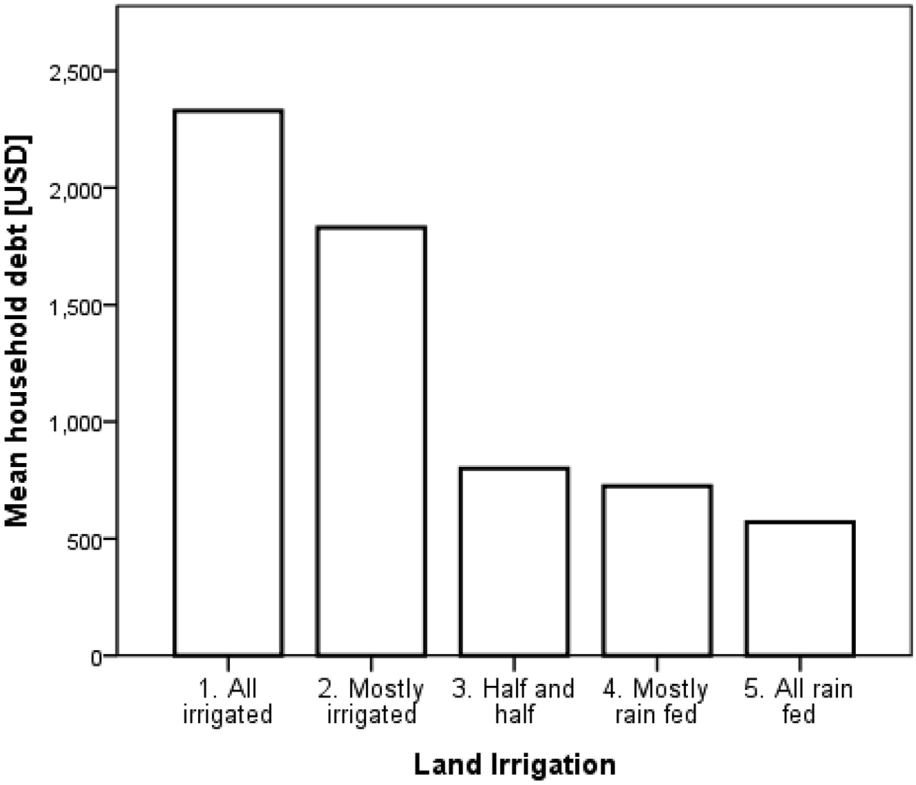

Fig. 5. Mean household debt against irrigation usage across all three villages (N = 308).

in the analysis of climate migration. Rather, the evidence here suggests that intermediary spatial and socio-economic factors play a key role in shaping the influence of the climate on mobility.

The possession or otherwise of agricultural land is one example of this. Households possessing agricultural land are more likely than those without to perceive changes in drought and rainfall. However, emerging most clearly amongst these factors, climate perception appears to be most closely linked to irrigation. Moreover, as shown in Table 1, the propensity of a household to contain migrants appears to be closely linked to the irrigation usage of the sender household. Households not containing migrants are therefore less likely to farm at all, as well as being considerably less likely than any other group to use

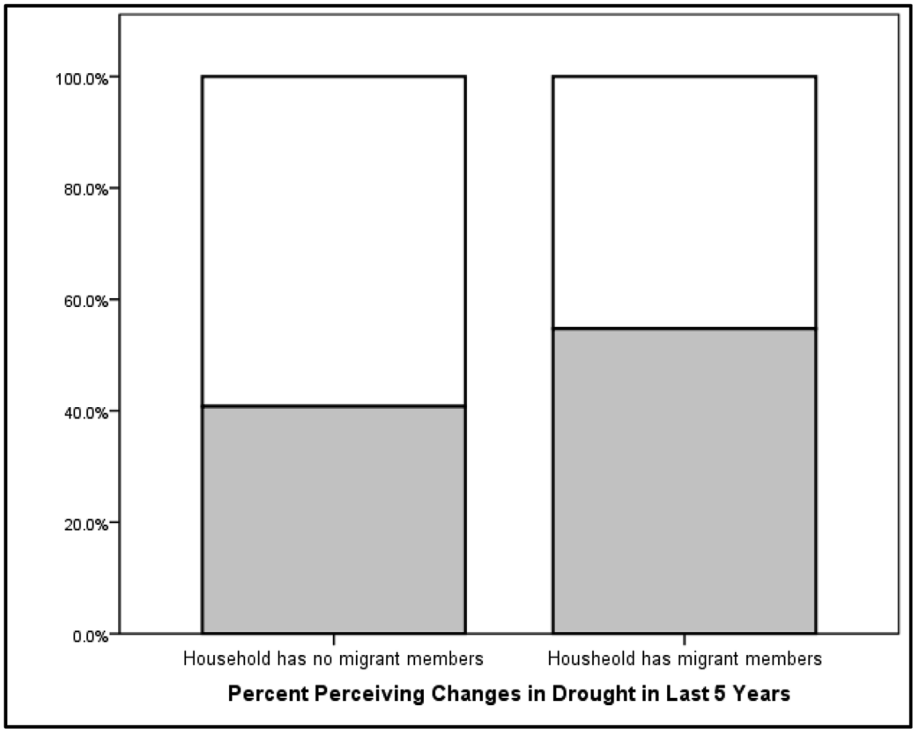

Fig. 6. Perception of changes in drought against the presence of migrants in the last 5 years (N = 308).

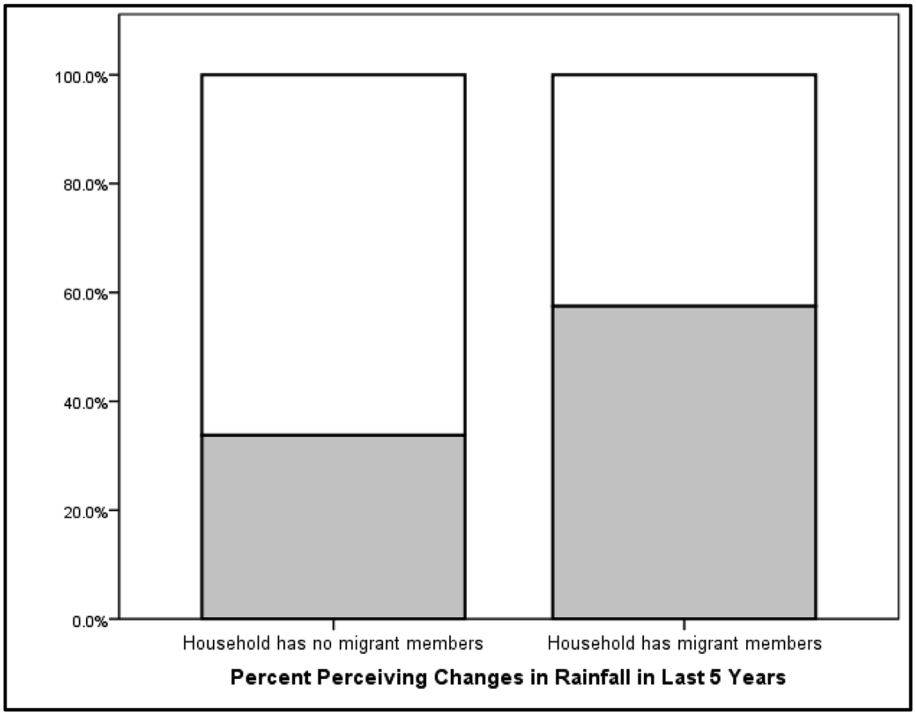

Fig. 7. Perception of changes in rainfall against the presence of migrants in the last 5 years (N = 308).

Table 1
Migrant occupation against home village irrigation usage.

Migrant Occupation	Irrigation Use			
	No agriculture [%]	All or mostly irrigated [%]	Half and half [%]	All or mostly rain fed [%]
Garment worker [n = 113]	29.2	20.4	0.9	49.6
Construction worker [n = 42]	31	23.8	0	45.2
Other (e.g. company staff, petty trader etc.) [n = 57]	38.6	8.8	5.3	47.4
Brick worker [n = 68]	44.1	29.4	1.5	25
No migrants [n = 136]	61	1.5	1.5	36

irrigation.

Moreover, although space, as shown above, has only limited direct influence on climate perception at this scale, it does appear to play a role in shaping how socio-economic factors, such as agricultural practice and irrigation use, influence that perception. Indeed, villagers' testimonies repeatedly highlighted the influence of spatial distances on migration decisions. Speaking of those who had migrated, for example:

> 'Their farmlands, around 4-5 guntas, [0.1 to 0.125 Acres], were far away from the wells. For us, who have around 4-5 ha of farmlands, we could barely grow rice, so what about them?' (Farming Focus Group, 22/02/2018)

Moreover, as they later elaborated.

> 'Those who didn't have enough water have gone to find work [outside the village]; the people down in those fields [there]. They only grow rice once a year using the stream water. When the stream dries out, they cannot grow [anything] anymore. No one drills the wells there because they cannot stay to guard the wells. Only people who can afford to drill the wells [themselves] can have enough water. [Only] if there are a lot of farmers in one particular place, can they get a well. If there's no water, it's useless having farmland' (Farming Focus Group, 22/02/2018)

These testimonies highlight the close relationship between migration and the small scale geography of irrigation. Yet beyond this binary analysis, a relationship is in evidence also in terms of the type of migration undertaken. In particular, there is a significant difference in the household irrigation usage of more desirable and higher remitting migrant groups such as garment work, construction work, petty trade and company jobs, compared with the least desirable migrant jobs, denoted here by brick work. As the data demonstrate, garment workers, construction workers, company staff, or self-employed workers, are almost twice as likely as brick workers to come from households whose agricultural land is all or mostly rain fed, as well as being significantly less likely to come from households whose agricultural land is irrigated.

Thus, what emerges most clearly of all is the relationship between irrigation use and entry to the worst forms of migrant labour, denoted here by brick work. Brick workers and villagers repeatedly emphasised that entry to bondage in this form is not merely a question of bad luck, but of processes closely linked to farming in a changing climate. As villagers themselves explained, 'people who left to work in the [brick] factories were very poor and couldn't continue growing rice due to the irregular rain. That is why they had to go and find a job [other than farming]: to earn a living and as well as paying their debts' (Farming Focus Group, 22/02/2018). Moreover, as the village chief of Poum, summarised:

> 'Yes, they had some difficulties before they went to the brick factory. Most of them rented farmlands to grow rice paddy but it was often unsuccessful so they were in debt. When they had no money to survive and pay the debt, they started selling their lands and finally moved to a brick factory. That was it. It was not about gambling or

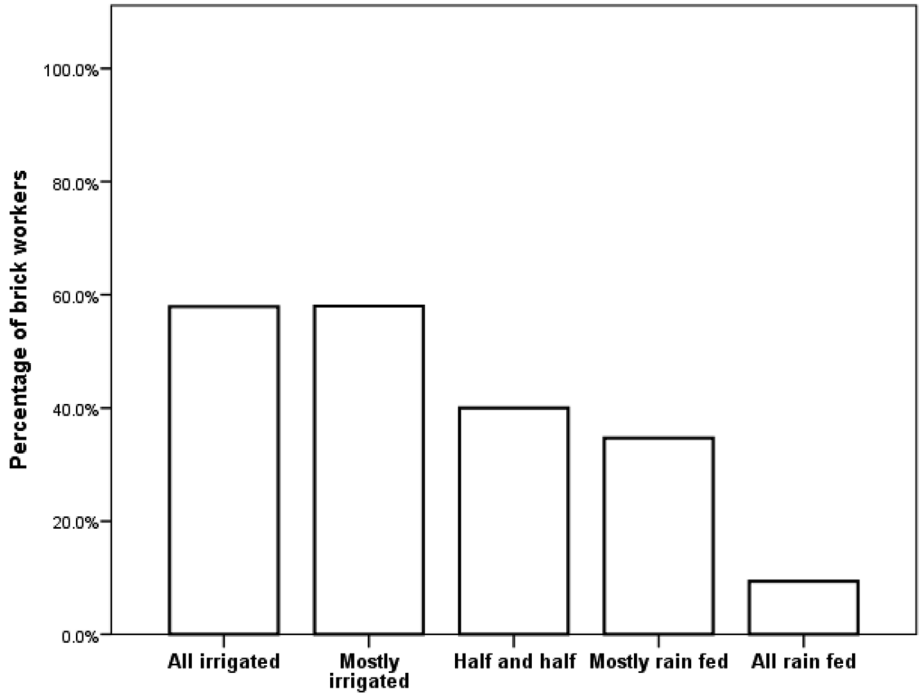

Fig. 8. Percentage of brick workers against type of irrigation in all three villages (N = 308).

anything; just the villagers not having a stable job and income. They solely depended on agriculture, which didn't go well for them because of natural disasters like floods and droughts. From one year to another, their debts kept increasing so they took their wages from the factory to pay off the old debts in the village. [In the end] working in a brick factory seemed to be better than [staying] in the village because at least they [would] have stable income [there]. That's all I have to say' (Poum Village Chief, 05/03/2018)

These testimonies highlight the centrality of water to the nexus of debt funded agriculture, climate change and entry to bonded labour in the brick industry. As they emphasise, brick workers households are poorer across all asset categories than non-brick working counterparts. Yet a focus on assets alone belies the role of space in structuring this disadvantage. The possession of assets is only one component of vulnerability to unmanageable debt.

As shown in Fig. 8, the more central irrigation is to a household's agricultural practice, the greater the proportion of brick workers in the sample. Moreover, the geospatial data present a yet clearer picture. As shown in Fig. 9, villagers' testimonies are correct in noting the spatial disadvantage of brick worker households' agricultural landholdings. In Poum, for example, brick worker household land is located discernibly further from the ground water wells which provide the most reliable agricultural water source, but closer to the less reliable canal system.

The quantitative data further support this relationship. As Table 2 shows, the average distance of a piece of agricultural land to its nearest well reveals a clear difference between households containing brick workers and those not containing them. In Cheik, this amounts to a roughly 6% difference, whilst in Svay this rises to 13% and 19% in Poum. Spatial distance from wells is therefore associated not only with higher debt, but unsustainable debt of the sort that leads to brick work. Although these differences are relatively small, their significance is enhanced by the direct relationship between distance and the cost of irrigation, effected via the gasoline cost of pumping water. In an agricultural landscape of fine margins, these discrepancies can not only mean the difference between profit and loss in the short term, but are amplified over time by the compounding effects of formal and informal interest payments.

Crucially, though, this is not a relationship that holds for other water sources. Whilst in Svay, brick workers' agricultural land is slightly (4.6%) further from the nearest canal than is non-brick workers' land, in Cheik and Poum, brick workers' agricultural land is in fact positioned closer to a part of the canal system by 18% and 100% respectively. Thus, those households falling into brick work are those with easier access to the repurposed Khmer Rouge built canal systems, but substantially less able to access ground water wells, leaving them with the choice between lower pumping cost from a less reliable water source, or a higher cost of pumping from a more reliable one.

Given the statements recorded above concerning the relative reliability of wells versus canals for irrigation, these data highlight how the relative quality of access to irrigation determines the outcomes of mobile as well as local responses to the changing climate. Thus, they highlight how the outcomes of attempts to respond to the changing climate are influenced by a combination of the spatial and social geography of water; or otherwise put, by hydrology as articulated through multi-scalar socio-economic inequalities. Moreover, in contributing to migration decisions, hydrosocial power has a translocal quality to it, influencing not only local livelihoods, but also migration decisions and migratory outcomes across significant spatial distances.

7. Conclusion

Cambodia has long been identified as one of the world's most vulnerable countries to climate change, as a result of both its propensity to floods and droughts, and its dependence on smallholder agriculture (Halsnaes et al., 2018; Touch et al., 2017). Moreover, it is also a highly mobile country: more than a third of the country's population is currently a migrant (UNICEF, 2018). If climate migration is to be observable anywhere, few contexts offer greater opportunity to observe its manifestation. Nevertheless, as this paper has aimed to show, the omnipresence of the climate as a factor in migration decisions does not equate to simplicity of analysis. Rather than producing clearly a observable response, the climate is perceived and responded to in myriad contradictory ways.

In particular, this paper has sought to highlight how observations and responses to large scale climate change are articulated by local

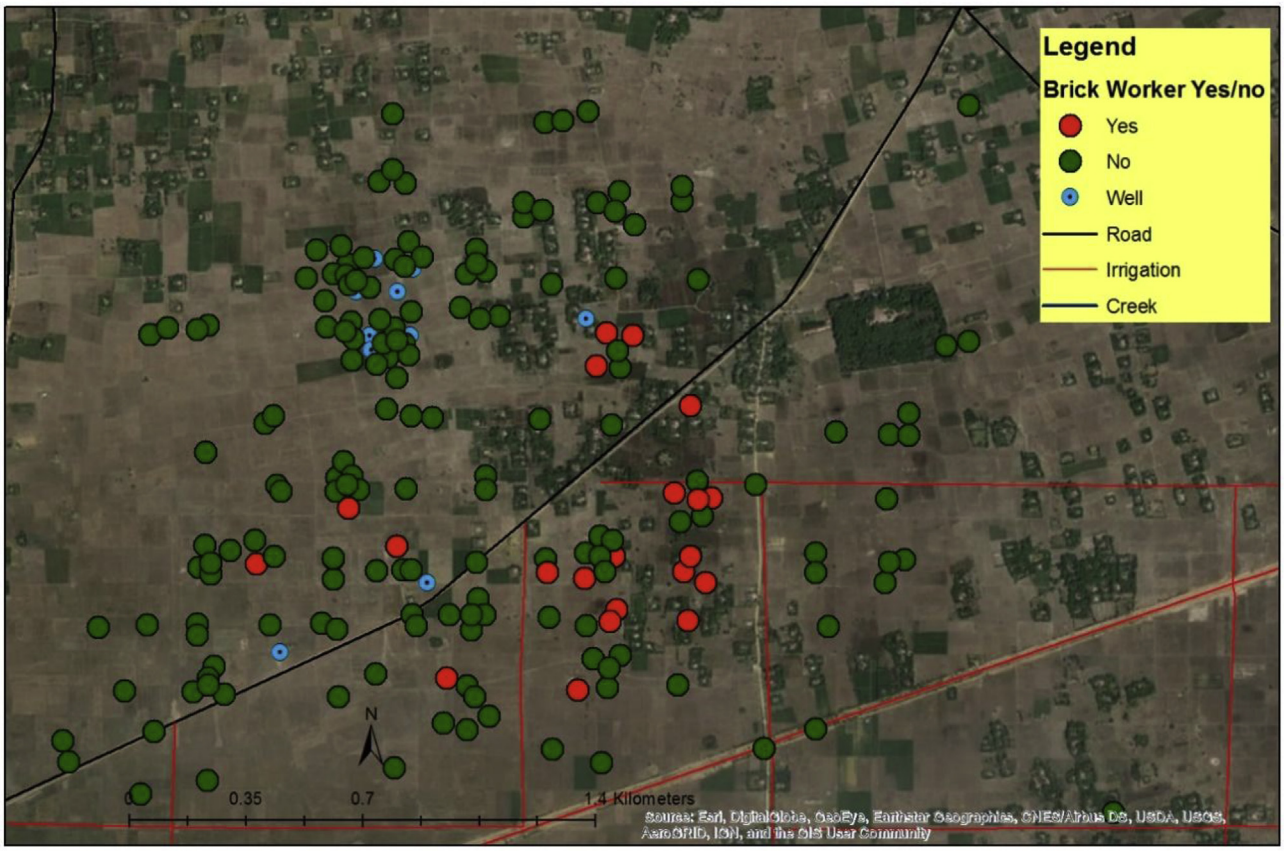

Fig. 9. Location of land possessed by brick workers and non-brick workers in Poum.

hydrology. The functionality of a canal, the presence of a well, or simply the distance between a plot of land and either, may make the difference between a water shortage being readily coped with, or spelling the end for a smallholder's farming activities. These 'socio-hydraulic landscapes' (Ekers & Loftus, 2008, p. 700), both human made and natural, shape how the climate is perceived. Consequently, changes to the climate are not experienced or determined directly by space, but through the lens of the social and physical geography of resources, thereby necessitating a smaller scale, geographically embedded, perspective on the drivers of climate migration, in order to understand its outcomes.

In view of its sensitivity to the intersection of material and immaterial infrastructure (Bijl, 2018; Camargo, 2017), The lens of hydrosocial power is presented here as an effective means to conceptualise this process. From this standpoint, the evidence here has therefore aimed to work towards a conception of these hydrosocial structures as interlocuters and 'power brokers' (Meehan, 2014, p. 215) between climate migrants and the geography in which they live. In other words, by considering adaptive responses to water scarcity in Cambodia from the perspective of hydrosocial power (Boelens, 2014; Meehan, 2014; Uson et al., 2017), it is possible to reframe climate response not as a unidirectional impulsion on humans by their environment, but as a dialogue between people, the resources they depend on and the contexts in which they are articulated.

Above all, therefore, this perspective insists on the necessity of complexity in a debate frequently framed in binary terms. Whether between minimalists and maximalists (Baldwin et al., 2014; Bettini, 2013; Suhrke, 1994), or between those advocating or refuting the influence of single factors on migration, debates over climate migration have rarely given full attention to issues of power (Cote & Nightingale, 2012; Nightingale, 2017) and even more rarely sought to integrate such considerations into analyses of spatial and geographic phenomena that shape climate migration. The local, therefore, in both its social and physical senses, has proved a curiously enduring absentee in a discussion fixed by default at the global and regional scale.

Indeed, beyond the specific concepts and methods employed here to observe climate migration, there is a wider issue elucidated by these approaches concerning the scalar disjuncture between scientific climactic observation on the one hand, and the climate as it impacts on human behaviour on the other. Simply put, climate data at the scale at which it is collected to observe climactic phenomena is not in itself an appropriate tool with which to accurately observe the climate's impact on human behaviour. Not only is much smaller scale climate data necessary to do so, but also a suite of further socio-economic, geographic, and hydrological data with which to construct the intermediary relations between global changes and local behaviours. Detail and scale, in

Table 2
Distance between agricultural land and key water sources by village.

	Cheik (n = 107)		Svay (n = 66)		Poum (n = 205)	
	Brick workers	Non brick workers	Brick workers	Non brick workers	Brick workers	Non brick workers
Mean distance of agricultural land to well (m)	369	349	373	329	473	399
Mean distance of agricultural land to canal (m)	299	354	605	577	254	497

sum, are key.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.polgeo.2019.102055.

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