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Journal of Environmental Policy & Planning

ISSN: 1523-908X (Print) 1522-7200 (Online) Journal homepage: https://www.tandfonline.com/loi/cjoe20

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To cite this article: Sam Grainger, Lena Hommes, Timos Karpouzoglou, Katya Perez, Wouter Buytaert & Art Dewulf (2019) The development and intersection of highland-coastal scale frames: a case study of water governance in central Peru, Journal of Environmental Policy & Planning, 21:4, 373-390, DOI: 10.1080/1523908X.2019.1566057

To link to this article: https://doi.org/10.1080/1523908X.2019.1566057

JOURNAL OF ENVIRONMENTAL POLICY & PLANNING
2019, VOL. 21, NO. 4, 373–390
https://doi.org/10.1080/1523908X.2019.1566057

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The development and intersection of highland-coastal scale frames: a case study of water governance in central Peru

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ABSTRACT

Scale framing makes an important difference to how complex environmental policy issues are defined and understood by different groups of actors. Increasing urban water demand and uncertain future climatic conditions in the Andes present major water governance challenges for the coastal regions of Peru. An understudied dimension of Peruvian water governance is how scale framing shapes the way problems are defined, and solutions are pursued. Here, we aim to strengthen the understanding of scale framing as it relates to highland-coastal interactions in central Peru between 2004 and 2015. By analysing this period of significant water governance reforms, we identify five prominent water-related frame dimensions and three differently scaled policy storylines and reveal how they developed and intersected over time. The storylines, supported by particular visualisations, either foreground 'urbanshed'-level investment in water supply infrastructure, community-level cultural restoration for improved local agricultural production, or nationwide watershed-level financial mechanisms for highland ecosystem conservation. Our study shows how the intersection of these storylines at different moments during the policy process often had a strengthening effect, creating a coalition of actors who were then able to generate sufficient momentum and support within the Peruvian government for the implementation of conservation-based watershed investments.

ARTICLE HISTORY
Received 21 July 2017
Accepted 7 October 2018

KEYWORDS
Scale framing; visualisations; highland watershed conservation; urban water supply; water governance; Peru

1. Introduction

Scale has attracted considerable attention and generated intensive debate in the environmental governance literature (Newig & Moss, 2017[1]). Much of relevant social-ecological systems (SESs) and resilience research relating to scale has been primarily concerned with seeking the 'correct' scale of governance or avoiding scale mismatch between the scale of the problem and the scale along which it is governed (Cash et al., 2006; Guerrin, Bouleau, & Grelot, 2014). In contrast to this approach, political and human geography scholars have focused on the social and political construction of scale (Newig & Moss, 2017; Swyngedouw, 2004). Through the development of different conceptual lenses, these studies have demonstrated that the scale (or more specifically the scale-level along a scale) at which governance issues are defined, a process known as scale framing (Van Lieshout, Dewulf, Aarts, & Termeer, 2011), makes an important difference to how problems and solutions are understood. In this paper we define 'scales' as constructed dimensions (e.g. spatial, temporal) used by actors to

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Supplemental data for this article can be accessed at 10.1080/1523908X.2019.1566057

describe and compare phenomena, and 'scale-levels' as different points, locations or analytical units along a scale (e.g. global, seasonal) (adapted from Gibson, Ostrom, & Ahn, 2000).

Scale framing is a particularly prominent process given that complex environmental policy issues increasingly play out between different groups of actors, with diverse priorities and knowledge bases, interacting with each other across multiple scales (Buizer, Arts, & Kok, 2011). For example, water users often have different views about the meaning, direction and purpose of water governance (Lebel, Garden, & Imamura, 2005; Moss & Newig, 2010). As a result, actors vary considerably in the scale-levels at which they frame water issues.

This diversity of scale frames is particularly prominent in mountain environments, which are often characterised, in the context of water supply and related ecosystem services, by upstream – downstream linkages. In the watersheds surrounding Lima (Peru), such diversity is inherent in the interplay between highland water users (such as the community of Huamantanga), actors concerned with supplying drinking water to the coastal urban population (such as Lima's water utility), and local and international non-governmental organisations (NGOs) working in the watersheds. Within these framings, scale is frequently referred to both explicitly, within the information gathering and products circulated among actors, but also more informally during negotiations (Cash et al., 2006). Therefore, the role of scale framing needs to be considered to better understand how scientific information and policy storylines are co-produced and deployed during complex water governance interactions and negotiations.

Here, we aim to strengthen the understanding of how scale framing defines the nature of water governance in central Peru. We focus on the relationships between highland communities and coastal urban actors in shaping water-related policy storylines. Our analysis starts in 2004 with the introduction of Integrated Water Resource Management (IWRM) into Peruvian water governance discourse, and culminates in 2015, with Lima's water utility committing to invest 1% of their income from urban consumer tariffs in conservation-based watershed interventions (Gammie & De Bièvre, 2015). It is a particularly interesting time to conduct such an analysis given this major reform period and the growing interest in 'green infrastructure' development in Latin America (Veiga, Calvache, Benitez, Leon, & Ramos, 2015).

Lima covers nearly 3000 km^2 (Weissinger, 2011) and represents a third of Peru's total population (INEI, 2007). Receiving on average less than 10 mm of rain per year (SENAMHI, 2009), the city has historically relied on seasonal Andean flows from the surrounding watersheds for its water supply (SUNASS, 2015). Securing water to meet increasing urban demands is a high policy priority in Lima and has been in part reinforced by current administration efforts to secure 100% coverage (Ioris, 2015). While the idea that Andean water resources will need to be better managed in order to avoid future shortages is becoming more prominent, the debate around how that should happen remains a subject of negotiation. Therefore, it is particularly pertinent to explore how water governance frames come together in policy storylines, how they are scaled and how they intersect with other storylines to provide legitimacy and support for specific policy directions.

We first discuss the framing and scaling literature that informs our analysis. Subsequently, we detail our data sources and methodological approach, followed by a description of the water governance context in Lima. We then analyse distinct water-related frame dimensions that recur between 2004 and 2015, using policy storylines as the analytical lens to reveal how these frame dimensions intersect over time. Additionally, we relate differently scaled policy storylines and frame dimensions with a timeline of important moments in the process to explain how, during these moments, particular storylines emerge, develop and intersect over time and which actors shape their construction. We conclude by summarising our main contributions and outlining several implications for future research and practice.

2. The role of scale framing and information in water governance

2.1. Understanding the notion of scale

The conceptualisation and significance of scale has been extensively studied in the environmental governance literature and is particularly relevant for water governance (Dewulf, Mancero, Cárdenas, & Sucozhañay, 2011; Moss & Newig, 2010; Ward & Kaczan, 2014). However, different studies apply different meanings to the concept of scale (Gibson et al., 2000; MacKinnon, 2011; Padt & Arts, 2014; Papanastasiou, 2016).

This paper takes the constructivist view that scale and scale-levels are not self-evident but, to a large extent, socially constructed (Marston, 2000). Many governance scholars, however, treat these constructed hierarchies as assumed 'truths' or 'real' entities (Buizer et al., 2011). Proponents of this framework, therefore, seek to define a 'correct' scale of governance as an unequivocal value, based on scientific consensus (Guerrin et al., 2014; Termeer, Dewulf, & Van Lieshout, 2010). However, if scale is understood as a socially constructed phenomenon then the process of scale framing, through which people position problems at particular scale-levels, becomes central to policy-making (Buizer et al., 2011; Guerrin et al., 2014; Rangan & Kull, 2009).

The social construction of scale is important for water governance as biophysical/hydrological scales play a prominent role within the dominant management configuration: the watershed (Moss & Newig, 2010). The watershed and larger or smaller sub-catchments thereof enjoy widespread status as suitable scale-levels to organise IWRM, for example in the EU water regulatory system (Moss & Newig, 2010). However, jurisdictional and institutional scales (Cash et al., 2006), along which administrative levels and formal and informal rules are organised, often match poorly with hydrological scales. Even when scale-levels for water management are defined in hydrological terms, the range of watershed sizes makes agreeing on an appropriate starting level challenging (Dewulf et al., 2011). Interventions defining appropriate water management scales have altered power geometries, to the benefit of those capable of acting across the new scale and scale-levels, while hampering those that operate using others (Guerrin et al., 2014; Moss & Newig, 2010).

2.2. Scale framing and 'politics of scale'

We can better understand how social construction of scale takes place through a focus on framing (Leitner, 2004). According to Entman (1993),

> to frame is to select some aspects of a perceived reality and make them more salient in a communicating context, in such a way as to promote a particular problem definition, causal interpretation, moral evaluation, and/or treatment recommendation for the item described (p. 52).

This process enables social actors to interpret and make sense of contentious issues and deploy these perspectives when interacting with others throughout a policy process (Van Lieshout et al., 2011). In this way, frames drive behaviour and social interaction (Chong & Druckman, 2007). During a framing process, social actors may also consciously or subconsciously select a scale, and level along that scale, to frame a water governance issue, based on their specific worldview or interest in the issue at stake (Guerrin et al., 2014). This then becomes part of the 'scale framing' process, which has considerable policy implications. For example, if a water issue becomes defined within a governance process as a local problem, this may imply that support from higher levels of governance is not to be expected. Conversely, if water is defined as an issue of national interest, local or regional concerns may be overruled.

Actors may have an interest in using their relative power and authority to promote certain scales or scale-levels above others, resulting in certain scale frames becoming more or less dominant within political negotiations (Leitner, 2004). This process, known as politics of scale (Delaney & Leitner, 1997; Jonas, 1994), or scalar politics (MacKinnon, 2011), involves actors continuously restructuring power and responsibilities (Kurtz, 2003; Leitner, 2004; Van Lieshout et al., 2011). In other words, actors use scale and scale-levels within their framing of an issue as political devices to negotiate an advantageous position for themselves (Padt & Arts, 2014; Termeer & Kessener, 2007; Van Lieshout et al., 2011). For example, scales and levels may be used to position oneself close to certain actors while, in other cases, far from (control by) the centre of power. These processes can be seen within a continuous feedback loop of negotiations, whereby framing influences the way in which problems are defined; which in turn, influences which actors are included, resources accessed, and issues prioritised within future policy processes (Dewulf et al., 2011; Termeer & Kessener, 2007; Van Lieshout et al., 2011). Furthermore, these situations are a result of diverging knowledge claims and interests, all with associated uncertainties and contentious approaches to scaling (Guerrin et al., 2014).

In the Mekong region, Lebel et al. (2005) argue that water scale choices are often subtly constrained by political choices around institutional design, technologies and scientific information. Crow-Miller and

Webber (2017) identified an upscaling process around China's South–North Water Transfer Project. In this instance, scalar constructions were used for political ends by the state as a way to reframe North China's water shortages as something that can bring benefits at the national (rather than local or bioregional) scale. Similarly, in twentieth century Spain, the state centralised water governance by relocating decision making powers from provincial governments (on an administrative scale) to larger watershed level authorities (on a hydrological scale) (Swyngedouw, 1999). Harris and Alatout (2010) focus on how Turkey's efforts to rescale the management of the Euphrates and Tigris into one transboundary watershed have been fundamental to legitimising the state's legal claim to the rivers' water resources (at the expense of others) (Harris & Alatout, 2010). We seek to build on these discussions and gain new insights into scale framing by focusing on the way in which scale frames emerge and develop to shape Peruvian water governance over time.

2.3. Scale framing, information and knowledge

Any piece of knowledge or information implies a particular scale frame while, at the same time, any scale frame creates the need for particular types of knowledge or information. Cash et al. (2006) introduces the notion of positioning knowledge along a scale ranging from large-scale, universal understanding produced by formal science down to context specific understanding embedded in local or traditional knowledge systems. During policy processes, actors frequently scale issues while gathering, repackaging and circulating information that matches their framings. As a result, what is included or excluded and where boundaries are drawn within circulated information (communications) is often indicative of this sense-making process. Visualisations are a particularly powerful and widespread way to communicate among actors (Grainger, Mao, & Buytaert, 2016; Karpouzoglou et al., 2016). Here, we use these artefacts to better understand how information is being scaled during governance processes.

2.4. Narrative approaches and policy storylines

Stories are ubiquitous within policy making to support arguments and make claims about past and future actions (Kaplan, 1993). We define a story or narrative as an 'ordering plot' (Kaplan, 1993) with at least three components: a starting state, an action and a consequential state (Czarniawska, 1998; Kaplan, 1993). When used as analytical devices, narrative approaches offer a powerful way to distil differing and sometimes contradictory interests, events and framings within complex policy processes.

We apply the related concept of policy storylines as lenses to analyse how frame dimensions come together and are communicated to other actors during water governance processes. Unlike a broader discourse, policy storylines argue for certain issues to be understood and addressed in a particular way (Fisher, 2012; Smith & Kern, 2009). These condensed narratives emerge when elements of framings become distilled within a particularly coherent and compelling story, argument or metaphor (Hajer, 1995; Smith & Kern, 2009). They often contain elements such as protagonists, antagonists, plots and specific settings; the latter relating closely to the implied scale-level on which the story unfolds. We are particularly interested in how coalitions of actors build consensus around policy storylines, close off alternative policy options and position themselves under influential institutions during governance processes.

2.5. Specific research questions

This paper is guided by the following overarching question:

How do scale frames and policy storylines shape Peruvian water governance during a water reform period between 2004 and 2015?

We address the overarching question through the following four sub-questions:

- What scale frames and policy storylines characterise the water governance process?
- How do these scale frames and policy storylines develop and intersect over time?
- What are the effects of these intersections?
- How is information related to these storylines being supported within particular visualisations?

3. Method

3.1. Overall approach

We use an interpretive approach to analyse how scale framing and policy storylines shape Peruvian water governance over time. This approach assumes that the world can be understood in multiple ways (Yanow, 2000; Yanow & Schwartz-Shea, 2006) and acquired knowledge is understood as the product of an interpretation process (Van Bommel, 2008; Yanow, 2007). We did this on the basis of a longitudinal, multi-sited case study, including diverse data collection methods (see section 3.3).

By adopting interpretive methods and a case study design, we analyse when different water-related frame dimensions and policy storylines were adopted and, by which actors, operating at which scales. We focus on the communicative side of policy storylines, thereby gaining a deeper understanding of what is being communicated between policy actors. We do not attempt to connect individual actors with individual frame dimensions or storylines but rather use the concepts of frames, storylines and scale frames to distil key patterns that then allow us, in the timeline analysis, to look at who carried forward the differently scaled storylines during the 2004–2015 reforms. Storylines are constructed as an intermediary step, and as a technique to streamline the analysis and make it more meaningful when discussing scale and framing concepts. We also analyse visualisations related to these storylines to better understand how information was scaled during the study period. By first identifying distinct water-related frame dimensions and differently scaled storylines, we prepare the ground for discussing how different actors deal with these different frames and storylines in the subsequent timeline reconstruction.

3.2. Overview of case studies: highland-coastal interconnections in central Peru

Our analysis focuses on two sites: a highland community that retains strong geographical, social and economic ties with Lima and the coastal city of Lima itself. In the following, we briefly introduce both.

3.2.1. Highland agricultural water users

Huamantanga (600 inhabitants) is located about four hours' drive from Lima at approximately 3400 metres above sea level (Figure 1). The community depends on water resources from the headwater of the Chillón watershed, particularly for dairy production (Vila Benites, 2014). The increasing number of cattle and the limited availability of pastures close to the community, has led to farmers extending their activities into the higher pastures. This has resulted in overgrazing and degradation of pasture, which in turn is believed to have had negative effects on water retention locally and potentially on a regional scale (Bremer, Gammie, & Maldonado, 2016a). Recently, NGOs have conducted water-related projects and studies in the community to address not only locally perceived problems but also to provide a test bed for a range of policy ideas and framings that connect activities in Huamantanga with the sustainability of Lima's water supply, restoration of ancient Andean water structures and culture, conservation of highland ecosystems and improved understanding of Andean hydrology. Since the NGO-led restoration of a pre-Incan infiltration canal in the community, Huamantanga and the approaches piloted there have caught attention from national and global media (America TV, 2015; Collyns, 2015). As a consequence, this community has become significant within water discourse in the region.

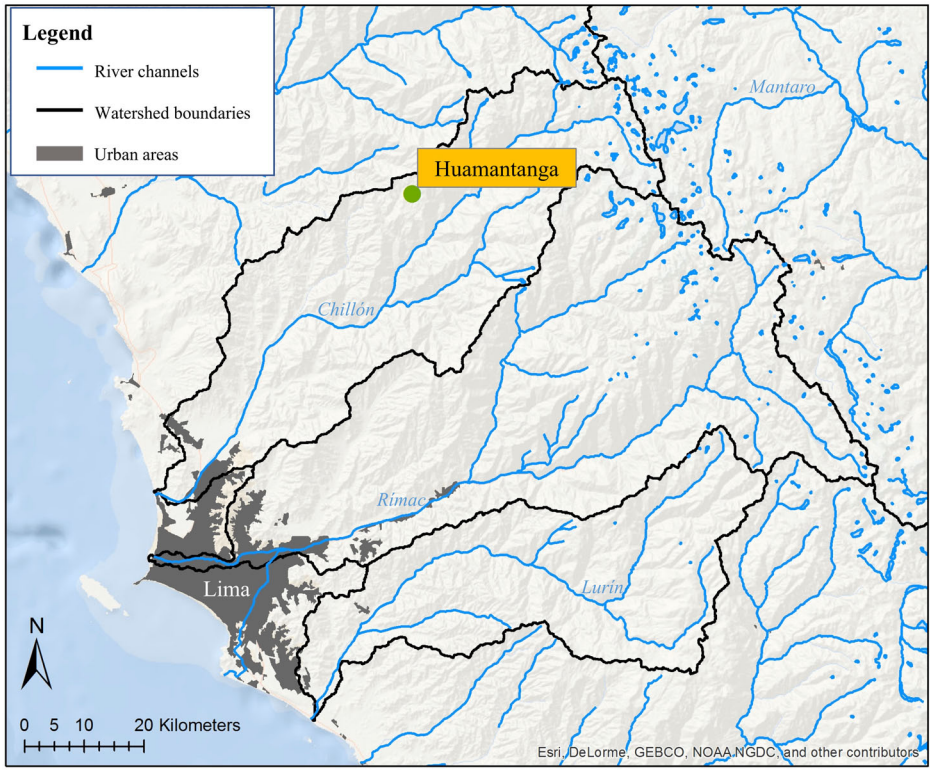

Figure 1. The geographical context of Lima, the Chillón, Rímac, Lurín and Mantaro watersheds and Huamantanga.

3.2.2. Coastal urban water users

Historically, Lima has been dependant on Andean flows from the Chillón, Rímac and Lurín watersheds. However, since the 1960s, an increasing component of Lima's water resources originates from the upper Mantaro watershed (a headwater of the Amazon), creating strong links between the dry coastal lowlands and wetter Andean highlands of central Peru (Hommes & Boelens, 2018).

Unlike the national picture where agriculture dominates, the majority of water withdrawals in the Chillón, Rímac and Lurín watersheds are by Lima's state-owned water and sewage company SEDAPAL that supplies water to most of the city's households, businesses and municipalities. Water demand in the city is projected to continue to grow, due to both rural-urban migration and internal population growth (Miranda Sara, Jameson, Pfeffer, & Baud, 2016; SUNASS, 2015). Likewise, concerns about the potential impact of increasingly irregular highland precipitation on Lima's water sources increase (Aguilar-Barajas, Mahlknecht, Kaledin, Kjellén, & Mejía-Betancourt, 2015). SEDAPAL's predominant response to these perceived threats has been to invest in large-scale 'grey infrastructure', augmenting water supply through the construction of dams and reservoirs in the upper Rímac and Mantaro watersheds (SEDAPAL, 2005).

SEDAPAL, like the other water utilities in Peru, is officially monitored and supervised by the national regulator SUNASS, who is also in charge of approving utilities' long-term planning documents and water tariff structures. SUNASS is therefore a key actor in the drinking water sector in Peru. However, a strong imbalance in status and power within central government has created a unique and sometimes challenging dynamic between the regulator and SEDAPAL, the biggest and most powerful utility in Peru. As our analysis explores in more detail, SUNASS is increasingly positioning themselves (in partnership with other state and non-state actors) as the 'progressive' state institution open to alternative or 'green' approaches to water supply management.

3.3. Data collection

Highland-coastal interactions in Lima were analysed using literature analysis, participant observation and 46 in-depth, semi-structured interviews conducted during 2014 and 2015 with key stakeholders in Lima and Huamantanga.

In Huamantanga, we interviewed 8 (past and present) community leaders and 25 resident farmers, and took part in community life and events, observing, for example, local water management practices and NGO-community interactions. In Lima, we conducted interviews with representatives of the Ministry of Housing, Construction and Sanitation (MINVCS), the Ministry of Environment (MINAM), SUNASS, the National Water Authority, the Water Fund for Lima and Callao (Aquafondo), the US Agency for International Development (USAID) and NGOs Alternativa, Forest Trends, The Nature Conservancy (TNC) and CONDESAN (see supplemental file for interview details). The interviews and participant observations were conducted by the first, second and fourth authors during repeated research stays in Lima and Huamantanga. The first author's interviews were used to drive interpretation (no transcription), others have validated this and integrated their own. These interviews did not follow a predetermined protocol but encouraged conversation based on similar themes including the role and interests of different actors, and information sharing and relationships between actors (Silverman, 2001) (see supplemental file for themes and sample questions). Furthermore, these actors, their interactions and ways of communicating were observed during relevant policy events. Insights about SEDAPAL's role and views were obtained from key planning documents and actors that worked closely with the utility. In addition to primary data collection, we analysed related scientific studies, policy documents, NGO reports and media articles published between 2004 and 2015 (see supplemental file for source documents and articles).

3.4. Analysis of frame dimensions and policy storylines

To identify water-related frame dimensions used by different actors, we repeatedly reviewed and analysed audio-taped interviews, field notes and secondary data. For each of the water-related frame dimensions, the particular problem and solution framings were analysed ('what is framed as problematic about this situation; and what is framed as a prerequisite to solving this problem?').

We then created a timeline of key moments between 2004 and 2015 and overlaid the corresponding frame dimensions. Key moments with the same combination of frame dimensions were grouped. These groupings were then used to construct context specific policy storylines. We gave each storyline a scale framing by determining at which level and along which spatial scale the narrative was being positioned. We then went back to the timeline and overlaid the storylines according to the frame dimension groupings. Finally, we analysed how these storylines intersected over time.

4. Results

The conventional watershed scale framing is defined by the boundaries of one hydro-geographical unit. In Lima's case, we identify the emergence, promotion and legitimisation of a city-centred 'urbanshed' scale-level as the dominant scale framing during the reform period. Our analysis contrasts this scale framing with others that support a more explicit recognition of highland watershed conservation and restoration of ancestral knowledge. We define an urbanshed as the total area of land that drains into a city; in the case of Lima referring to the Chillón, Rímac and Lurín watersheds (collectively referred to as 'ChiRiLu'). This particular politics of scale can result in other issues being excluded from political negotiations. For example, actors from the central highland Mantaro watershed (where a significant proportion of Lima's water originates) were, until 2015, largely absent from this reform process (Hommes & Boelens, 2017).

Our analysis focused on identifying prominent water-related frame dimensions and exploring how they come together in different combinations at specific moments during the reform process. Five identified frame dimensions, each with a corresponding problem and solution framing, are presented in Figure 2. Three differently scaled, higher-level policy storylines were constructed by grouping moments from the reform

period that shared the same combination of frame dimensions (Figure 3). They are introduced in the following section through a synthesis of the data assembled from interviews, documents and observations. These framings and storylines do not represent direct material from the field that can be exclusively linked to one singular actor or document, but rather were constructed as a necessary step for the subsequent timeline analysis (see Section 3.1 for a more detailed explanation).

FRAME DIMENSION	PROBLEM FRAMING	SOLUTION FRAMING
Water for urban water users	Urban water resources are under increasing stress from climate change, growing urban water demands and many other factors.	Need to increase urban water supply.
Water for highland freshwater ecosystem conservation	Highland freshwater ecosystems are under pressure from human impacts.	Highland freshwater ecosystems should be preserved.
Water for community agricultural production	In highland communities, the lack of sufficient pasture during the dry season has led farmers to extend grazing to higher pastures that are crucial for regulating and supplying irrigation water to the community.	Communities need to adopt water retention practices/infrastructure that better regulate and increase availability of irrigation water for the community.
Water for cultural value	Communities are losing links with heritage/ancestral knowledge, resulting in poorly maintained infrastructure and inappropriate land use.	Communities need to rediscover ancestral technologies/knowledge in order to improve livelihoods.
Water for hydrological knowledge generation	There is currently limited understanding of land use-hydrology interactions in the Andes.	Targeted hydrological monitoring in the region could greatly improve hydrological understanding.

Figure 2. Five water-related frame dimensions.

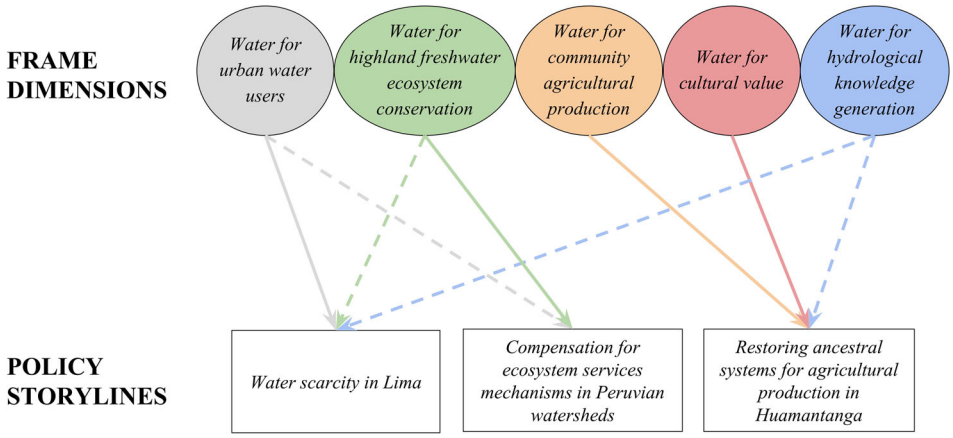

Figure 3. The relationship between the frame dimensions and the policy storylines (dashed lines indicate frame dimensions of secondary importance).

4.1. Prominent policy storylines throughout the reform period (2004–2015)

4.1.1. The 'water scarcity in Lima' policy storyline

Due to negligible rainfall, Lima relies on seasonal water flows from the ChiRiLu including water transferred from the Mantaro watershed. Climate change, a growing urban population and environmental degradation in these watersheds are making the city's water users increasingly vulnerable to water shortages, which could threaten to undermine recent economic prosperity. While Lima receives enough water annually, supplying the city is particularly challenging during the dry season when reservoirs and rivers run low. This water supply challenge should be addressed through investment in both large-scale engineering projects (e.g. desalination plants, dams and interbasin transfers) and, potentially more cost-effective, green infrastructure options (i.e. improved hydrological regulation through changes in land use and watershed conservation).

The '*Water scarcity in Lima*' policy storyline (hereafter referred to as the *Lima* storyline*)* relies heavily on the '*water for urban water users*' frame dimension (hereafter referred to as the *urban* frame dimension) (Figure 3). Water issues are presented from Lima's perspective, depicting urban water supply as vulnerable. Two potential solutions for increasing water flows to Lima in the dry season are proposed.

On the one hand, the 'green' solution framing relies on the '*water for highland freshwater ecosystem conservation*' frame dimension (hereafter referred to as the *conservation* frame dimension) (Figure 3), arguing that preservation of highland ecosystems in the ChiRiLu would improve hydrological regulation and dry season water availability for Lima. The ChiRiLu urbanshed scale-level is seen as appropriate for addressing Lima's water problems. On the other hand, proponents of further investment in large-scale engineering projects portray conventional hydraulic infrastructure as the only viable solution, supposing that headwaters are freely available. This 'grey' solution framing is scaled in line with Lima's existing water sources and supply infrastructure, predominantly at the Rímac-Mantaro watershed scale-level.

The problem framing within the *Lima* storyline is graphically presented within a report produced by CONDESAN and Forest Trends (Gammie & De Bièvre, 2015) (Supplemental Figure 1). This area graph uses hydrological data to highlight that Lima's water problems are not related to water availability as such, but rather the uneven distribution of water flows throughout the year. In the same report, the marginal costs of proposed green and grey infrastructure in Lima's watersheds are compared, illustrating that green infrastructure can deliver hydrological benefits at costs that are competitive with those of grey infrastructure (Supplemental Figure 2). This graph represents the green solution framing. The grey solution framing is represented in diagrams, circulated by SEDAPAL, of trans-Andean water supply infrastructure extending across the continental divide between the Rímac and Mantaro rivers (Supplemental Figure 3). So, whereas the problem framing illustrated by Gammie and De Bièvre (2015) would be representative for a wide range of actors, the solutions derived from it differ substantially.

4.1.2. The 'compensation for ecosystem services (CES) mechanisms in Peruvian watersheds' policy storyline

> *Agricultural practices and socio-demographic dynamics in Peru's highlands are taking an increasing toll on highland freshwater ecosystem functionality and consequently water availability in lowland (urban) regions. To reverse this trend, SUNASS and the MINAM in collaboration with international researchers and NGOs, are promoting CES mechanisms as a way 'to redistribute the benefits of a healthy watershed equitably' (CONDESAN, 2014, p. 4) between all water users. Lowland (urban) water users need to reward communities for preserving highland ecosystems and thereby improving downstream hydrological services. These types of agreements between land stewards and service beneficiaries (e.g. agribusinesses and municipalities) have the potential to establish long-term protection of Andean watersheds.*

The *conservation* frame dimension dominates the '*CES mechanisms in Peruvian watersheds*' storyline (hereafter referred to as the *CES* storyline) as lowland water problems are predominantly attributed to the negative impacts of human activity on highland freshwater ecosystems. This storyline is also implicitly reliant on the *urban* frame dimension, emphasising the need to consider highland-lowland relations for addressing lowland (urban) water challenges. It is simultaneously scaled at a national level on the governance scale, and at a watershed level on the hydrographical scale, stressing the need to identify and implement conservation-based projects across watersheds in Peru. Highland agricultural communities are promoted as key custodians of lowland ecosystem services that can, if sufficiently incentivised, provide hydrological services for whole watersheds (Bremer et al., 2016b). This storyline also plays out within the international discourses around free market environmentalism. MINAM produced an illustration within a promotional leaflet as a way to promote the potential benefits of CES mechanisms for watershed management (Supplemental Figure 4). Given MINAM's national-level perspective, the *urban* frame dimension of the storyline is not represented. The left and right side of the image represent the storyline's problem and solution framing, respectively. The implementation of a CES mechanism is depicted as a win-win arrangement, symbolised by two farmers shaking hands.

4.1.3. The 'restoring ancestral water systems for agricultural production in Huamantanga' policy storyline

> *Intensified grazing in Huamantanga's upper sub-catchments have reduced the ecosystem's ability to capture and regulate wet season flows to the extent that the community receives less water for irrigation in the dry season. This is further aggravated by locally perceived changing climatic conditions. With the help of a diverse group of NGOs, some community members are reconnecting with ancestral practices and restoring a network of pre-Incan diversion canals and natural infiltrations systems (locally known as 'mamanteos'). These narrow canals redirect wet seasons flows to ditches and mountain slopes that allow water to infiltrate and resurface in community springs during the dry season. Animal exclusion from the upper sub-catchments is promoted as a way to further improve water retention in the high pastures, and ultimately, to provide more irrigation water in the dry season. Hydrological monitoring to quantify the impact of such interventions is crucial for Huamantanga itself and for exemplifying the potential of green infrastructure in general.*

The '*water for cultural value*' (hereafter referred to as the *cultural* frame dimension) and '*water for community agricultural production*' frame dimensions are important in this policy storyline (Figure 3). Clear references are made to the Huamantanga community not only rediscovering cultural links with ancestral practices and infrastructure, but also improving local agricultural production and livelihoods. The '*water for hydrological knowledge generation*' frame dimension is also relevant for this storyline given that CONDESAN has recently started monitoring rainfall and streamflow in the upper sub-catchments of the community.

This storyline is scaled at community level since it is framed entirely within Huamantanga's territory. Any potential benefits to Lima's water supply are not at all, or only secondarily, mentioned. It is important to emphasise, however, that these framings did not originate from the community and in fact, at this stage, the community members themselves could have potentially developed very different framings of these activities and their potential impacts on the community. Graphical representations of the mamanteo infiltration process were circulated by CONDESAN and Forest Trends during the later stages of the reform period (Supplemental Figure 5; Supplemental Figure 6). These diagrams support the solution framing within this storyline from a technical point of view but leave out the cultural aspects associated with this system, emphasised by other involved NGOs.

4.2. Timeline outlining the phases of the reform period and development of three policy storylines

This section outlines some of the key moments in the reform period and explains how, during these moments, policy storylines (as outlined in the previous section) emerged and developed over time and which actors shaped their construction. We have divided the reform period into three distinct phases (Figure 4).

4.2.1. Phase 1: National-level institutional and legal reform of water governance and emergence of the 'Chirilu' scale frame (2004–2009)

In 2004, IWRM and urban water scarcity started to become more prominent within Peruvian water discourse (Budds & Hinojosa-Valencia, 2012; Stern & Echavarria, 2013a). In the late-2000s, the *Lima* storyline (relying exclusively at that stage on the *urban* frame dimension) began to emerge within city-level studies conducted by local NGO Grupo GEA (2007) and the United Nations (2009). This represents the early stage of a process that led to the establishment of Aquafondo, as outlined later in the timeline (TNC, 2017). Trade negotiations with the United States (2006–2009) led to the creation of MINAM and an autonomous and cross-sectoral national water authority in 2008 (Budds & Hinojosa-Valencia, 2012). As plans developed in 2009 for an IWRM-style watershed council and local water authority for the Chillón, Rímac and Lurín watersheds, the ChiRiLu scale frame started to emerge as an important structural principle of the *Lima* storyline (FFLA, 2014; Stern & Echavarria, 2013a).

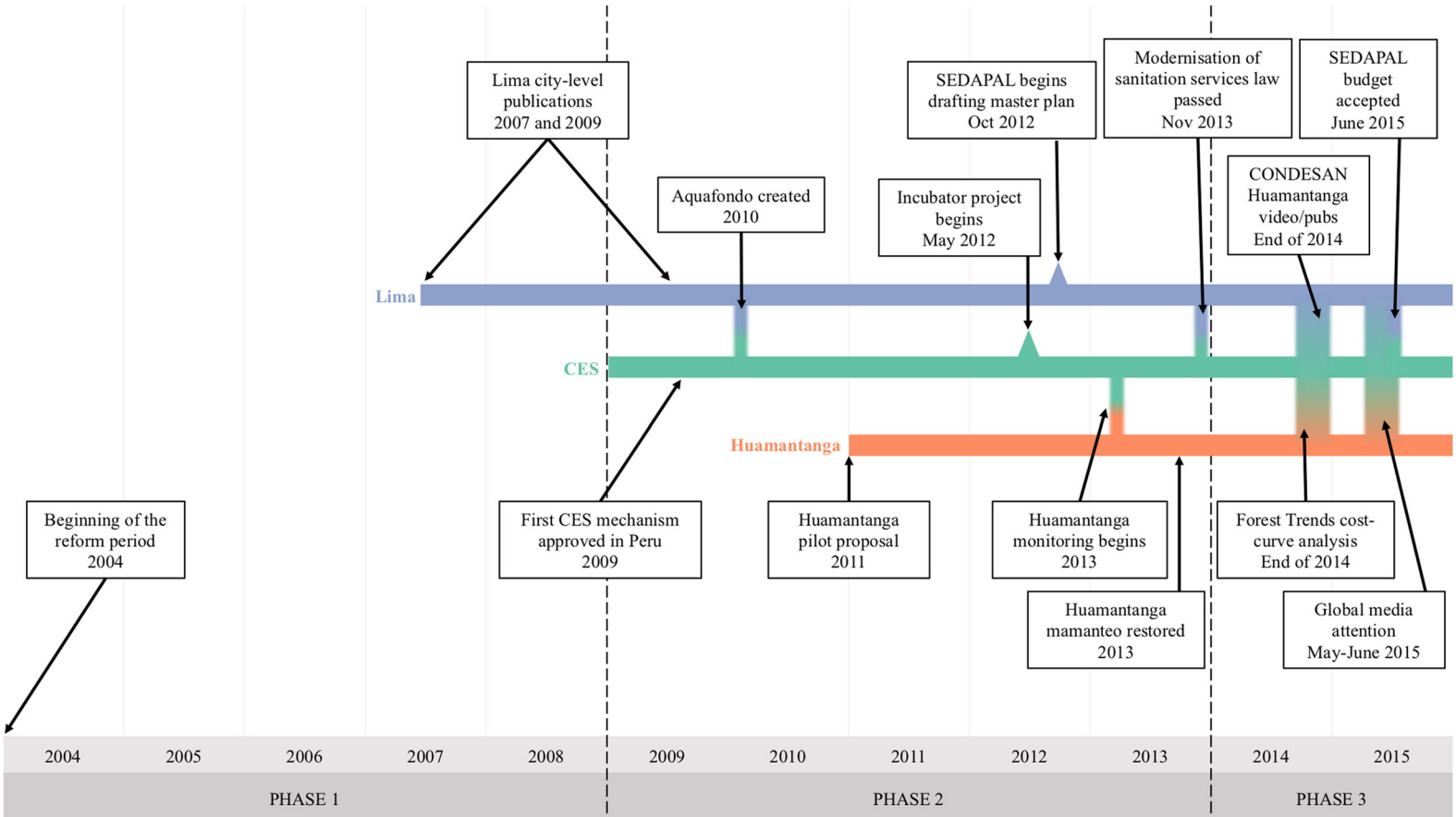

Figure 4. The three phases of the reform period and policy storylines from their emergence, prominence (Spikes) and intersection (Vertical bars) at important moments between 2004 and 2015 ('Water scarcity in Lima' (Blue), 'CES mechanisms in Peruvian watersheds' (Green), 'Restoring ancestral water systems for agricultural production in Huamantanga' (Orange)).

4.2.2. Phase 2: Multi-level parallel strands of activity (2009–2014)

By 2009 the *CES* storyline, started to emerge with the implementation of Peru's first PES-type scheme in Moyobamba (Stern & Echavarria, 2013b). This was scaled by CONDESAN and Forest Trends at watershed level and later upscaled to the national policy scale, emphasising the relationship between highland agricultural communities and lowland (predominantly urban) water users.

In 2010, Aquafondo was set up (with support from US conservation NGO TNC) as a mechanism to provide water security for Lima by channelling funds from private and public lowland water users to highland conservation activities in the ChiRiLu (Veiga et al., 2015). We interpret this as the moment when conservation framings within the urbanshed scaled *Lima* storyline and nationally scaled *CES* storyline began to intersect (Figure 4). After having set up the water fund, the founding institutional members of Aquafondo started considering several proposals for pilot projects throughout 2011. One of which, developed by Lima-based NGO Alternativa, aimed to restore a mamanteo canal in the upper Chillón community of Huamantanga. The '*Restoring ancestral water systems for agricultural production in Huamantanga*' policy storyline (hereafter referred to as the *Huamantanga* storyline) emerged when actors involved in this project introduced a local storyline around the restoration of ancestral knowledge and small-scale infrastructure towards improved local agricultural production. The narrative of the Alternativa staff member who initiated the project confirms this. He explains that:

> People in Huamantanga have forgotten the importance of rainwater harvesting (…), they forgot their own customs and are negating their past (…). When I went to Huamantanga and saw the archaeological water structures, I talked to the people about their existence. (…) The most important thing for me is that they understand the importance of these techniques. (Interview project initiator, September 2014).

This project and related storyline were scaled (at least formally) at the highland, community level. Around this time, the *CES* storyline gained in prominence with the new national-level incubator project for ecosystem services mechanisms, and its ability to influence government agencies and shape ongoing legal reforms.

In early 2013, the *CES* storyline intersected with the *Huamantanga* storyline when international actors with a range of interests (Aquafondo, TNC, CONDESAN and Forest Trends) started collaborating on a hydrological monitoring and social impact study in Huamantanga (Bremer et al., 2016a) (Figure 4). Specifically, solution framings began to be scaled up at the watershed or urbanshed scale-level; an important step towards engaging governmental actors in Lima. At this moment, it seems that these international actors had a mutual interest in demonstrating the effectiveness of these practices to national-level decision makers. At the end of 2013, the mamanteo restoration project in Huamantanga had been completed and a new domestic water supply law was passed mandating all water utilities to include CES mechanisms in their water tariffs. A product of an emerging alliance between the incubator project (supported by Forest Trends and MINAM) and SUNASS, this reform combined elements of both the *CES* and *Lima* storylines. In a parallel process, conventional engineering logic associated with formal agencies was still central to the prevailing solution framing within the *Lima* storyline as SUNASS and SEDAPAL began drafting up a new water tariff structure and Master Plan for 2015.

4.2.3. Phase 3: Change in momentum and mutual reinforcement of all three policy storylines (2014–2015)

By 2014, elements of all three, differently scaled, storylines were being circulated by a coalition of international actors interested in scaling up green activities beyond Huamantanga, under a new Ecosystem Services Law. Some SUNASS officials who allied with the incubator project hoped that SEDAPAL, as Peru's biggest and most influential water company, would now be persuaded into taking a pioneering role in promoting compensation mechanisms nationally:

> In (…) pilot places we saw the benefits and so some people from SUNASS – yet not all – are convinced of possible benefits and thought that it is important that also the biggest water company of the country [SEDAPAL] does it. Then we can say: "look, they have incorporated it", so as to make an example. If they do it, it will be ground-breaking. In the beginning, SEDAPAL didn't want it; but now the discussion is not anymore if, but how. (Interview SUNASS representative, September 2015)

Towards the end of 2014, CONDESAN published promotional material within which elements of all five frame dimensions and three storylines were referenced (see Acosta, 2014; CONDESAN, 2014). In early 2015, CONDESAN and Forest Trends published a cost-curve analysis that continued to adopt a combination of storylines and scale frames so that governmental actors could easily compare the alternative (green) solution framing with traditional large-scale supply projects (see Gammie & De Bièvre, 2015).

In March 2015, SUNASS adjusted SEDAPAL's proposed budget to include a $112 million levy from SEDAPAL's water consumer tariffs (5% of the total income) to be invested in climate change adaptation, disaster risk reduction and green infrastructure, including further restoration of ancestral canals in the upper ChiRiLu watersheds (Miranda Sara et al., 2016). SEDAPAL finally obtained approval from SUNASS in mid-2015 (SUNASS, 2015). This was the first time that the *Lima* and *CES* storylines were assembled in an official SEDAPAL document. Following this breakthrough, Forest Trends played a very active role in garnering international and US media attention by releasing press statements publicising SUNASS, CONDESAN and their organisation's achievement. While not viewed as a silver bullet, combined watershed and canal restoration is presented in these articles as a low risk strategy and win-win scenario for all parties, even though the exact distribution and size of the 'wins' is yet to be evaluated and discussed with stakeholders in both upstream rural communities and Lima.

4.3. The effect of storyline intersection on the reform process

During the study period (2004–2015), a series of framings about the scope of water governance emerged at community, watershed and national level but in a fairly isolated way, until they converged around the time SEDAPAL committed to highland watershed investment in the ChiRiLu. The media attention that followed allowed the *Huamantanga* storyline to re-emerge more prominently than the other two storylines, as a way to engage with international readers. Given how the origin of this storyline is rooted in the *cultural* frame dimension it is interesting to see that, at the crucial intersection moment in 2015, this aspect again played a key role: It proved to be more effective at capturing attention for highland communities than local agricultural framings. Besides, the intersection of particular storylines at different moments during the process often had a strengthening effect, creating a coalition of actors who were then able to generate sufficient momentum and support within government ministries and SUNASS for the inclusion of conservation-based water planning within SEDAPAL's budget. The intersection of all three storylines also resulted in further legitimacy given to the ChiRiLu scale frame within actor solution framings and interventions in the Chillón watershed.

Intersections were only made possible because SUNASS, Forest Trends, CONDESAN and MINAM left out key elements and tensions between the storylines and scale frames during interactions and within communications. During these intersections, a mutually reinforcing relationship emerged as information related to these storylines was supported and similarly scaled within visualisations shared among governance actors and international media. The scalar concessions were deemed acceptable since, at these moments, actors had a mutual interest in demonstrating the effectiveness of conservation practices to national-level decision makers. For example, while CONDESAN did not share the same end goals as Forest Trends, bridging different policy arenas and making links between different knowledge systems in this way, appeared to help their interests in the long-term.

5. Conclusions

We conclude that water issues were framed from different perspectives and at a range of scale-levels during this eleven-year period. Framings around urban (coastal) water supply, highland conservation, Andean water culture, local agricultural production and hydrological knowledge generation combined and manifested in different ways, and at different times, within persuasive narratives that were then circulated visually between actors to solidify the scale of the problem and potential policy response. These policy storylines provided powerful reinforcement that helped to change momentum at decisive moments in this period of water

governance reform. We assert that these processes have had a significant impact on the relationship between highland communities, urban (coastal) water supply actors and international organisations operating in these watersheds.

5.1. Implications for future research

Scale framing is a useful concept for making the politics of scale concrete and researchable. We not only highlight the importance of individual scale frames but also analyse their intersection. We argue that the constructivist frame perspective brings to the forefront some of the unarticulated assumptions and differently scaled storylines associated with evolving environmental policy and planning processes. Rather than providing a comprehensive theory to explain this process, we have focused on interesting patterns that may emerge in similar circumstances. Our interpretive approach innovatively combines concepts of scale framing and policy storylines with visualisation analysis. This helped us to understand the different varieties of frames associated with actors operating at different scales, and the processes in which these frames developed and intersected over time.

Our analysis builds on previous studies that highlight how differences in policy narratives and scale frames are often neglected or simply misunderstood during policy processes and, as a result, marginalised perspectives that raise important concerns are deemed less worthy of discussion by influential actors (Van Lieshout, Dewulf, Aarts, & Termeer, 2017). This type of research could therefore have implications for the actors that are actually involved in these processes by making them aware of how they are positioned in a complex puzzle of water governance. In a recent study by Zulkafli et al. (2017) some of the emancipatory implications of understanding scalar dimensions of Peruvian water governance, particularly for marginalised water users have been explored. In addition to case study research on scale frame intersection and implications thereof, future studies should continue to explore the role of visualisations as scaling devices within water governance. Another interesting horizon for future research could be the role of social media as emergent technologies of discourse circulation (increasingly used by governments and international NGOs) and hence new spaces for diverse actors to promote different scale frames (Karpouzoglou, Pereira, & Doshi, 2017; Stevens, Aarts, Termeer, & Dewulf, 2016).

5.2. Implications for water governance

In our case study, given that SEDAPAL is now legally required to implement watershed conservation and climate change adaptation projects in the ChiRiLu highlands, it will be crucial for actors involved to address any potential divergence in the scale framing of projects' aims and expectations. For example, will wet season flows be captured for community agricultural use, for Lima's municipal use or for both? Who will benefit, in what way, and on which scale? Even though knowledge concerning the exact provision of water resources may often be uncertain or absent, addressing issues of scales of benefits and objectives within conservation projects will be essential to avoid misleading highland, rural and coastal, urban actors.

Accepting there is no way to objectively define the scale or level of a problem, scholars and practitioners need to move away from preferable or optimal fit thinking (Padt & Arts, 2014). Scales frames co-exist with varying degrees of success and failure. What is particularly important within decision making is for actors to become reflective of which scale frames they are implying in their policies, projects or communications, and how they relate to other framings. Explicitly drawing attention to tensions between scale frames is directly relevant to policy since it can result in more pragmatic and context specific arrangements that do not privilege particular viewpoints at the expense of others. Ultimately, greater sensitivity towards scale framing in the water sector could lead to better dialogue amongst concerned stakeholders. However, one should not lose sight of the difficulties associated with uncovering the perspectives of socially excluded groups, particularly when powerful interests are involved in legitimising particular scale frames.

Note

1. This is an introductory article from a recent special issue of this journal on 'scale in environmental governance' (2017, volume 19, issue 5): https://www.tandfonline.com/toc/cjoe20/19/5?nav=tocList

Acknowledgements

The authors would like to acknowledge funding received from the UK Research Council NERC/ESRC/DFID ESPA programme (project NE- K010239-1, 'Adaptive governance of mountain ecosystem services for poverty alleviation enabled by environmental virtual observatories' Mountain-EVO). We would especially like to thank all those who participated in the interview process in Lima and Huamantanga. An earlier version of this paper was presented at the 11th Interpretative Policy Analysis Conference in July 2016. Finally, we are grateful for comments received by the anonymous reviewers that have helped improve the article.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work was supported by Economic and Social Research Council [Grant Number NE/K010239/1]; Natural Environment Research Council [Grant Number NE/K010239/1].

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