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ORIGINAL ARTICLE

In search of the good dam: contemporary views on dam planning in Latin America

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Abstract

Dam planning and construction is notoriously difficult. It is highly complex, involving a multitude of social, environmental, economic and technological questions that often become politicised in the process; negative impacts are often concentrated on small, vulnerable groups within society, while the benefits are typically spread in a much more diffuse pattern; it requires changing riverine ecosystems, often irreversibly so; and it takes a very long time, with often harsh consequences if mistakes are made. These challenges have generated decades of debate around dams and development, yet it is not clear how dam planning and management can be improved. To address this question, the present study used Q methodology to analyse the views of social and environmental researchers on dams in Latin America on the principles that should guide dam development. The Q analysis rendered three idealised viewpoints: The first suggested that defending the rights of vulnerable people should be the main priority, as a counterbalance to the natural bias towards economically and politically powerful actors within the political economy of dam construction. The second implied adoption of a holistic and scientific vision towards dam decision-making and a focus of efforts on perfecting formal procedures and participatory processes to build better dams in the future. The third called into question the need for dams altogether and concentrated attention on invisible and overlooked aspects of dam decision-making, particularly past injustices, and the rights of indigenous communities to determine their own model of development. Each viewpoint represents an alternative vision for future dam planning and clarifies the choices available to policy-makers and development actors. Moreover, viewpoints give insights into the motivations of those who seek to inform debates on dams and development. While they were identified in the context of dam-decision making, our findings may also be relevant to other fields of sustainable development.

Keywords Dam impacts · Latin America · Political ecology · Q methodology · River basin planning · Sustainable water resources development

Introduction

The planning, construction, operation and management of dams present complex challenges that epitomise large development projects more generally. Dams are large engineering structures that are costly and slow to build and require intensive planning across many different agencies and areas of expertise. Both during construction and subsequent operation, dams lie at the heart of extensive networks of infrastructure, for example supply networks of electricity or water. They shape the movements of energy, materials, goods and people (Larkin 2013). Dams transform the flows of rivers downstream and the ecosystems that depend on them and they shape the lives of those they displace or who benefit from their creation (Nüsser 2014). As development projects, dams often have significant symbolic importance, emblematic of modernist development (Abbink 2012; Beattie 2002).

Dams can provide various services, such as water storage for urban water supply and irrigation, hydroelectric power generation, flood regulation, reservoir fisheries and recreation. Concern about climate change has fuelled interest in hydropower dams, which may cause fewer greenhouse gas emissions than fossil fuel alternatives and can be operated

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so as to deliver electric energy at peak demand times, unlike solar and wind energies (Erlewein 2014; Kaygusuz 2009).

Yet, dams have a long history of controversy, arising from the considerable social and environmental impacts that may result from their construction and operation. Dams with large reservoirs present particular challenges of resettlement and safeguarding of cultural heritage in newly inundated areas (Hay et al. 2019). These are rarely handled to the satisfaction of all stakeholders and may leave resettled people permanently disadvantaged. They often affect indigenous or marginalised rural populations (Scudder 2005). Downstream impacts may also be significant, where dams change natural flood cycles, which may impact riparian and aquatic ecosystems, floodplain agriculture and river fisheries (Adams 2020; Lima et al. 2020; Resende et al. 2019).

Dams can also present a safety risk (Huber et al. 2017; Louzada and Ravena 2019), destroying downstream settlements and causing fatalities through sudden flooding, when they fail, with long-lasting implications for public health (Freitas et al. 2019), the environment and the local economy (Garcia et al. 2017; Wilson Fernandes et al. 2016). Planning and management of dams is made more complex where corruption, or at least overly optimistic economic appraisal enter the picture (Plummer Braeckman et al. 2020; Sovacool and Walter 2019), with recent studies calling into question the economic viability of many large dams over the course of their life cycle (Ansar et al. 2014).

These challenges have generated considerable ongoing debate about the benefits and costs of large dams, dam planning and management, as well as ways to address negative impacts (Schulz and Adams 2019). Such debates are often characterised by polarisation. The 1990s were a particularly conflictive period, in which the World Bank withdrew from several controversial large dam projects, following internal and external reviews (Adams 2020; Fox and Brown 1998). These controversies were the main stimulus for the creation of the World Commission on Dams (WCD, 1998–2000), a 12-member expert global environmental governance forum with a dedicated secretariat in Cape Town, South Africa. WCD was tasked with overcoming conflicts through a global review of evidence, wide-ranging stakeholder consultations and the formulation of recommendations and best practice guidelines for dam planning, construction and management (WCD 2000).

The WCD's report marked a hiatus in the funding of large dam projects in the developing world. It undoubtedly heightened global awareness of the social and environmental impacts of dams, and its recommendations were selectively taken up (Schulz and Adams 2019). Yet its attempt to provide a new approach to dam planning and a set of techniques that would predict and avoid negative impacts was not globally successful. Some have criticised WCD's report for overly focusing on the negative impacts of dams (Briscoe 2010), and controversies about dam construction have persisted (Schulz and Adams 2019). Although some have declared the era of large dams to be over (Magilligan et al. 2016; Scudder 2017) there has been a recent resurgence of large dam construction, particularly for electricity generation (Erlewein 2014). Zarfl et al. (2015: 165) identify 3,700 hydropower dams with a capacity of more than 1 MW each either under construction (17%) or planned (83%) in 2014. Most of these dams are small (75% are less than 100 MW), but 93% of predicted global hydropower capacity is provided by 847 large dams (of greater than 100 MW installed capacity).

The twenty-first century expansion of dam construction has focused attention on the methods and processes used to plan, design and operate them. These have evolved, especially where governments and dam engineering companies have adopted the Hydropower Sustainability Assessment Protocol (HSAP, https://www.hydrosustainability.org/) (Haas et al. 2015; International Hydropower Association 2018). However, dam projects are frequently the focus of campaigns by social movements and social justice organisations (Borgias 2018; Del Bene et al. 2018; Franco Moreira et al. 2019; Mora 2018; Silva 2016). Social and environmental researchers continue to document significant negative impacts of dams on upstream and downstream communities and ecosystems (e.g. Owusu et al. 2019), as well as shortcomings with dam planning, design and management (e.g. Hess and Fenrich 2017; Johnston 2004; Spears 2018). The political ecology of the uneven distribution of benefits and costs of dam construction reflects power relations between various actors and their different ability to influence dam decision-making (Cuadra Montoya 2015; Del Bene et al. 2018; Romero Toledo et al. 2009; Siciliano and Urban 2017; Zhouri and Oliveira 2007).

This paper addresses contemporary thinking among social and environmental researchers with knowledge of dam planning, design, construction and operation of projects and their impacts. We explore what such observers see as priorities for dam design, construction and operation in dam planning. We do this through a case study of the views of such researchers in one of the major dam building regions of the world, Latin America. As in Africa and Asia, Latin America is currently witnessing a resurgence in interest in dams as a source of renewable energy (Athayde et al. 2019; Calheiros et al. 2018; Howe 2015; Varas et al. 2013), despite a long and often violent history of dam-related conflict in the region (Cuadra Montoya 2015; Evans 2019; Hall and Branford 2012; Hernando-Arrese and Tironi 2019; Hess and Fenrich 2017; Johnston 2004; Kornfeld 2011; Orellana 2005; Zhouri and Oliveira 2007). Policy interest in dam construction shows no sign of declining, indeed in countries such as Brazil the reverse is the case (Latini and Pedlowski 2016; Schulz et al. 2019). Historically, most dams in Latin

America were planned and built by the state (see e.g. Evans 2019; Hall and Branford 2012; Varas et al. 2013), but the importance of private investment in dam construction has been growing across the region, sometimes facilitated by easing regulatory procedures or providing financial incentives (Couto and Olden 2018; Latini and Pedlowski 2016).

The views of expert observers of dam projects and the debates that swirl about them both reflect and help shape public debate and the views of future generations of dam specialists via teaching in higher education (Le Heron et al. 2006). They may also directly affect the ideas of activists, governmental planners and commercial actors (Franco Moreira et al. 2019; Reid and McCormick 2010). Using a Q methodological approach (Brown 1980; Watts and Stenner 2012), we aim to understand attitudes towards dam decision-making not framed within the simplified categories of pro- and anti-dam, which have often unhelpfully characterised the debate in the past. This method works best by focusing on the views of specific groups of people (Watts and Stenner 2012), in this case, social and environmental researchers studying dam planning and management in Latin America. Moreover, it is important to consider that critical attitudes towards dams may have diverse and even contradictory reasons, which may also influence opinions on appropriate pathways forward. While the present study discusses dam decision-making, it may also offer lessons for understanding divergent visions for sustainable development more generally (see, e.g. Park 2009; WCD 2000) and the motivations of those that seek to promote sustainable development.

Methods

To investigate the ideas of Latin American dam researchers about dam decision-making, we employed Q methodology, a quali-quantitative method that is suitable to explore subjective views on a given topic (Brown 1980; Watts and Stenner 2012). Q methodology is often used to analyse the range and composition of viewpoints and opinions about (controversial) environmental governance issues (Peritore and Galve Peritore 1990; Sandbrook et al. 2013). This is achieved by producing a set of statements about a particular topic that interviewees then rank according to their relative relevance to a research question. These relative rankings or 'Q sorts' are then intercorrelated and subjected to factor analytical techniques to extract a set of shared viewpoints within the pool of study participants (Watts and Stenner 2012).

For the present study, a set of 42 statements was derived from the recommendations about best practices for dam decision-making made by the World Commission on Dams (WCD 2000). To date, the report of the WCD (*Dams and Development*) remains the most comprehensive review of evidence and stakeholder consultation around large dams ever conducted, coupled with concrete recommendations on how to improve dam decision-making. The WCD's broad approach (with the exception of technical and engineering aspects, which were considered to be the domain of engineering associations such as the existing International Commission on Large Dams, ICOLD) means that its recommendations cover a very wide spectrum of aspects of decision-making about dams. Using the WCD's recommendations as the basis for the set of statements for the Q study, therefore, allowed us to test the importance attached by today's specialists to a wide range of principles important to dam planning, and the extent to which the ideas of the commission retained their relevance, as all study participants were asked to comment on missing relevant recommendations.

The WCD produced 26 guidelines for good practice and 33 associated policy principles, among other, broader recommendations (WCD 2000). We reviewed these and translated them into a 'statement format' that could be used with Q methodology. The WCD guidelines and principles focused on the processes and principles that should guide dam planning to ensure that outcomes maximised social benefit and minimised negative social impact (Schulz and Adams 2019). This applied focus makes them a suitable basis for the design of a Q set on methods for improving dam decision-making (as opposed to, e.g. attitudes towards dams in general), which will be of interest to practitioners and researchers on dams alike. We simplified recommendations so that every Q statement would contain no more than one idea. For example, the WCD's policy principle 1.1 ("Recognition of rights and assessment of risks are the basis for the identification and inclusion of stakeholders in decision-making on energy and water resources development", WCD 2000: 215) was divided into two statements, one about recognition of rights and a second about assessment of risks, since these capture two distinct ideas that respondents may have distinct views about.

Study participants were recruited and interviewed in person at a specialist conference on water management held in Chile in 2019. This was a pragmatic yet powerful strategy to reach a reasonably sized set of knowledgeable experts within a relatively short time-frame (Sandbrook et al. 2013). The conference, the Xth International Meeting of the WATERLAT-GOBACIT network,[1] was held at the University of Concepción, Chile, from the 7th to 11th October 2019. The WATERLAT-GOBACIT network describes itself as "an inter- and transdisciplinary network for teaching, research and practical action on the politics and management of water." (WATERLAT-GOBACIT 2019).

[1] https://waterlat.org

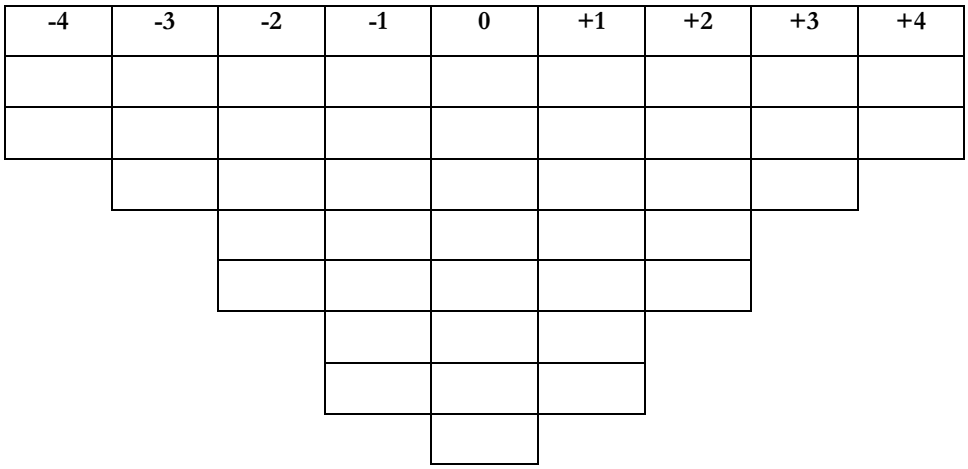

Fig. 1 Response grid for Q sorting exercise

The conference was attended by more than 250 researchers, practitioners and stakeholders from 15 countries, the vast majority from Latin America. Of these, 21 people with experience of research on dams agreed to participate in the present study, ranging from very senior experts with up to 50 years of professional experience to junior researchers in their mid-20s who attended to present their first major piece of research on dams. They included political ecologists, critical social scientists and interdisciplinary researchers from the Latin American region who specialise in water issues. Typical research interests were inequalities and injustices caused by dam projects, social and environmental impacts of dams, public participation in dam planning, or dam disaster risk management. About half of participants were Brazilian, reflecting Brazil's importance as a major dam builder in the region, as well as the fact that two special sessions on hydropower dams were organised by Brazilian researchers who thus outnumbered even dam researchers from Chile at the conference. The sample included 8 female and 13 male respondents.

Study participants were interviewed individually in Spanish or Portuguese and asked to rank all WCD-inspired statements about improving dam decision-making according to their personal priorities and opinions, based on their experience with the subject matter. In most cases, responses were informed by respondents' own previous research, conducted in several Latin American countries. A set of 42 laminated cards was prepared, each with one statement. The interview opened with an initial process of familiarisation with the set of statements, in which respondents expressed their agreement, disagreement or mixed views on each of the 42 cards (but cards were not edited or changed as a result of this process). Respondents were then asked to rank all 42 cards by sorting them into a preconfigured distribution grid (see Fig. 1).

The grid forced the choice of two top priorities for improving dam decision-making, placed in the + 4 column, three relatively less important priorities under the + 3 column and so on, with statements placed under -4 given the least priority. Crucially, these values only represent relative importance, meaning that respondents do not necessarily disagree with statements with negative values. Positive, negative and mixed views about statements were recorded for each respondent, with the majority agreeing with a relatively large number of statements. Following the completion of the ranking exercise, respondents were asked to reflect on their choices as well as explain their views on individual statements, this way gathering qualitative information beyond the quantitative information captured in the Q sorts.

Results

Each study participant produced one specific configuration of preferences (Q sort) of the statements which reflected their views of current priorities for improving dam decision-making. The resulting 21 individual Q sorts were intercorrelated and subjected to a factor analysis using the PQMethod software package (version 2.35, 2014).[2] Three factors were extracted via centroid factor analysis and subjected to varimax rotation. Together, these explained 44% of the study variance. 16 Q sorts correlated exclusively with one of the three factors at a significance level of $p < 0.01$, with three Q sorts loading highly on two factors and two not loading significantly on any of the factors (see Table 1 in "Appendix"). While a four-factor solution was also considered, given that four unrotated factors had eigenvalues above 1, only a three-factor solution ensured that a minimum of three Q sorts were associated with each factor, this way ensuring greater reliability of

[2] Freely available at http://www.schmolck.org/qmethod (last accessed November 2019).

the remaining three factors. Q sorts loading significantly and exclusively on a single factor were manually flagged in PQMethod, i.e. only their data were used to determine the composition of factors and factor arrays. A second criterion for flagging was that the square loading on that factor was higher than the sum of the square loadings for all other factors (Brown 1980; Zabala 2014).

Each of the three extracted factors represents one viewpoint on improving dam decision-making, defined by the way statements were prioritised in the Q sorting exercise. This information is captured in Table 2 in "Appendix". The 'rank' columns indicate the relative rank a statement would have been given in a Q sort typical for the respective factor, as defined by its z-score; these factor-defined Q sorts are known as 'factor arrays' in the Q methodology literature. PQMethod also allows identifying statistically significant differences in sorting patterns between factors, highlighted in bold, known as 'distinguishing statements'. Statements in italics were not statistically different between factors, thus also known as 'consensus statements'. Two factors (1 and 3) are relatively similar, with a correlation of 0.46; Factor 2 is clearly different, with a correlation of 0.19 with Factor 1, and 0.13 with Factor 3. The three viewpoints will be presented in a narrative style below, as is established practice in Q methodological studies (Watts and Stenner 2012).

Factor 1: protecting the vulnerable in dam planning, construction and management

The Q sorts of 11 respondents were significantly associated with this factor, eight of them exclusively so; it explains 21% of the study variance. Top priorities within this factor were the central importance of social dimensions in dam planning as well as the need to ensure recognition for the rights of those affected by dam projects (1, 12). The majority of statements in the top three categories were about the importance of ensuring participation of vulnerable stakeholder groups, including women and indigenous peoples (3, 4, 5, 6, 8). Factor 1 is the only factor that gives high importance to additional support for women (3). One researcher who placed this recommendation in the highest category argued that women are much more aware of the non-monetary impacts of dam construction than men, e.g. on the sense of community that is lost through resettlement or the ecological changes that may impact fishing and small-scale agriculture, making them their primary source of information when visiting communities for research on dam impacts. Another researcher highlighted the need to provide childcare or transport to public hearings to give women the opportunity to participate in dam decision-making processes. A third researcher suggested that patriarchal governance was a major problem in many indigenous communities, similar to the rest of society. Another statement ranked higher in Factor 1 was about maintaining fisheries (30), which one respondent justified with a concern for the subsistence livelihoods of vulnerable rural populations, as well as the social, cultural and economic importance of fishing.

The two statements ranked lowest in Factor 1 were related to the importance of economic and financial factors in dam decision-making (15, 37). Their low ranks were often accompanied by a comment that the main criterion used in dam decision-making in Latin America *were* the financial considerations of dam developers, and other factors deserved more attention. Hydropower dams in particular were generally described as profitable and safe investments for private investors ("the best business in the world, with 25 years of guaranteed income!"). Respondents suggested that this primary focus on financial returns had caused many of the social and environmental problems with dams in the first place, reflecting the growing importance of private investment in hydroelectricity in the region (Couto and Olden 2018; Latini and Pedlowski 2016). Many respondents gave lower importance to the need for planning to consider technical factors (14); one respondent suggested that "technology needs to be at the service of people" and that a primary focus on technology would obscure the political nature of dam projects by taking away attention from people. Another respondent suggested that a focus on technological solutions may often miss the broader root cause of problems, as illustrated by the (real) example of a fish passage built on a dam that was operated without consideration for environmental flows, leaving the river without water and killing all fish in the process.

Many respondents seemed disillusioned with current regulations and formal procedures for dam planning and design and lacked trust in the capacity of independent institutions to improve dam decision-making (34, 36, 42). One respondent gave very low priority to the principle of making dam-affected people the first beneficiaries (33), arguing that problems of corruption (in this instance in Brazil) would stifle any attempts at realising this idea. Explaining their scepticism about enforcing existing legislation to fight corruption (36) and even suggesting that this may encourage further corruption, a respondent used the expression "hecha la ley, hecha la trampa", which roughly translates to "every law has its loophole". Another Brazilian respondent suggested that environmental licensing processes had been significantly weakened under the new Bolsonaro government and that enforcement would thus offer little improvement over the current situation. The same respondent placed comparatively less importance on the involvement of independent institutions (34, 42), suggesting that while in principle this was desirable, they would be incapable of countering the political and economic clout of entrepreneurs and government. Similarly, a senior researcher cited power asymmetries as a principal concern that would invalidate any formal routes

towards 'fixing' dam decision-making. While it was generally considered important to address existing social issues with dams, one researcher suggested that this should not delay the construction of better new dams, recognising that in principle, dams may provide benefits to society, if only more attention was given to vulnerable people in the process.

Factor 2: scientific decision-making for good dams

The Q sorts of five respondents were significantly associated with Factor 2, three of them exclusively so; it explains 13% of the study variance. The two top priorities within this factor were the need to make negatively affected people the first beneficiaries of dams (33) and to conduct comprehensive ecological studies early on in the dam planning process (25) so that negative environmental impacts could be understood and mitigated as well as possible. Justifying the choice of statement 25 as the first priority, one respondent suggested that "the environment took thousands of years to develop, society did not". The same respondent further suggested that it was easier to address social impacts than environmental impacts, stating that in principle, "money can buy everything". Nevertheless, by also ranking statement 33 as a top priority, Factor 2 expressed strong care for dam-affected people as well, seeing them as the only stakeholder group that could legitimately expect differential treatment, as further corroborated by the relatively high importance attributed to considering the risks to different stakeholder groups (2). These rankings may have also captured a preference for dealing with traditional, 'scientifically measurable' impacts first (such as numbers of houses flooded, etc.), as opposed to more complex social issues of indigenous rights or gender inequality.

Overall, respondents associated with Factor 2 may have had more faith in the possibility of getting the process right than those who scored highly on the other factors. For example, enforcing existing legislation was given the second-highest importance (36). One respondent justified this choice with the case of the Brumadinho mine tailings dam failure in Brazil in 2019 (Freitas et al. 2019), where consistent application of existing regulations could have prevented a disaster. This dam collapsed in January 2019, killing more than 300 people, leaving more than 100 homeless and contaminating the Paroepeba River over an estimated distance of 250 km (Freitas et al. 2019). Many of the statements ranked higher in Factor 2 relate to environmental concerns (11, 13, 27, 28). By subscribing to the WCD's proposal to involve stakeholders at all key decision-making points (7), a holistic vision becomes apparent, in which environmental and social factors are both of strong importance, without singling out any one stakeholder group.

One respondent described this holistic vision on dam decision-making as "a careful balancing act", in which neither entrepreneurs, women, nor indigenous peoples should have special rights and in which giving women additional support (3) would violate the principle of gender equality. Similarly, indigenous peoples were considered as important stakeholders, but only if on an equal footing with non-indigenous people, reflected in the low ranking of the importance of the principle of right of free, prior and informed consent for indigenous peoples (8) in Factor 2. One respondent suggested that giving additional rights to indigenous peoples would expose them to additional risks of manipulation by outside actors such as foreign NGOs due to their lack of information and specialist expertise on dams.

Interestingly, one respondent suggested that including people in participatory processes based on whether their rights had been affected, one of the core tenets of WCD demonstrated the lack of a holistic vision. In their opinion, such a focus on rights would prevent participation from potentially useful outsiders, such as the social and environmental researchers of the kind interviewed for this study, since they would not normally be affected by dam construction. While a holistic approach to planning was popular with most, if not all study participants, only Factor 2 translated this into a rejection of statements that were taken to unduly benefit individual stakeholder groups. The second statement placed in the lowest category was about the need to resolve outstanding issues with existing dams before new dams are developed (32), which was perceived as unfair on well-intentioned dam constructors of the present, who should not be held back by the failures of their predecessors. Rather the merit of each dam project was to be considered on a case by case basis. This suggests that relatively speaking, Factor 2 reflects the most optimistic outlook on the possibility for good dams and that the focus on environmental impacts, dam-affected people and a holistic vision for planning and management should be understood as a 'scientific' recipe or pathway towards such 'good dams'.

Factor 3: an idealised past and a dam-free future as an alternative vision for development

The Q sorts of six respondents were significantly associated with this factor, five of them exclusively so; it explains 10% of the study variance. The two top priorities within this factor were the provision of sufficient information to all stakeholder groups (5), a consensus statement (see next section), and resolving outstanding social issues within dam-affected communities before building new dams (32). Further statements given relatively higher importance than in the other factors are also retrospective in nature, e.g. focusing on improving existing infrastructure (16), monitoring the impacts of existing dams (21) and improving operating rules of existing dams (23, 24). One respondent justified the focus on monitoring existing dams by citing cases where dam

builders had strategically applied for (more easily obtainable) licenses for small hydropower dams, and then silently expanded their capacity over the longer term, continuously increasing environmental and social impacts as well.

Factor 3 also ranks the possibility of decommissioning dams (22) higher than factors 2 and 1, as well as the idea of having a national policy to maintain some rivers free-flowing (26). Both these statements contrast an idealised undammed past with a possibly dammed future, with one Paraguayan respondent commenting that "the demolition of Itaipu would be an icon for an alternative model of development". The same respondent only agreed to participate in the study under the condition that their general objection to the construction of new dams would be registered, since these represented a failed model of "development by accumulation", with humanity having taken a wrong turn 15,000 years ago with the invention of agriculture (said tongue-in-cheek). Similarly, the relatively higher importance given to the rights of indigenous peoples (8) as opposed to women (3) and vulnerable stakeholder groups in general (6), could be construed as idealising a past in which these peoples lived undisturbed by dams, with one respondent calling them "allies for sustainability".

Factor 3 is the only factor to strongly prioritise the impacts of dams on public health (19), which are placed in the second-highest category. One respondent explained that they felt that dam impacts on public health lacked visibility in public debate and should, therefore, receive additional attention. In this sense, the overall theme behind Factor 3 is a fight for recognition for the 'forgotten' issues of dam construction, encompassing both invisible problems and wrongs of the past. This also combines well with the high priority given to the provision of sufficient information to stakeholders (5), which may go some way towards achieving this recognition.

Interestingly, there is a relatively high correlation between Factor 3 and Factor 1, as both give relatively high importance to information (5), the rights of indigenous peoples (8) and recognising the rights of the dam-affected (1). As in Factor 1, Q sorts of Factor 3 demonstrated high scepticism about financial incentives for dam developers (37) and considering economic and financial factors (15), which were placed in the lowest and second-lowest categories respectively.

Unique to Factor 3, however, is the very low priority given to the completion of risk assessments to ensure the inclusion of all stakeholders in dam decision-making (2). This was placed in the lowest category, in stark contrast to the high ranking given to the issue of the rights of affected people. In fact, all but one respondent whose Q sorts were used to assemble Factor 3 registered their disagreement with this recommendation even before beginning the Q sorting exercise. One respondent suggested that a focus on risks would be "undemocratic", and that dam decision-making should rather focus on ways to ensure effective societal oversight. Another respondent simply commented that it would be "insufficient" to focus on risks for identifying appropriate stakeholders, despite their particular research focus on dam hazards. However, considering overall response patterns within this viewpoint, one may also hypothesise that a retrospective focus on affected rights chimed much better with this group of respondents than the forward-looking focus on risks: it is easier to establish that rights have been affected when a dam has already been built, and the language of risks seems more appropriate for the evaluation of as yet un-built dams, although admittedly neither focus applies exclusively to the past or the future.

Further evidence for this interpretation might be that a relatively large number of statements with a focus on dam planning (as opposed to management and operation) were ranked lower in Factor 3 than in Factors 1 and 2 (6, 10, 11, 12, 13, 18, 30, 31, 35). For example, statement 10 ("Development needs should be identified and all options considered, before a dam is planned and built") is ranked much lower in Factor 3, perhaps because it does not preclude the construction of a dam, if identified as the best option. One respondent justified disagreement with this statement based on their experience working with indigenous dam-affected communities in Chile. They suggested that such wording is implicitly biased towards the worldview of non-indigenous outsiders seeking to 'bring development' to indigenous peoples, whereas indigenous communities may have a completely different understanding of the meaning of the concept of development and should keep their right to autonomous decision-making. An almost fatalist attitude became apparent in a comment made by one respondent who scored highly on Factor 3, after completion of the Q sorting exercise. They suggested that all statements failed to take into account that strategic dam planning de facto takes places among a tiny group of specialists, who may take joint decisions for 200 dams at a time, completely removed from the participatory and research-based spirit of planning that is common to WCD's recommendations. Overall, it seems fair to suggest that the viewpoint captured by Factor 3 appears as the most sceptical about the future of dams, informed by failures of the past.

Consensus statements

Several consensus statements were mentioned in the preceding sections; consensus statements are those that attained a relatively similar ranking across all factors. An example is the necessity of conducting cultural heritage impact assessments (9), which was given strong, but not foremost importance in all three factors. Several respondents commented that "it hurts" not giving it the top priority, reflecting the forced choice nature of the Q methodological set-up. Several

respondents further explained that cultural heritage should include the tangible and intangible heritage of the continent's indigenous peoples, with one suggesting that its insufficient consideration may be a contributing factor to elevated suicide rates e.g. among Canadian indigenous peoples (see also Leenaars 2006; Pollock et al. 2018).

The assessment of net greenhouse gas emissions of dam projects (11) was generally considered a positive, but not a priority. Similarly, most respondents did not consider life cycle assessments of dams to be a priority (17), but did not strongly disagree with the proposition either. Many had moderate doubts about the feasibility of such life cycle assessments though, with one respondent commenting that it would be like "demanding a life cycle assessment for a pyramid" or that it would be "muita bola de cristal" (i.e. "it would require clairvoyance"). "There are dams that will exist until the end of the universe" commented another researcher.

Several statements were ranked low by many respondents. Transboundary issues between countries (39) were generally not considered a top priority, perhaps because dams with transboundary impacts are less common in Latin America than in other world regions (see e.g. Li et al. 2011), with the prominent exception of the Itaipu Dam that is shared between Brazil and Paraguay upstream of Argentinean territory (Blanc 2018).

Most respondents also gave low priority to resolving dam conflicts via the judicial system (40), either because of a lack of trust or because they felt that this would be a strategy of last resort that should not be prioritised over more constructive and positive approaches that could prevent conflicts.

Few respondents gave priority to the idea of financial incentives for compliance with norms and regulations (37), despite this logic being the main driver behind measures such as Payments for Ecosystem Services. Only one respondent commented that it was "good to reward those who do the right thing".

Ensuring stakeholder access to information (5) was given very high priority by all respondents, possibly reflecting the fact that all interviewees were researchers, whose work is all about generating information. One respondent whose Q sort was strongly associated with Factors 1 and 2 suggested that bad communication and misinformation was the most common obstacle to effective stakeholder participation and that this statement (5) could serve as an all-encompassing "umbrella concept" that would support all other positive recommendations. Yet, understandings of the role of information may have differed, as information may be interpreted as a vehicle for uncovering past wrongs, overlooked negative impacts and alternative visions for development (Factor 3); for ensuring that the best possible procedure for dam construction is followed (Factor 2); or for the empowerment of vulnerable stakeholder groups against the uncaring forces inherent to the political economy of dam construction (Factor 1). One respondent illustrated this last viewpoint well by giving the example of royalties paid to municipalities affected by the construction of the Itaipu Dam: "as pessoas nem sabem o que são os 'royalties'" ("people don't even know what 'royalties' are"), using an English term for this particular benefit-sharing mechanism, and as a result, dam-affected people do not participate in decision-making about their potentially beneficial use.

Discussion

Q methodology is an abductive research method (Watts and Stenner 2012). Abduction is closely associated with the philosophy of pragmatism (Frankfurt 1958) and is sometimes understood as switching back and forth between inductive and deductive logics to develop novel insights and hypotheses (Kapitan 1992). This abductive form of reasoning takes place particularly during the generation and interpretation of idealised viewpoints as expressed through factor scores (Watts and Stenner 2012). This flexibility allows simultaneous thinking about quantitative factors and qualitative comments in relation to existing theories, e.g. from political ecology or psychology, as well as conceptualising them as novel hypotheses that are generated bottom-up by Q participants and the interpreting researchers. Thus, here we summarise and discuss potential factors that may explain differences in viewpoints.

Particular case vs. universal rule

Factor 2 demonstrates a certain belief in universalism, suggesting that if only the rules of dam decision-making could be perfected, dams will have good effects. It suggests that all stakeholders should be treated equally (except those affected negatively by a dam who should receive preferential treatment). If that is not currently the case, it should be striven for. As noted above, this way of thinking may explain why a respondent might reject the idea of selective free, prior and informed consent for indigenous peoples. In contrast to this belief in the possibility of universally appropriate procedures, implicit in the very idea of a 'World Commission on Dams' (WCD 2000) as well, the viewpoint captured in Factor 3 was associated with a need for locally autonomous governance, independent of externally imposed ideas of development. Our Q study, therefore, reflects debates

on the appropriate scale for decision-making about dams or other development schemes (Sneddon and Fox 2008): whether local actors should have final authority, or whether adherence to national and international norms and regulations should be a sufficient criterion for the approval of dam projects. Choices of scale are often the subject of political contestation due to their wide-ranging implications (Cox 1998; Jensen 2017), especially where indigenous peoples are concerned (Hernando-Arrese and Tironi 2019).

The discussion about differential rights and support for various stakeholder groups within society also implicitly relates to ideological debates about identity politics and the need (or not) to distinguish between different social groups in political decision-making. Some researchers might be more open to the idea of giving additional support to certain disadvantaged people affected by dams (e.g. women and indigenous peoples), although the debate on identity politics and political ideologies is far from resolved (see, e.g. Fukuyama 2018; Walters 2018), and discussing this in depth would exceed the scope of the present paper.

Optimism vs. pessimism

On a more existential level, different viewpoints on dam planning, such as the three factors identified in this study, may reflect different levels of optimism or pessimism regarding the possibility of good dams vs. the likelihood of bad dams. This clearly distinguishes Factors 2 and 3, but may also explain differences between Factors 1 and 3, despite the overall critical stance on dam decision-making that they show. The anti-dam vs. pro-dam dimension of the debate, that was used, e.g. to guide the selection of commissioners for the World Commission on Dams (Schulz and Adams 2019), reflects this same tension. Pessimism, informed by the experience of having witnessed repeated failures of the past, may lead to an anti-dam stance (Factor 3), while a more optimistic viewpoint may allow for the possibility that dams may, under the right conditions, provide net societal benefits (Factor 1). Optimism and pessimism are sometimes classed as character traits (Colligan et al. 1994), but it lies beyond the scope of this study to explore whether differences between viewpoints reflect personality or different previous professional experiences.

Looking forwards vs. looking backwards

Differences between viewpoints also reflect different positions on time. Thus, Factor 3 is clearly backward-looking, whereas Factors 1 and 2 emphasise proactive engagement to improve future dam decision-making procedures. While all respond to the question: "what needs to be done?" the difference in vision and outlook is obvious, as proposed responses tackle different stages of the dam life cycle. Particularly the difference between fixing the dam planning process and fixing badly built dams is striking. Attending to distinct temporalities may often be an entry point into exploring difference (Laurie and Baillie Smith 2018).

However, it is also possible that the emphasis on different parts of the planning cycle simply acts as a disguise for preferences for or against the construction of new dams. This interpretation is suggested by the way in which dam industry representatives have in the past described the WCD's specific guidelines on addressing existing dams as "highly unrealistic" compared to industry-formulated guidelines (Gagnon et al. 2002: 1302). They, too, may have preferred a forward-looking approach with a focus on building new dams, rather than a backward-looking approach on existing dams that would lead to a focus on old problems and slow down dam construction.

People vs. the environment

The question of the balance to be struck between the consideration of development project impacts on people and on the non-human environment is central to thinking about dam construction. Respondents whose Q sorts were used to assemble Factor 1 tended to rate people first (which they often mentioned themselves to explain their overall response patterns) and sometimes considered ecological issues such as impacts on fish and fishing only in terms of their social and cultural importance. In contrast, a respondent whose Q sort was strongly associated with Factor 3 suggested that despite its social and cultural importance, the impacts of fishing should be evaluated critically on a case by case basis, and where it harms the natural environment, it should be discouraged. Factor 2 gave relatively higher importance to environmental factors, although not at the expense of humans altogether. In this sense, our findings may relate to debates about ecocentrism vs. anthropocentrism in environmental management (e.g. Kortenkamp and Moore 2001).

Yet, previous research on human values has shown that concern for the environment often goes along with concern for social issues and people (Kortenkamp and Moore 2001; Schulz et al. 2018), and frequent comments by respondents in the Q study on the need to jointly consider social and ecological factors are consistent with such research. A greater source of difference in opinions may often be a preference

for economic policy strategies vs. a combined preference for environmental and social strategies (Schulz et al. 2018).

Using vs. critiquing economic logics

While only one respondent rated financial incentives for dam developers favourably, questions of political economy nevertheless had a significant impact on response patterns. Some respondents thought that the good design of participatory processes could eventually overcome the pressures of a political economy heavily stacked in favour of dam developers (Factor 2), whereas others were less convinced and instead sought to maximise support to the victims of a strongly unequal power distribution either to benefit from dams that would inevitably be built (Factor 1) or to fight back and resist against a failed model of development (Factor 3).

Many political ecologists and critical social scientists reject capitalism or the application of capitalist logics to environmental governance (e.g. Corson et al. 2013; Huber et al. 2017). It was, therefore, not surprising to encounter strong scepticism towards any statements related to economics or finance among the pool of interviewees, many of whom had a strong profile in the critical social sciences and political ecology. Yet the consistency with which economic arguments were rejected is noteworthy in so far given that dam construction is often problematic from an economic standpoint, too (Plummer Braeckman et al. 2020), and indeed, experiences, e.g. with the Arun III Dam in Nepal have shown that an anti-dam campaign can be successful if pointing out a dam's economic inefficiency (Dixit and Gyawali 2010). While an investment in dams may be the result of a relatively rational cost–benefit analysis of the developer, the same analysis conducted from the perspective of society as a whole may not be so favourable, opening up the opportunity to combine economic arguments with a critical stance on dams.

Social scientific vs. scientific perspectives

As expressed in the name given to Factor 2, some respondents may have preferred an approach to dam decision-making that might give stronger preference to (natural) scientific methods, measuring direct and tangible impacts on people and the environment and mitigating them 'rationally'. In this sense, differences in viewpoints may be related to different disciplinary backgrounds, and the 'two cultures problem' between the natural and social sciences more broadly, which may translate into different methodological preferences, among others (Adams 2007; Snow 1969).

Some have argued that familiarity with dams may impact one's attitudes towards them (Sousa et al 2019). While this argument implies that one should treat the views of the average citizen differently from those of a dam specialist, it can be extended to account for differences in viewpoints among dam specialists. It would be conceivable that familiarity with different aspects of dams (e.g. environmental impacts or impacts on vulnerable people) may also lead to different attitudes, if anything, due to simple psychological biases. One such bias has been called the "availability heuristic", i.e. people are prone to making judgements based on information that can easily be retrieved from personal memory (Kahneman 2011). In the present case, that would simply mean that respondents who frequently conduct environmental impacts assessments would rank their importance more highly than those who frequently work with indigenous peoples. Yet, overall, it is not possible to come to a definite conclusion about this proposition, not least because respondents' research was often highly interdisciplinary.

Indeed many respondents commented on the disjointed nature of ranking individual statements, when what was needed was an integrative vision that would combine social, environmental, economic and technological considerations. In response, many advocated social–ecological systems thinking (see, e.g. Roquetti et al. 2017), with humans taking the status of "part of the environment". To illustrate, one respondent suggested we should not say "el agua es nuestra" ("the water is ours"), but "somos del agua" ("we are of the water").

Conclusions

In this study, we have sought to explore the views of social and environmental researchers on dam planning, construction and management in Latin America. While there is a shared understanding that improvements are necessary, priorities for improvements differ. Using Q methodological techniques and a set of policy recommendations inspired by those originally made by the World Commission on Dams (WCD 2000), we identified three different viewpoints on priorities for improving dam decision-making among dam researchers in the region. The first viewpoint suggests that vulnerable people's rights and needs should be of central concern in improving dam planning, considering their limited access to decision-making structures as opposed to more politically and economically powerful actors. The

second viewpoint suggests that dam planning should be approached with scientific methods and a holistic vision, studying ecological impacts on rivers early on and optimising the design of benefit-sharing mechanisms for those negatively affected, to ensure that good dams will be built. The third viewpoint suggests that invisible problems and failures of the past should receive more attention in dam management before turning to new construction projects, which conveys a sceptical attitude towards dams as a development option.

Our presentation of three different factors represents one conceptual lens to understand different viewpoints within dam planning and construction from a social and environmental perspective, but evidently, they simplify the debate, and other configurations are conceivable. Our analysis suggests that researchers may differ with regards to: (1) their preferences for designing universally applicable rules vs. attending to the local particularities of individual dams and different social groups; (2) their optimism vs. pessimism about the possibility of improving decision-making procedures; (3) their outlook on time, i.e. whether tackling failures of the past should take precedence over improving procedures for designing future dams or not; (4) how impacts on people vs. impacts on the non-human environment should be handled; (5) whether they prefer to use or to critique/reject economic logics in dam planning and assessment; and (6) whether they apply social scientific or scientific methods in assessing dam projects.

Thus, 20 years after the World Commission on Dams made recommendations for the improvement of dam decision-making, there is no consensus on how to move forward, even if overall, these recommendations still resonate with today's social and environmental dam research community. Beyond dam planning, the identified viewpoints may also represent more general visions for sustainable development, capturing alternative choices that can be made in the field. In this sense, our study shines a light on the motivations of those who seek to inform sustainable development debates and outlines potential pathways forward.

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Appendix

See Tables 1 and 2.

Table 1 Rotated factor matrix; Q sorts in bold indicate a defining sort; values above 0.38 indicate significance level of $p < 0.01$

Q sort	Loadings		
	Factor 1	Factor 2	Factor 3
1	0.5227	0.2020	0.4633
2	0.2931	0.0133	**0.5725**
3	**0.5664**	0.0327	0.2833
4	0.2780	0.3055	**0.4444**
5	**0.8185**	0.2088	0.1106
6	**0.7019**	− 0.0552	0.1081
7	0.2050	0.3677	0.2447
8	0.6069	0.5838	0.1111
9	**0.6720**	0.2681	0.1562
10	0.2217	0.1548	**0.5895**
11	**0.6051**	0.2726	0.2252
12	0.2918	− 0.0451	0.3408
13	0.1447	**0.8131**	0.0383
14	− 0.1044	**0.7612**	− 0.0951
15	**0.5701**	− 0.0366	0.2046
16	0.5212	0.4295	0.0627
17	0.2665	− 0.0897	**0.4448**
18	− 0.0919	− 0.0491	**0.4877**
19	**0.4356**	− 0.3129	0.2718
20	**0.5433**	− 0.0835	0.1692
21	− 0.0467	**0.6376**	− 0.0118
% explained variance	**21**	**13**	**10**

Table 2 Factor arrays with z-scores for the three factors

Statement	Factor 1		Factor 2		Factor 3	
	Rank	Z-score	Rank	Z-score	Rank	Z-score
1 A recognition of rights affected should be the basis for the inclusion of stakeholders in dam decision-making	4	1.66	**– 1**	**– 0.45****	3	1.17
2 An assessment of risks should determine the inclusion of stakeholders in dam decision-making	**0**	**– 0.03****	**2**	**1.10****	**-4**	**– 1.97****
3 Women should be given additional support to participate in dam decision-making	**2**	**1.23****	– 3	– 1.91	-3	– 1.29
4 Indigenous groups should receive additional support to participate in dam decision-making	2	1.01	**0**	**– 0.08***	1	0.74
5 All stakeholder groups should receive sufficient information to be able to participate in dam decision-making	*3*	*1.59*	*2*	*1.16*	*4*	*1.94*
6 Vulnerable stakeholder groups should be given legal support to participate in dam decision-making	**3**	**1.47***	1	0.70	1	0.60
7 Dam planning should integrate all relevant stakeholder groups via negotiated agreements at key decision points	0	0.23	**3**	**1.34****	0	0.17
8 Dams should only be built with the free, prior and informed consent of affected indigenous peoples	3	1.37	**– 4**	**– 1.93****	3	1.20
9 A cultural heritage impact assessment should always be part of dam planning	*2*	*0.74*	*0*	*– 0.04*	*1*	*0.54*
10 Development needs should be identified and all options considered, before a dam is planned and built	2	0.86	2	0.96	**– 2**	**– 1.11****
11 Future net greenhouse gas emissions of a project should be assessed before a dam is built†	*– 1*	*– 0.59*	*– 1*	*– 0.44*	*– 2*	*– 0.45*
12 Social aspects should be given primary significance in assessing dams and alternative options	**4**	**1.67****	0	0.13	– 1	– 0.18
13 Environmental aspects should be given primary significance in assessing dams and alternative options	– 1	-0.38	**1**	**0.39***	– 2	– 0.63
14 Technical aspects should be given primary significance in assessing dams and alternative options	**– 3**	**-1.85***	**– 2**	**– 1.12***	**– 1**	**– 0.37***
15 Economic and financial factors should be given primary significance in assessing dams and alternative options	– 4	-2.40	**– 3**	**– 1.13***	– 3	-1.93
16 Improving existing water systems should be prioritised in the assessment of options	– 1	-0.48	– 2	– 0.55	**1**	**0.65****
17 A life cycle assessment covering the entire life time of a dam should be part of every dam planning process†	*– 2*	*-0.82*	*– 1*	*– 0.33*	*– 1*	*-0.42*
18 Dam planning should always include an analysis of direct and indirect distributional impacts	1	0.56	2	0.78	**– 1**	**– 0.28****
19 All dam projects should be assessed for their public health impacts	1	0.46	0	– 0.16	**3**	**1.32****
20 The benefits of existing dams should be monitored and reviewed periodically	***– 1***	***– 0.65****	*0*	*0.00*	*0*	*– 0.05*
21 The impacts of existing dams should be monitored and reviewed periodically	**– 1**	**– 0.57****	1	0.28	2	0.88
22 Dams should be decommissioned if they no longer provide sufficient benefits	– 3	– 1.23	– 2	– 0.70	0	– 0.02
23 Operating rules of existing dams should be improved to address environmental concerns†	*0*	*– 0.14*	*– 1*	*– 0.38*	*0*	*– 0.03*
24 Operating rules of existing dams should be improved to address social concerns	-2	– 0.83	– 1	– 0.52	– 1	– 0.07
25 River ecosystems should be fully understood before any dam or development planning begins	2	0.89	**4**	**1.96****	2	0.95
26 There should be a national policy to maintain selected rivers with high ecological value in their natural state	**0**	**0.33***	**– 2**	**– 0.58****	**2**	**0.89***
27 Dam projects should avoid or compensate significant negative impacts on endangered species	*– 1*	*– 0.24*	*1*	*0.54*	*0*	*0.08*
28 Large dams should release environmental flows to maintain downstream ecosystems	0	0.02	**3**	**1.24****	0	0.14
29 Large dams should release environmental flows to maintain downstream livelihoods	0	– 0.15	**2**	**1.04****	0	0.03
30 Dam planning should ensure that fisheries will be maintained	**1**	**0.49****	**– 1**	**-0.50***	**-2**	**– 1.27***
31 Impact assessments should include all negatively affected people in the entire catchment area, upstream and downstream of dams†	*1*	*0.48*	*1*	*0.61*	*0*	*0.09*

Table 2 (continued)

Statement	Factor 1		Factor 2		Factor 3	
	Rank	Z-score	Rank	Z-score	Rank	Z-score
32 Outstanding social issues within dam-affected communities should be resolved before new dams are built	**1**	**0.43****	**− 4**	**− 2.00****	**4**	**1.46****
33 Negatively affected people should be the first beneficiaries of dam projects via benefit-sharing mechanisms	0	0.09	**4**	**2.19****	1	0.41
34 An independent review of constructors' and financers' compliance with laws and regulations should be mandatory in all dam projects	**− 2**	**− 0.83****	1	0.26	2	0.87
35 All dam projects should include a budget for compliance costs	0	0.09	1	0.21	**− 3**	**− 1.66****
36 Existing legislation should be enforced consistently to combat corruption	**− 2**	**− 0.66****	3	1.33	2	1.02
37 There should be financial incentives for dam proponents who respect laws and regulations	− 4	− 2.43	**− 1**	**− 0.32****	− 4	− 2.80
38 External financing bodies should withdraw funds from government agencies who do not comply with laws and regulations	*− 1*	*− 0.50*	*− 2*	*− 0.96*	*− 1*	*− 0.26*
39 Dams in transboundary river basins should not be built if a neighbouring country raises an objection	*1*	*0.44*	*0*	*− 0.20*	*− 1*	*− 0.16*
40 Conflicts around dams should be resolved by the judicial system	− 3	− 1.00	**− 3**	**− 1.81***	− 2	− 0.74
41 The benefits of rivers, including those provided by dams, should be shared equitably among all users	*1*	*0.46*	*0*	*− 0.23*	*1*	*0.26*
42 Conflicts around dams should be resolved by independent institutions	**− 2**	**− 0.80****	0	0.12	1	0.28

Distinguishing statements are marked in bold (**significance level of $p < 0.01$; *significance level of $p < 0.05$); consensus statements at non-significance level of $p > 0.01$ are marked in italics. Those marked with a † are also non-significant at a level of $p > 0.05$

References

Abbink J (2012) Dam controversies: contested governance and developmental discourse on the Ethiopian Omo River dam. Soc Anthropol Anthropol Soc 20(2):125–144

Adams WM (2007) Thinking like a human: social science and the two cultures problem. Oryx 41(3):275–276

Adams WM (2020) Green development: environment and sustainability in a developing world, 4th edn. Routledge, London

Ansar A, Flyvbjerg B, Budzier A, Lunn D (2014) Should we build more large dams? The actual costs of hydropower megaproject development. Energy Policy 69:43–56

Athayde S, Mathews M, Bohlman S, Brasil W, Doria CRC, Dutka-Gianelli J, Fearnside PM, Loiselle B, Marques EE, Melis TS, Millikan B, Moretto EM, Oliver-Smith A, Rossete A, Vacca R, Kaplan D (2019) Mapping research on hydropower and sustainability in the Brazilian Amazon: advances, gaps in knowledge and future directions. Curr Opin Environ Sustain 37:50–69

Beattie J (2002) Dam building, dissent and development: the emergence of the Three Gorges Project. N Z J Asian Stud 4(1):138–158

Blanc J (2018) Itaipu's forgotten history: the 1965 Brazil–Paraguay border crisis and the new geopolitics of the Southern Cone. J Latin Am Stud 50(2):383–409

Borgias SL (2018) "Subsidizing the State:" the political ecology and legal geography of social movements in Chilean water governance. Geoforum 95:87–101

Briscoe J (2010) Overreach and response: the politics of the WCD and its aftermath. Water Altern 3(2):399–415

Brown SR (1980) Political subjectivity: applications of Q methodology in political science. Yale University Press, New Haven

Calheiros DF, Ikeda Castrilon SK, Bampi AC (2018) Hidrelétricas nos rios formadores do Pantanal: ameaças à conservação e às relações socioambientais e econômicas pantaneiras tradicionais. Revista Ibero-Americana de Ciências Ambientais 9(1):119–139

Colligan RC, Offord KP, Malinchoc M, Schulman P, Seligman MEP (1994) Caveing the MMPI for an optimism-pessimism scale: Seligman's attributional model and the assessment of explanatory style. J Clin Psychol 50(1):71–95

Corson C, MacDonald KI, Neimark B (2013) Grabbing "green": markets, environmental governance and the materialization of natural capital. Hum Geogr 6(1):1–15

Couto TBA, Olden JD (2018) Global proliferation of small hydropower plants—science and policy. Front Ecol Environ 16(2):91–100

Cox KR (1998) Spaces of dependence, spaces of engagement and the politics of scale, or: looking for local politics. Political Geogr 17(1):1–23

Cuadra Montoya X (2015) Conflictos ambientales en territorios indígenas y el rol de la reivindicación por el consentimiento libre, previo e informado: un análisis del caso Neltume en Chile. Justiça do Direito 29(2):294–312

Del Bene D, Scheidel A, Temper L (2018) More dams, more violence? A global analysis on resistances and repression around conflictive dams through co-produced knowledge. Sustain Sci 13(3):617–633

Dixit A, Gyawali D (2010) Nepal's constructive dialogue on dams and development. Water Altern 3(2):106–123

Erlewein A (2014) The promotion of dams through the Clean Development Mechanism: between sustainable climate protection and carbon colonialism. In: Nüsser M (ed) Large dams in Asia: contested environments between technological hydroscapes and social resistance. Springer, Dordrecht, pp 149–168

Evans S (2019) Dams in the desert: an environmental and agricultural history of water in Sonora, Mexico. Glob Environ 12(1):182–205

Fox JA, Brown LD (eds) (1998) The struggle for accountability: the World Bank, NGOs and grassroots movements. MIT Press, Cambridge

Franco Moreira P, Kishen Gamu J, Aoki Inoue CY, Athayde S, da Cal Seixas SR, Viola E (2019) South-South transnational advocacy: mobilizing against Brazilian dams in the Peruvian Amazon. Glob Environ Politics 19(1):77–98

Frankfurt HG (1958) Peirce's notion of abduction. J Philos 55(14):593–597

Freitas CM, Barcellos C, Asmus CIRF, da Silva MA, Xavier DR (2019) From Samarco in Mariana to Vale in Brumadinho: mining dam disasters and public health. Cadernos de Saúde Pública 35(5):e00052519

Fukuyama F (2018) Against identity politics: the new tribalism and the crisis of democracy. Foreign Aff 97:90–114

Gagnon L, Klimpt J-É, Seelos K (2002) Comparing recommendations from the World Commission on Dams and the IEA initiative on hydropower. Energy Policy 30(14):1299–1304

Garcia LC, Ribeiro DB, de Oliveira Roque F, Ochoa-Quintero JM, Laurance WF (2017) Brazil's worst mining disaster: corporations must be compelled to pay the actual environmental costs. Ecol Appl 27(1):5–9

Haas L, Skinner J, Soanes M (2015) Hydropower sustainability assessments can unlock carbon financing. IIED Briefing Paper, IIED, London

Hall A, Branford S (2012) Development, dams and Dilma: the saga of Belo Monte. Crit Sociol 38(6):851–862

Hay M, Skinner J, Norton A (2019) Dam-induced displacement and resettlement: a literature review. FutureDAMS Working Paper 004, The University of Manchester, Manchester

Hernando-Arrese M, Tironi M (2019) Worlding hydropower: river realities in the Chilean Patagonia. Tapuya 2(1):295–309

Hess CEE, Fenrich E (2017) Socio-environmental conflicts on hydropower: the São Luiz do Tapajós project in Brazil. Environ Sci Policy 73:20–28

Howe C (2015) Latin America in the Anthropocene: energy transitions and climate change mitigations. J Latin Am Caribb Anthropol 20(2):231–241

Huber A, Gorostiza S, Kotsila P, Beltrán MJ, Armiero M (2017) Beyond "socially constructed" disasters: re-politicizing the debate on large dams through a political ecology of risk. Capital Nat Soc 28(3):48–68

International Hydropower Association (2018) Hydropower sustainability assessment protocol. IHA, London

Jensen CB (2017) Mekong scales: domains, test sites, and the uncommons. Anthropologica 59(2):204–215

Johnston BR (2004) "Reparations for dam-displaced communities?" Report from the Chixoy Dam Legacy Issues Meeting, July 25, 2003, Pacux, Guatemala. Capital Nat Social 15(1):113–119

Kahneman D (2011) Thinking, fast and slow. Farrar, Straus and Giroux, New York

Kapitan T (1992) Peirce and the autonomy of abductive reasoning. Erkenntnis 37(1):1–26

Kaygusuz K (2009) The role of hydropower for sustainable energy development. Energy Sour Part B 4(4):365–376

Kornfeld IE (2011) Adiós to paradise: the Yacyretá Dam and the destruction of environmental and human rights. Florida A M Univ Law Rev 7(2):181–228

Kortenkamp KV, Moore CF (2001) Ecocentrism and anthropocentrism: moral reasoning about ecological commons dilemmas. J Environ Psychol 21(3):261–272

Larkin B (2013) The politics and poetics of infrastructure. Annu Rev Anthropol 42:327–343

Latini JR, Pedlowski MA (2016) Examinando as contradições em torno das Pequenas Centrais Hidrelétricas como fontes sustentáveis de energia no Brasil. Desenvolvimento e Meio Ambiente 37:73–90

Laurie N, Baillie Smith M (2018) Unsettling geographies of volunteering and development. Trans Inst Br Geogr 43(1):95–109

Le Heron R, Baker R, McEwen L (2006) Co-learning: re-linking research and teaching in geography. J Geogr High Educ 30(1):77–87

Leenaars AA (2006) Suicide among indigenous peoples: introduction and call to action. Arch Suicide Res 10(2):103–115

Li Z, He D, Feng Y (2011) Regional hydropolitics of the transboundary impacts of the Lancang cascade dams. Water Int 36(3):328–339

Lima MAL, Carvalho AR, Nunes MA, Angelini R, Doria CRC (2020) Declining fisheries and increasing prices: the economic cost of tropical rivers impoundment. Fish Res 221:105399

Louzada AF, Ravena N (2019) Dam safety and risk governance for hydroelectric power plants in the Amazon. J Risk Res 22(12):1571–1585

Magilligan FJ, Sneddon CS, Fox CA (2016) The era of big dam building: it ain't over till it's over. In: Ashcraft CM, Mayer T (eds) The politics of fresh water: access, conflict and identity. Routledge, London, pp 78–97

Mora S (2018) Resistencias sociales a la cooperación de China en infraestructura: las represas Kirchner-Cepernic en Argentina. Colomb Int 94:53–81

Nüsser M (2014) Technological hydroscapes in Asia: the large dams debate reconsidered. In: Nüsser M (ed) Large dams in Asia: contested environments between technological hydroscapes and social resistance. Springer, Dordrecht, pp 1–14

Orellana MA (2005) Indigenous peoples, energy and environmental justice: the Pangue/Ralco hydroelectric project in Chile's Alto BíoBío. J Energy Nat Resour Law 23(4):511–528

Owusu K, Asiedu AB, Yankson PWK, Boafo YA (2019) Impacts of Ghana's Bui dam hydroelectricity project on the livelihood of downstream non-resettled communities. Sustain Sci 14(2):487–499

Park S (2009) The World Bank, dams and the meaning of sustainable development in use. J Int Law Int Relat 5(1):93–122

Peritore NP, Galve Peritore AK (1990) Brazilian attitudes toward agrarian reform: a Q-methodology opinion study of a conflictual issue. J Dev Areas 24(3):377–406

Plummer Braeckman J, Disselhoff T, Kirchherr J (2020) Cost and schedule overruns in large hydropower dams: an assessment of projects completed since 2000. Int J Water Resour Dev 36(5):839–854

Pollock NJ, Naicker K, Loro A, Mulay S, Colman I (2018) Global incidence of suicide among indigenous peoples: a systematic review. BMC Med 16:145

Reid LA, McCormick A (2010) Knowledge transfer at the research–policy interface: the geography postgraduates' experiences of collaborative studentships. J Geogr High Educ 34(4):529–539

Resende AF, Schöngart J, Streher AS, Ferreira-Ferreira J, Piedade MTF, Silva TSF (2019) Massive tree mortality from flood pulse disturbances in Amazonian floodplain forests: the collateral effects of hydropower production. Sci Total Environ 659:587–598

Romero Toledo H, Romero Aravena H, Toledo Olivares X (2009) Agua, poder y discursos en el conflicto socio-territorial por la construcción de represas hidroeléctricas en la Patagonia chilena. Anuario de Estudios Americanos 66(2):81–103

Roquetti DR, Moretto EM, Pulice SMP (2017) Dam-forced displacement and social-ecological resilience: the Barra Grande Hydropower Plant in Southern Brazil. Ambiente Soc 20(3):115–134

Sandbrook CG, Fisher JA, Vira B (2013) What do conservationists think about markets? Geoforum 50:232–240

Schulz C, Adams WM (2019) Debating dams: the World Commission on Dams 20 years on. Wiley Interdiscip Rev Water 6(5):e1396

Schulz C, Martin-Ortega J, Glenk K (2018) Value landscapes and their impact on public water policy preferences. Glob Environ Change 53:209–224

Schulz C, Martin-Ortega J, Glenk K (2019) Understanding public views on a dam construction boom: the role of values. Water Resour Manag 33(14):4687–4700
Scudder T (2005) The future of large dams: dealing with social, environmental, institutional, and political costs. Earthscan, London
Scudder T (2017) The good megadam: does it exist, all things considered? In: Flyvbjerg B (ed) The Oxford handbook of megaproject management. Oxford University Press, Oxford, pp 428–450
Siciliano G, Urban F (2017) Equity-based natural resource allocation for infrastructure development: evidence from large hydropower dams in Africa and Asia. Ecol Econ 134:130–139
Silva E (2016) Patagonia, without Dams! Lessons of a David vs. Goliath campaign. Extr Ind Soc 3:947–957
Sneddon C, Fox C (2008) Struggles over dams as struggles for justice: the World Commission on Dams (WCD) and anti-dam campaigns in Thailand and Mozambique. Soc Nat Resour 21(7):625–640
Snow CP (1969) The two cultures and a second look: an expanded version of the two cultures and the scientific revolution. Cambridge University Press, Cambridge
Sousa S, Botelho A, Costa Pinto LM, Valente M (2019) How relevant are non-use values and perceptions in economic valuations? The case of hydropower plants. Energies 12(15):2986
Sovacool BK, Walter G (2019) Internationalizing the political economy of hydroelectricity: security, development and sustainability in hydropower states. Rev Int Political Econ 26(1):49–79
Spears E (2018) Scale and political ecology: a conceptual analysis of the Brazilian Samarco disaster. Environ Politics Soc 25:151–162
Varas P, Tironi M, Rudnick H, Rodríguez N (2013) Latin America goes electric: the growing social challenges of hydroelectric development. IEEE Power Energ Mag 11(3):66–75
Walters SD (2018) In defense of identity politics. Signs 43(2):473–488
WATERLAT-GOBACIT (2019) About us. Available at: www.waterlat.org (accessed November 2019)
Watts S, Stenner P (2012) Doing Q methodological research: theory, method and interpretation. SAGE, London
World Commission on Dams (WCD) (2000) Dams and development: a new framework for decision-making. Earthscan, London, Sterling
Wilson Fernandes G, Goulart FF, Ranieri BD, Coelho MS, Dales K, Boesche N, Bustamante M, Carvalho FA, Carvalho DC, Dirzo R, Fernandes S, Galetti PM Jr, Garcia Millan VE, Mielke C, Ramirez JL, Neves A, Rogass C, Ribeiro SP, Scariot A, Soares-Filho B (2016) Deep into the mud: ecological and socio-economic impacts of the dam breach in Mariana, Brazil. Nat Conserv 14(2):35–45
Zabala A (2014) qmethod: a package to explore human perspectives using Q methodology. R J 6(2):163–173
Zarfl C, Lumsdon AE, Berlekamp J, Tydecks L, Tockner K (2015) A global boom in hydropower dam construction. Aquat Sci 77(1):161–170
Zhouri A, Oliveira R (2007) Desenvolvimento, conflitos sociais e violência no Brasil rural: o caso das usinas hidrelétricas. Ambiente Soc 10(2):119–135