Global Environmental Change 42 (2017) 82–92

Contents lists available at ScienceDirect

Global Environmental Change

journal homepage: www.elsevier.com/locate/gloenvcha

Evolution of the societal value of water resources for economic development versus environmental sustainability in Australia from 1843 to 2011

Jing Wei[a,*], Yongping Wei[b], Andrew Western[a]

[a] The Department of Infrastructure Engineering, The University of Melbourne, Parkville 3010, Australia
[b] School of Geography Planning and Environmental Management, The University of Queensland, Brisbane St. Lucia, Queensland 4072, Australia

ARTICLE INFO

Article history:
Received 19 May 2016
Received in revised form 6 December 2016
Accepted 12 December 2016
Available online xxx

Keywords:
Societal values
Water catchment management
Newspaper content analysis
Transition theory
Co-evolved social-ecological system

ABSTRACT

Societal values are generally seen as leading to changes in human decisions and behavior, but have not been addressed adequately in current water management, which is blind to changes in the social drivers for, or societal responses to, management decisions. This paper describes the evolution of the societal value of water resources in Australia over a period of 169 years. These values were classified into two groups: those supporting economic development versus those supporting environmental sustainability. The *Sydney Morning Herald* newspaper was used as the main data source to track the changes in the societal value of water resources. Content analysis was used to create a description of the evolution of these societal values. Mathematical regression analysis, in combination of transition theory, was used to determine the stages of transition of the societal value, and the co-evolved social-ecological framework was used to explain how the evolution of societal values interacted with water management policies and practices, and droughts. Key findings included that the transition of the societal value of water resources fitted the sigmoid curve – a conceptual S curve for the transition of social systems. Also, the transition of the societal value of water resources in Australia went through three stages: (1) pre-development (1900s–1962), when the societal value of water resources was dominated by economic development; (2) take-off (1963–1980), when the societal value of water resources reflected the increasing awareness of the environment due to the outbreak of pollution events; (3) acceleration (1981–2011), when the environment-oriented societal value of water resources combined with the Millennium Drought to trigger a package of policy initiatives and management practices focused on sustainable water resource use. The approach developed in this study provides a roadmap for the development of new disciplines across social and natural science.

1. Introduction

The scale of human activity in the last 200 years has reached a point where our actions are affecting the global biophysical environment to such a degree and at such a speed that irreversible effects are being observed (Crutzen and Steffen, 2003). We have entered a new epoch, the Anthropocene, when humans constitute the dominant drivers of change to the Earth's systems (Vitousek et al., 1997; Crutzen 2002; Steffen et al., 2007; Rockström et al., 2009; Vörösmarty et al., 2010; Zalasiewicz et al., 2010; Poff et al., 2012). A daunting task lies ahead for scientists and policy makers to learn how to manage feedbacks between human activities and our biophysical environment, thus guiding society towards sustainability (Crutzen, 2002).

As the most fundamental and essential element of life, water represents a key sustainability challenge facing humans in the Anthropocene (Maass 1962; Falkenmark and Rockström, 2004; Sivapalan et al., 2014). Human appropriation of water resources and modification of landscapes exert an increasing negative influence on water-cycle dynamics and catchment ecosystems, from local to global scales and from decadal to century timescales (Falkenmark and Lannerstad, 2005; Rockström et al., 2009; Vörösmarty et al., 2010; Carpenter et al., 2011) The pressure on freshwater resources around the world caused by the human activities, both now and into the future, requires a radical paradigm

* Corresponding author.
E-mail addresses: jingwei@student.unimelb.edu.au, weijing826@gmail.com (J. Wei).

http://dx.doi.org/10.1016/j.gloenvcha.2016.12.005
0959-3780/

shift in approaches to water resources management (Gleick, 2003; Pahl-Wostl et al., 2008; Sivapalan et al., 2014).

Societal values has been frequently invoked in discussion of environmental problems. Societal values – a set of common values, beliefs and attitudes shared by the majority of a regional population – represent the core societal practice within a region (Dietz et al., 2005). Changes in values are seen as leading to changes in decisions, and thus to changes in behavior (Beddoe et al., 2009). Those social scientists concerned with human impacts on the environment have often suggested that changes in values that are more protective of the environment will lead to behaviors and policies for more sustainable resource management (Dietz et al., 2005).

However, societal values have not been addressed adequately in current water management studies (Sivapalan et al., 2012). For much of the 20th century, water catchment management was dominated by engineers and hydrologists by managing fast variables (e.g. economic and hydrologic) based on economic optimisation under the assumption of hydrologic stationarity (Brouwer and Hofkes, 2008; Savenije and Van Der Zaag, 2008). This has been implemented through formal, mathematical models linking relevant hydrological and biogeochemical processes to economic 'laws' of supply and demand underlying the provision of scarce water services (Rosegrant et al., 2000; Cai et al., 2003; Brouwer and Hofkes, 2008). The timescales of these hydrological and economic models may be days, months, seasons or years (Dudley 1972; Andreu et al., 1996; Rosegrant et al., 2000; Cai et al., 2003; Brouwer and Hofkes, 2008). Recent development focuses on managing relatively slow ecological variables (eutrophication of freshwater lakes, and re-vegetation). Changes in environmental and social aspects of societal values operate at the timescale of decades to centuries and, in most cases, are the underlying determinant of the overall rate of change in the entire system (Hedley, 2000). Hence, current water catchment management is insensitive to societal values and seemingly blind to change in the social drivers for, or social response to, management decisions (Rammel et al., 2007). This seriously compromises our capacity to foster social–ecological sustainability of water catchments in the long term.

A wide variety of environmental social sciences – such as environmental or ecological anthropology, environmental history and environmental sociology – have emerged to address the interactions of societal and ecological systems including human–water relationships (Worster, 1985; Braun, 2000; Castree and Braun, 2001; Liu et al., 2007; Ostrom, 2007). Traditionally, the core of social science research on values is descriptive, offering analyses of how we think about and value the environment (Geels, 2010). For example, numerous authors have highlighted the importance of water resources management, taking into account socio-cultural contexts by recognizing that societal and hydrologic systems are in many cases inseparable (Sivapalan et al., 2012; Baldassarre et al., 2013). However, these 'thick description' approaches, rather than explanatory approaches, have not often been applied in water catchment management, which is dominated by hydrologists and engineers.

Given this background, our paper aims to develop an approach to describe the evolution of the societal value of water resources quantitatively. The societal value of water resources is classified into two groups: those supporting economic development versus those supporting environmental sustainability. Australian management of water catchment systems is taken as a case example. Some aspects of Australia's physiographic and socio-economic characteristics are important for context. Water scarcity in the context of climate variability is very pronounced issue in Australia like other arid and semiarid countries (Connell and Grafton, 2011), which means water is often a limiting resource and tends to lead to a focus on water quantity. Australia shares similar lessons in terms of overuse and misuse with many parts of the world and the transitions described later in this paper are likely to be relevant to many other jurisdictions either now or in the future (Connell, 2011). It is also a country in a neo-liberal economy where water policy has been successfully shifted to the market-based approach, including market-based water management mechanisms. While agriculture is important in Australia, one differentiator that is important to agricultural business decisions (and hence water use) is that Australia does not experience the distortions of the diverse production subsidies that many economies pay to farmers. Nevertheless water infrastructure has certainly been subsidized in Australia (NWC, 2011).

This paper builds on the analysis of newspaper coverage of water management in Australia by addressing three specific research questions:

1) How did the societal value of water resources for economic development versus environmental sustainability in Australia evolve over this 169 year period?
2) What was the transition pattern of the societal value over this period?
3) In what context does such a transition occur, and what factors possibly trigger such a transition?

This paper aims to uncover the pattern of changing societal value – a slow variable in water catchment management – and its interaction with the economic and biophysical environment. It is hoped that the research findings will provide basis for incorporating societal values into water catchment management to reduce the influence and restricted perspective of 'fast' variables on management decisions. This is critical for the development of more-sustainable water catchments.

2. Methods

2.1. Describing evolution of the societal value using content analysis of a newspaper

It is believed that humans live in a 'symbolic environment,' an 'environment of words and images of meanings that surround us from our earliest moments of existence' (Danielson and Lasorsa, 1997). News media write the first draft of history; a draft which can both influence and reflect public opinion (Howland et al., 2006). Newspapers are very commonly used as data sources to track the changes of societal values because news accounts are rich in description and they reflect and influence public values and opinion on certain issues at their time of publication (Roznowski, 2003; Hale, 2010; Hurlimann and Dolnicar, 2012). Content analysis of newspapers has been widely used in a variety of fields as a research technique for systematic and quantitative analysis of the texts to the contexts of their use (Mazur and Lee, 1993; Bengston et al., 1999; Joshi et al., 2011; Altaweel and Bone, 2012). In this study, we used the newspaper content analysis approach to describe the evolution of the societal value of water resources for economic development and environmental sustainability in Australia. Our content analysis included five steps: newspaper selection, determination of study period, sampling, data collection and text coding.

We selected *The Sydney Morning Herald* as the case newspaper because it is one of the oldest continuously published newspapers in Australia and it has diverse coverage and wide readership. The timeframe chosen for this study starts from the earliest date that news content is digitally accessible and spanned 169 years: 1843–2011. This long timeframe covers changes in hydrological cycles and political reforms that influenced water resources