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Analysis

Tracking cultural ecosystem services: water chasing the Colorado River restoration pulse flow

Rosalind H. Bark [a,*], Catherine J. Robinson [b], Karl W. Flessa [c]

[a] Marie Skłodowska-Curie Fellow, Sustainability Research Institute, School of Earth and Environment, University of Leeds, Leeds LS2 9JT, England, United Kingdom
[b] Land and Water Flagship, CSIRO, Brisbane, PO Box 2583, 4001, Queensland, Australia
[c] Department of Geosciences, University of Arizona, Tucson, AZ 85721, USA

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ABSTRACT

The release of environmental flows for ecological restoration is a challenge for water policymakers and managers as it involves complex trade-offs between productive and ecosystem uses of water. While it is crucial to demonstrate that such environmental flows produce the desired hydro-ecological results, allocation of environmental water is also influenced by perceived social values of this water. This research draws on the sub-field of socio-hydrology to track two-way feedbacks between humans and environmental flows and shows why and how social responses to river restoration can be monitored. Media coverage, posted comments and in-person interviews were used to track the responses of stakeholders who 'chased' the progress of the 2014 "pulse flow" down the Colorado River. These data framed in the cultural ecosystem systems typology revealed the temporal patterns and dynamics of dramatic shifts in socio-hydrologic processes and highlight the value of understanding the human wellbeing benefits and complex social values that are affected by freshwater restoration. This experimental and mixed evidence approach is useful for contexts where multiple stakeholders shape water resource management and we suggest it can be used by water decision-makers in their efforts to understand and appropriately respond to the social-ecological dynamics of a changing river system.

1. Introduction

The Colorado River has long been viewed as a 'frontier' that marks the enduring American theme of subjugating wilderness to serve national needs: "a vision of lonely lands made fruitful", in the words of the plaque atop Hoover Dam. This enduring ideology has justified the river being 'tamed' by large dams and aqueducts and a water policy that has reduced the diversity of the basin's cultural and ecological terrains to serve irrigated agricultural production and urban development. Until 2014, there had been no allocation of water for the river's habitats in its delta. In most years since 1960 and the completion of the two main dams on the river (Hoover Dam creating Lake Mead and Glen Canyon Dam creating Lake Powell), the river ran dry before it reached the sea.

Recent water planning reforms have marked a shift towards a sustainable reconciliation with the land and its people. River flows have been created in sections of the Colorado River for the enjoyment of rafters (Patten et al., 2001), ecosystems (Meretsky et al., 2005) and water rights of Native American communities (Hundley, 2009). Conventional environmental and cultural understandings of the river are slowly being decoded, recalled and re-negotiated. On the ground, this trend necessarily re-introduces local people's interpretations and expressions of their relationships to the river. In theory it has led to the development of the new sub-field of socio-hydrology (Sivapalan et al., 2012; see Blair and Buytaert, 2015 for a review) which is explicit about the "two-way feedbacks between human and water systems" (Sivapalan et al., 2014: 225).

Sivapalan et al. (2014) call for the study of real-world systems as a means to understand human-water dynamics; we propose that the study of environmental flows in fully allocated river basins for ecological restoration of riverine and/or estuarine ecosystems is a fertile one to discover these dynamics. This is because it offers means to explore if and how culture adapts and changes with environmental change (Caldas et al., 2015). Cultural dimensions of water can underpin tensions between stakeholders in over-allocated basins. The decision to allocate environmental water can add to this conflict and be a difficult and contentious task (Szemis et al., 2013). At the same time water managers are seeking to utilise and quantify information about human water values and preferences so that it can inform decision-making mechanisms such as hydrological models (Jacobs et al., 2012).

Three lines of enquiry in socio-hydrology – historical, comparative and process – have been suggested (Sivapalan et al., 2012; Sivapalan and Blöschl, 2015). In practise this requires data collection and analysis that explains interactions between people and water and subsequent conversion of such evidence into metrics that can be used to inform

* Corresponding author.
E-mail addresses: R.H.Bark@leeds.ac.uk (R.H. Bark), Catherine.Robinson@csiro.au (C.J. Robinson), kflessa@email.arizona.edu (K.W. Flessa).

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water planning and decision-making. There is a small but growing area of scholarship that has considered how a better understanding of nature-society inter-relationships can be useful to water managers in operational planning (Bark et al., 2015; Robinson et al., 2014). In this research we find that such information could also be useful in restoration decisions.

There are two key questions related to collecting such data: why monitor? and monitor what (how and when)? To answer the why question, monitoring provides evidence not just anecdotes about success (Kondolf et al., 2007) and information for adaptive management (Harris and Heathwaite, 2012) and to answer the what question in relation to the effectiveness of restoration, Palmer et al. (2005) suggest that there are three axes to measure: ecological success, learning success and stakeholder success. The pulse flow on the Colorado River was part of an agreement, Minute 319.[1] The Minute incorporates monitoring to measure the ecological success of the pulse flow, specifically an evaluation of "the ecosystem response, most importantly the hydrological response and, secondarily, the biological response" (IBWC, 2012, Sec 6,c, iv). This monitoring effort continues through 2017 and involves binational teams of scientists from U.S. and Mexican universities, government agencies and environmental NGOs (Flessa et al., 2013; Flessa et al., 2014).

The (adaptive) learning dimension is intrinsic in the experimental nature of the pulse flow event, however, here we broaden this to also assess institutional and international learning, as well as, learning about the process of restoration (Eden and Tunstall, 2006; Pahl-Wostl et al., 2007).

The third dimension, of stakeholder success, is absent from the monitoring plan. To answer the why monitor, social responses may add to greater understanding of social values which is key to assess public support for river restoration (Loomis, 2006; Trabucchi et al., 2012), to the design of incentives for restoration activities (Seidl and Stauffacher, 2013), and to improve the uptake of restoration activities (Eden et al., 2000; Eden and Tunstall, 2006; Schlapfer and Witzig, 2006; Jacobs et al., 2012; Robinson et al., 2014). Generating data on the interaction of biophysical and human dimensions of restoration (Sivapalan et al., 2014) and the competition among different stakeholders (Sivapalan and Blöschl, 2015) is a key goal of this paper.

Therefore, to answer the what dimension we first have to define the stakeholders. The literature on stakeholders is extensive (see Reed et al., 2009), here we identify stakeholders in the pulse flow event as those actors who are involved in restoration planning and design, local people and observers directly participating in the event, and the wider public that engage with media on the event. To answer the how and when dimensions we use three different data sources – content analysis of media coverage, on-site semi-structured interviews, and direct observations – thereby sampling different cultural processes affecting stakeholder values (Caldas et al., 2015) over the period of the restoration flow.

The paper proceeds with some background on the pulse flow, the methods used, results on tracking social responses to the pulse flow, and a discussion of the usefulness of such monitoring to the study of socio-hydrology, for water management, and restoration policy.

2. Background

Bark et al. (2014) provide background on the administration of the Colorado River system and the history of Minutes leading up to Minute 319 (IBWC, 2012). The pulse flow implemented in 2014 as the result of Minute 319 has been lauded as a major breakthrough in Colorado River water management (Festa and Enstminger, 2014) and is the result of decades of negotiations. The actual timing of the pulse flow was, however, inauspicious. Although not supplied with water from the Colorado River, northern California was in the grip of a serious drought in spring 2014. Fears were widespread that Lake Mead, a critical storage reservoir, would drop below a critical level and trigger downstream rationing (Jerla et al., 2011). Adding to the anxiety, the U.S. Bureau of Reclamation, the water manager in the U.S. portion of the basin, had pointed out that rising demand had already exceeded supply and that projected climate change impacts would make matters worse (USBR, 2012).

Concerns that the Minute 319 pulse flow would not be well-received in such a climate of scarcity were widespread within the river management agencies and environmental NGOs of both countries. Pre-pulse flow messages emphasised: 1) the small amount of water involved; 2) that the flow itself was a planned experiment that would add to the body of knowledge on how best to approach riparian restoration (e.g. Flessa et al., 2013); and 3) that it was a symbol of a new era of cooperation that heralded a new and a mutually beneficial approach to river management.

The pulse flow began on March 23, 2014 when the diversion dam at the border between the U.S. and Mexico, Morelos Dam was opened and pulse flow water began to flow down the dry river bed. The flow was slow enough to walk in front of; it was however not predictable in all places which branch(es) of the old river bed it would flow in, prompting the term "water chaser" for those who tracked its downstream progress. Water releases for the pulse flow peaked on April 27. The hydrograph of the pulse flow was developed to both mimic a spring flood and to ensure that flows reached restoration sites, see Fig. 1. On May 15, 2014 the river reached the sea, see Fig. 2. Flows ceased on May 18, 2014.

3. Methods and data

We drew on socio-hydrology to interrogate media reports about the pulse flow, posted comments, semi-structured interview responses and observation to address the three goals of socio-hydrology, which are to: (S-H1) analyse the temporal patterns and dynamics of socio-hydrologic processes; (S-H2) understand and interpret socio-hydrologic processes on human wellbeing; and, (S-H3) understand the value of water culturally, politically (and economically) (Sivapalan et al., 2014; see Bark et al., 2014 for a review of the economics of this transboundary flow).

Media reports on the pulse flow were collected between December 30, 2013 and June 14, 2014 using a daily Google News Alert and Google News searches using the search keywords: "Colorado River Delta", "Colorado Delta", "pulse flow", and "Minute 319". The period chosen was longer than the restoration event to pick up early analysis of the event and later reflection on the event. A total 263 reports comprising

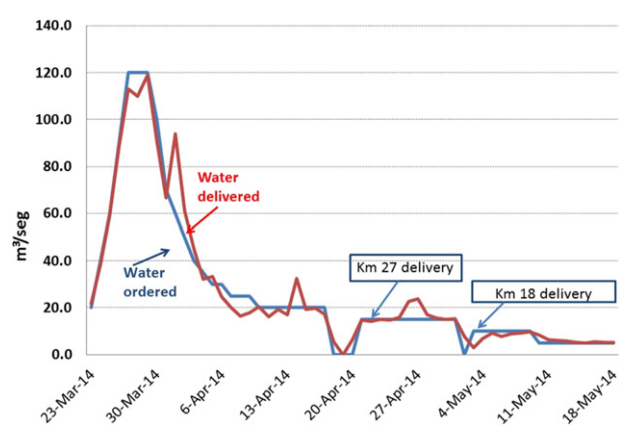

Fig. 1. Pulse flow hydrograph: actual vs planned (source: the United States Bureau of Reclamation). Note: Differences between actual and planned releases are the result of complex river management operations to meet multiple demands in the Lower Basin. Deliveries were also made at the 18 km and 27 km points via irrigation canals to ensure water researched restoration sites.

[1] A Minute, as opposed to an amendment, is a mutual agreement for modifications to a treaty in this case the 1944 treaty between the United States of America and Mexico that governs the transboundary "Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande."