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Abstract

This paper is a social-ecological systems (SES) analysis of tourism and water inequity in Bali. It uses Elinor Ostrom's SES model to look at the particular niche of Bali's tourism and water nexus. Re-analysis of previous qualitative research revealed that the vulnerability of the SES was due to numerous characteristics. In particular, user groups are highly diverse, transient and stratified, thereby inhibiting communication and knowledge sharing. This, in combination with weak governance systems and the economic power of the tourism industry, interact to affect declining water resources and the iniquitous impact of this. Whilst there are obvious indications that Bali's water resources are over stretched, there is no feedback loop to the institutional structures that would help enable appropriate responses from the user groups or governance system.

INTRODUCTION

This paper analyses water inequity in a popular tourism destination, Bali, using Common Pool Resource (CPR) and social-ecological system (SES) theory, in an attempt to develop a previously unexplored niche within these fields. Bali is particularly relevant in this investigation, with a rich history in its sophisticated traditional water management system (Lansing 2007) subject to much debate in this journal (Nitish Jha and Schoenfelder 2011) and also as a mature tourist destination with a deepening water crisis (Cole 2012, JICA 2006). Applying these findings to a large scale SES is a difficult, yet necessary, endeavor in a world characterized by blurring boundaries and increasingly interconnected systems (Young et al. 2006). Additionally, a socio-ecological approach is intended to give an alternative diagnostic approach to the elusiveness of sustainability in tourism.

We are using Ostrom's general SES framework (2009) to examine a particular niche in a SES, i.e. the water tourism nexus in Bali, to initiate the creation of a more detailed and relevant model, specific to diagnosing issues of water inequity and management challenges that are increasing in tourism destinations (Cole 2012; Gossling 2001; Gossling et al. 2012; Kent et al. 2002; Nobel et al. 2012). Rather than narrowly analyzing water problems in tourism destinations as simple problems of consumption, the model is both broad and structured enough to examine a diverse range of dimensions to the issue, thus averting the dangers of mono-consequentialism in the analysis of SES (Agrawal and Chhatre 2011) and oversimplified diagnoses (Ostrom 2007a; Ostrom and Cox 2010). As this paper demonstrates, Ostrom's model allows a flexible analysis of water inequity in tourism destinations as one aspect of the multifaceted outcomes in large scale, complex and transformative SESs, where many different processes at different scales occur simultaneously.

In the following paragraphs we will explain the theoretical frameworks, Bali's socio-economic, political and ecological context and our SES analysis in more detail. Using qualitative information from pre-existing research and a literature review, this is a preliminary attempt to outline this SES niche. This Balinese example is presented on its own, in order to introduce readers to the authors' analytical approach. It is intended that this will lay the groundwork for further comparative analyses of the tourism-water nexus in other destinations using the SES framework. Therefore, this paper is an initial step towards utilizing Ostrom's SES framework as

a diagnostic tool for commonalities and differences in outcomes of water inequity in tourism destinations.

THEORETICAL BACKGROUND: COMMON POOL RESOURCES (CPRs), SOCIO-ECOLOGICAL SYSTEMS (SES) AND RESILIENCE

Common Pool Resource (CPR), social-ecological system and resilience theory are interlinked and overlapping fields of research. At the core of these, is the diagnosis and solution of problems relating to SESs, the institutions that govern CPRs, and their vulnerability (Adger et al. 2006; Agrawal 2001, 2002 ; Anderies et al. 2004, Dietz et al. 2006; Ostrom 1990; Ostrom and Cox 2011). CPRs are defined as resource units that are rival (if consumed by one person, they cannot be consumed by another) and non-excludable (it is difficult to restrict use to a single user or user group through physical or institutional barriers) (Ostrom et al. 1994, 2010). Resources such as groundwater and river water certainly meet these criteria with consumption by one user resulting in subtraction, depletion and reduced availability for other users. It is also particularly challenging and costly to create management institutions and regulations that can exclude users (Wade 1987).

A social-ecological system (SES) is “the subset of social systems in which some of the interdependent relationships among humans are mediated through interactions with biophysical and non-human biological units” (Anderies et al 2004: p. 3). Within a SES a complex multitude of subsystems and internal variables, both social and ecological, continuously interact and transform the SES as a whole (Anderies et al. 2004; Ostrom 2009; Ruiz-Ballesteros 2011; Strickland Munroe 2010; Young 2010). Analyzing the characteristics of its components and their interactions can help diagnose outcomes. The resilience of SESs refers to the ability to absorb changes without shifting to a new phase or state of equilibrium and retaining the same form and function (Folke 2006; Gunderson 2000; Pollard and du Toit 2011; Walker et al. 2006). In practice this represents an enormous methodological challenge, as there are many different variables which require different methods and knowledge sets to investigate (Cote and Nightingale 2011). In a resilient SES, disturbances can offer the opportunity to innovate the nature of the relationship between social and ecological components (Folke 2006), while in vulnerable ones small disturbances can have significant negative inter-related social and environmental impacts (Adger 2006). In large, complex, dynamic and unpredictable systems, such as watersheds, the ability to cope with uncertainty is a particularly desirable trait that is conferred by a suite of criteria such as leadership, communication, governance and, importantly, feedback loops that enable learning and self-regulation (Pollard and du Toit 2011). Change is inherent in all components of a SES, including the social components which can be as unpredictable as its biophysical counterparts. But to maintain what are considered to be positive outcomes, the feedback mechanisms must be nurtured in social components of SESs, and is therefore an essential consideration in CPR and SES analysis.

There are no broad-brush solutions that can be applied to CPR and socio-ecological problems (Ostrom 2007a, Agrawal and Chhatre 2011), therefore it is necessary to consider the unique conditions that apply to each. In our case, we are concerned with a well-developed tourism destination, its water resources and the large-scale social and ecological systems that maintain these. In addition to facing challenges associated with the management of a common pool resource, water resources are inextricably bound up with other CPR's. Within watersheds, forest and other types of terrestrial ecosystems are important for the maintenance and regulation of water flows (Brendan et al. 2010). Moreover, water availability is also dependent on local and regional weather patterns, which vary seasonally in Bali, and are changing as a result of climate change.

As various studies have shown (Berkes 2006; Cumming et al. 2006; Fisher et al. 2010), issues of scale are a central and predominant challenge. Forest cover within upstream catchment areas being particularly important for regulating river flows for communities downstream (Fisher et al. 2010; Van Oel et al. 2009). Within a large SES, the direct consumption, pollution and land use patterns of one person can affect water availability for another user in a different part of the

basin. Within watersheds, not only is hydrological modelling a challenge (Fisher et al. 2010), but gaining knowledge of the relationship between a large number of users and the relevant aspects of the ecosystem is also difficult. Therefore, the complexity inherent in the large scale of the watershed is not just limited to ecosystem dynamics, but also to user groups. In a complex SES, there will be numerous and diverse users and user groups, with access to different, yet integral parts of the ecosystem. Therefore, scale mismatches can occur (Berkes 2006; Cumming et al. 2006) where there is insufficient governance over the entire watershed system.

Tourism adds a further dimension to CPR management and SES dynamics. In most cases it is very seasonal and arrivals can count in the millions. Furthermore, in terms of CPR management, it adds to the heterogeneity of users. New actors, such as tourism developers and tourists, who become active users, will have widely disparate perspectives and consumption patterns of water use and importantly, they lack knowledge of local water availability. These new water users can also have much greater social power than the majority of their local counterparts. The development of the tourism industry is also usually accompanied by a myriad of other transformations, including changes in traditional land use and tenure, urbanisation, and inward migration, all leading to concentrated human activity with a greater water footprint. As it is difficult to deconstruct and isolate the tourism components within specific SESs, it is also necessary to consider the parallel effect of globalisation on complex SESs (Young 2006).

There has been minimal use of CPR and SES theory in tourism research and the few studies vary widely in their application; some analyse ecotourism's/community based tourism's (CBT) affect on CPR outcomes and SE resilience (Ruiz-Ballesteros 2011; Strickland-Munro et al. 2010), while others apply it to mathematical models of tourism development (Lacitignola et al. 2007; Petrosillo et al. 2006). Some analyse tourism very narrowly, rather than being components/interactions of the much larger SES within destinations (Blanco 2010). Araral (2013) considered tourism as one of the factors that is affecting the resilience of the Ifugao SES in the Northern Philippines. Given that tourism represents both a significant outcome and driver of socio-ecological change associated with globalization (Macleod 2004; Mowforth and Munt 2009), this is an exciting niche in which to develop and expand SES research (Young et al. 2006). We hope to build on this previous work by more directly applying SES theory to understanding and assessing water inequities.

CASE STUDY: BALI

Bali is a small, rugged, tropical island in the center of the Indonesian archipelago. Measuring 140km by 90km the island has an area of 5,632sq km. An east-west chain of volcanic mountains, containing four caldera lakes, separate a narrow coastal plain to the north, from a broad gently sloping, fertile, plain to the south. As a tropical island it has a warm, humid climate with two seasons: the wet season from October to March and the dry season from April to September. Mean annual rainfall is also spatially heterogeneous ranging from less than 500mm up to 3500mm in the mountains, which reach 3,142m (McTaggart 1988). There are three categories of water resources in Bali, the crater lakes which make an important contribution to underground reserve, the rivers and groundwater. Groundwater mainly lies in quaternary ignimbrites. These layers of volcanic ash-flow deposits, inter-layered with andesitic lava, have high permeability, but its precise hydrological characteristics are not well known (McTaggart 1988). Some low lying areas have secondary sedimentary aquifers.

Insert figures 1 and 2 here

Bali is a single Indonesian Province, but is divided into nine Regencies (*kabupaten*), each with a Regent (*Bupati*), or area head. In 1999, following 30 years of highly centralised dictatorship,

Indonesia gave considerable autonomy to each of the Regencies in response to a long period of growing distrust and antagonism to appease separatists (Seymour and Turner 2002). The new laws invited intense competition over local resources and political power. With autonomy bestowed at the regency level the leader who can claim “local” voice has far-reaching powers. As Usman (2001), Benda-Beckmann and Benda-Beckmann (2001), and Antlov (2001) note; with regency autonomy comes the power, obligation and responsibility to raise local revenue.

At the local level Bali is divided into *banjars*. These traditional neighborhoods are territorial, social and cultural units (Hussey 1989). Only Balinese belong to these physical and conceptual organizations or *Banjar Adat*, not the immigrants from other islands and nations. *Banjars* order civic aspects of the community and have a significant impact on local level decision making. The head of a *Banjar* is democratically elected and decisions are made democratically, but only by male heads of households.

A third dimension of social organisation, of particular importance to water management, is the *Subak*, headed by a *pekaseh*. These are self-governing, adaptive, democratic associations of farmers who have managed the apparently just and efficient system of sharing Bali’s water Lansing (2007). While neither homogenous nor harmonious, with internal workings which are complex and contested (MacRae and Arthawiguna 2011); the *subak* is a religious as well as administrative community, which carries out the necessary rituals and ceremonies related to the capture and use of water, itself a sacred substance (McTaggart 1988, Hauser-Schäublin 2011). The water temples of Bali are still actively used and maintained by local populations, but the *subak* system is endangered (Lorenzen and Lorenzen, 2011). Wet rice cultivation is both a productive activity and a sacred one, it symbolizes the “Balinese lifestyle” (Straus, 2011), is part of the Balinese “ecological identity” (Gossling, 2003:9), and is important for thinking about cultural identity (MacRae, 2005).

Bali has been promoted for tourism since Dutch colonial times. “More than any other tropical island, Bali has become the most exotic of exotic locations, a fantasy of all the splendors of the Orient and beauties of the Pacific” (Vickers, 1989:2). By the end of the 1930s tourists were arriving in their thousands (Picard, 1997). By the 1960s they were arriving in their tens of thousands and by the 1980’s in their hundreds of thousands. During Indonesia’s New Order era (1966-1998), the development agenda was to open up Bali to mass tourism and growth came at any cost (Warren 1998, Lewis and Lewis 2009). From 5000 rooms in 1987, there were 13,000 in 1992, and over 50,000 in 2010. Despite disquiet over the exploitation of the island, outside investors and powerful government officials with links to Regents continued to get concessions. Investment pressure, especially from Jakarta conglomerates, ensured the development policy was “almost entirely geared towards gross maximization of the number of tourists and income they might generate” (Warren, 1998:233).

Tourism is an integral part of Balinese culture (Picard, 1997) and economy providing 481,000 direct jobs, equating to 25% of the work force and supporting a further 55% thereby contributing 30% of Bali’s GDP (BPS, 2010). While many Balinese have benefited from tourism, it is estimated that 85% of the tourism economy is in the hands of non-Balinese (MacRae, 2010), who may not be directly affected by tourism’s negative impacts, including the declining quality and quantity of water. It is within this socio-economic and political context that tourism accounts for 65% of water consumption (Merit, 2010).

METHODOLOGY

Primary research in Bali took place between the 22nd of June and the 29th of July 2010. Thirty-nine interviews and two focus groups were conducted along with 110 tourist surveys. The participants of the interviews were: the heads or deputy heads of the 11 government departments that have responsibility for water or impact on it, such as tourism and planning (cf. Cole 2012); representatives of four Non-Governmental Organisations, four academics, representatives of three tourism industry associations (the deputy chairman of the Bali chapter of the Indonesian Hotel and Restaurant Association, the chairman of Bali Villa Association, and the manager of Bali Villa network); the head of corporate social responsibility at Aqua (bottled water company, owned by Danone), the technical operations manager at Coca-Cola, a developer, an architect, a manager and the head technician of two different hotels, four representatives of the villa sector (two owners and two managers), a businessman who has become an expatriate activist, a restaurant owner, a laundry worker, three spa workers, representatives of two community groups, four individual community members, and a *Pekaseh* (democratically elected head of a *subak* irrigation system). The community members and *pekaseh* were from the village of Canggu, which lies on the North fringe of over-developed South Bali. Some villages in Bali remain largely agricultural, while others have been thoroughly changed by tourism. Canggu is an illustrative example of a village presently still partly agricultural but also already changed by the tourism boom. The research was facilitated by a Balinese research assistant who helped make relevant connections and translated where necessary.

The study to understand the tourism–water nexus was first analyzed and written in political-ecological terms (Cole 2012). In this paper, fieldwork data is used in the broader SES framework to comparatively analyze SES outcomes; namely of how tourism as an economic and leisure activity is affecting interactions between users, governance systems, water and water relevant ecosystems to create unequal access to water and, ultimately, unsustainable outcomes.

Defining the resource system and the units represented a challenge in this analysis, because of the lack of clarity of water system boundaries. The over-extraction/pollution and general disruption to groundwater systems were the focal environmental issues. Therefore, the SES under analysis includes aquifers, the units of water that comprise it, the related watershed and hydrological processes that determine the amount of water available, their relevant social counterparts including a diversity of users, infrastructure and governance systems.

Our general approach has its advantages and its challenges. For example, the research was not designed specifically for this purpose. While Ostrom’s flexible and comprehensive model rendered it adaptable enough for this retrospective analysis of results, there are some limitations to this. The active re-analysis of research outcomes was essential in its reinterpretation. Furthermore, this is an interdisciplinary endeavor that attempts to use different types of analytic approaches and knowledge towards a political, economic and social coalescent interpretation of the environment. This can be particularly challenging given disparate perceptions and worldviews of those involved. Scientific discourse has been intensely criticized for its dichotomous nature: culture interpretation of human environment relationships (Milton 1996). Similarly, Kottak (1999) claims that Euro-American developmentalism and environmentalism ideals challenge and marginalize ‘traditional’ ethnoecologies. Ingold’s (1992) theoretical stance is useful given its focus on the “mutual constitution of persons and environment” (40) and that with the co-formation of human-environment relations, perceptions are based on possibilities for interaction. This is particularly relevant where water is concerned, for in Balinese terms, its meaning, use and distribution is central to Balinese world views and ways of living. Therefore this is an alternative ethnoecological approach that offers a way to capture the dynamics of this mutual constitution, in a way that identifies the convergence of different ethno-ecologies, the interactions between persons and their constituted environment and the continuous transformations of these.

RESULTS: BALI’S TOURISM AND WATER SES

Water is a very mobile resource unit that is part of a dynamic system. Often inconspicuous and lacking visibility, water resources that are part of the hydrological system encompass large, ill-defined and complex watersheds, making it difficult to predict how changes in one part of the system might affect another. For example, because of the lag between the extraction of groundwater and its local and neighboring impacts, linking the extent and timescale of negative water related outcomes is difficult (Theesfold 2010). Therefore, the components of the resource system and the water units themselves are interdependently linked within a large complex process that is difficult to map, monitor and predict. In Table 1, below, we have summarized the most salient aspects of Bali’s water tourism SES, adapted from Ostrom’s (2009) SES framework.

Insert Table 1 here

Resource Users

Bali’s numerous and diverse water users were highlighted during the fieldwork through stakeholder identification (Cole 2012), including a variety of tourism related business, local

communities and households, farmers, expatriates, manufacturing industry, water companies, government actors, and tourists. Bali's population numbers 3.5 million, with 5 million tourists visiting (BPS 2012) and 25,000 migrants arriving from other islands (Bali Discovery 2010) to the region every year. The rate of change among users is significant; Bali's population is projected to increase by 32% to over 4 million by 2025 (Data Statistik Indonesia 2013) and foreign tourist arrivals by 150% between 2000 and 2025.

Accepting that the stakeholder groups are heterogeneous and there are some shared norms between the different stakeholders, largely each has their own values and requirements in relation to water. At the very basic level, water is indispensable to all users for consumption and sanitation. It is certainly critical to local households; both farming and non-farming alike, whose livelihoods and well-being rely on its availability. In Bali's highly stratified society, those in the lowest socio-economic categories are the most impacted by water inequalities, yet also have the least participation in relation to water issues. Among tourists, perspectives and values of water are entirely different, with leisure being at the forefront of water usage. For the tourism industry, it is core to the provision of services and the success of tourism related businesses; golf courses, high-end accommodation and spas can be particularly water intensive (Warren 2000, Cole 2014).

In addition, as Cole's (2012) political analysis demonstrates, there is a marked power asymmetry between these groups, which is skewed towards the tourism industry. This is a significant factor that determines infrastructural and human capacity, participation and input into institutional processes, water consumption and, ultimately, equality of water access. Whilst a large proportion of households (64%) are directly connected to the water supply, their access is still limited, as pipe pressure is low and water flows only at certain times. As one respondent explained "I have to catch drips all day, if there is no-one at home who will change the bowls over when they are full up". Typical household wells, which are hand-dug to 12 meters, are particularly prone to seasonal shortages. Contrastingly, tourism establishments can afford to have deep (60m) bored wells with electric pumps to compensate for the deficit in public infrastructure. The asymmetry in economic and power relations manifest themselves as inequity in access to water resources.

In Bali, there is a clear lack of knowledge among decision-makers and users, of the status of water resources and there is little awareness of how their water usage can be reduced through simple water saving measures. The head of the department of mining, with responsibilities for all underground water, told us that "wells were not more than 40m deep" – this data is extremely out of date – all respondents with bore wells and pumps said that it was necessary to go to 60 m to get clean water. None of the villas or guest houses were aware of or using any of the common water saving techniques except dual flush toilets. As one said, "Please come and teach us about these things (low flow showerheads, rain water collection), there is no information about this in Bali". The refusal on the part of hotels to pay public water tariffs (Kompas 2010) and to ignore metering regulations on private boreholes, demonstrates the lack of awareness that payment for water provision is essential to maintaining these very services. Finally, tourists' perceptions of local water abundance do not align with the reality of declining water availability. 90% of the tourists surveyed believed Bali has plenty of water, and 50% were very surprised when told Bali had a water crisis. Given the diversity of users present, a large proportion of whom are transient, the absence of common knowledge and awareness is an unsurprising but critically absent pre-requisite for self-organization.

Governance

Governance of water resources and important regulatory SESs is extremely inefficient in Bali for several reasons. The responsibility for water resource management falls to eleven different governance institutions, each at different levels of the Indonesian government (Cole 2012). At the most local level, the Regencies follow rules set at the Provincial level, which follows rules set

at the national level. Since 1999 Indonesia gave the Regencies autonomy, so they frequently make their own rules. “Regents, unfortunately, can and often do ignore the provincial government in important matters such as coordinating a sustainable approach to resource management and tourism development” (Reuter, 2011:64). Cooperation and communication between departments at all levels is very poor and competition for monetary resources is intense, therefore there is little concerted effort towards creating an integrated and cohesive water management plan. As one activist explained “all departments work alone, have their own plans, their own rules...”. This competition for resources has resulted in some Regencies putting tariffs on water redirected for tourism. This has created inter-institutional conflict, particularly where water resources run across more than once district. Conflicts also occur between and within villages, between those that manage the water (*Pekaseh* on behalf of the *Subak*) and the village that allows tourism development, or sell water to the bottled water refill operators.

There are numerous laws that are created by each department, without the motivation or capacity to implement them. Nearly every respondent from village to head of government departments told us that the problem is “weak law enforcement”, “lack of control over law breakers”, “regulations do not function”, “supervision is weak” or that “laws are not implemented”. This creates confusion and enables free-riding, as it is difficult to identify which rules to follow. For example, the types of permits that establishments are required to obtain are poorly defined, allowing larger and more consumptive businesses to classify themselves as small-scale ones. The absence of active monitoring, sanctions and awareness raising campaigns results in the degradation of the watershed and unregulated, un-metered extraction of water. Most tourism establishments had unregistered and un-metered wells and were not paying for all, or a proportion of their water, and claimed unawareness of the relevant laws and regulations.

Despite the widespread recognition of government disorganization and inefficiencies, relative immunity is granted by the cultural norm of collectivism, whereby authority is revered and uncontested (Erb 2000; Kling 1997; Raka 2000). There is a nascent civil society movement in Bali that has coalesced against mega developments, but the political authoritarianism of the New Order Government stifled democratic mobilization (Suasta and Connor 1999). Whilst Warren (1998) explains the apolitical orientation to result from the consequences of the 1965-1966 massacres, locals today say it is a fear of putting tourists off. “If we protest, tourists will see it on TV and will not come to Bali” a taxi driver told the researcher. The proactive local participation and collective community action needed to ensure fair governance is thus lacking in Bali.

Interactions and Outcomes

Previously heralded as a resilient SES (Lansing 2007; Andries et al. 2004), the community-led system of resource management of terraced rice farming, its farmers and the *Subak* that governs it, is in decline for numerous inter-related reasons. In common with other South East Asian countries, there is a shift away from agrarian economies. With fewer people from younger generations continuing the activities, farmers are now an aging population (Lorenzen and Lorenzen 2011). Generally speaking, farming is now difficult and unprofitable as a result of several factors. Water is increasingly limited due to diversion for tourism and rainfall has become unpredictable in recent years. Pollution in paddy fields requires that farmers allocate much more labor to clearing fields and they also increasingly suffer from skin ailments from contact with contaminated water. Farmers also reported that the overall reduction in farmland has translated to greater numbers of birds feeding on fewer fields, requiring more time being dedicated to bird scaring. Finally, land taxes are based on market value rather than use, so the rise in land prices associated with tourism has meant land taxes are unaffordable for farmers. In 2010, all Canggu farmers refused to pay land taxes as they were unaffordable, however pressure from developers to sell land creates opportunities to do so. This ultimately results in the abandonment of farming activities and facilitates the overall process of agrarian change.

Bali's traditional agriculture is being progressively marginalized in an economy dominated by tourism (MacRae, 2005). The conflict between farmers and tourism stakeholders is symptomatic of the competition for water resources between these two users. Ironically, with rice terraces being such an integral part of Bali's cultural identity, farmers reported being paid by hoteliers to continue their farming activities on land adjacent to tourism developments. Meanwhile, of the 400 rivers in Bali, 260 have run dry and water levels in Lake Buyan have also dropped significantly (Fogarty 2007).

The process involving the conversion of farmland is a significant driver behind the changes in the broader hydrological system. About 1,000ha of rice paddy are lost each year (Ministry of Culture and Tourism 2009) and has a yet unquantified impact on Bali's hydro-ecology. Furthermore, degradation of essential forest cover continues on the mountainsides. During fieldwork, hotels were found in green belt and protected areas, including a 400 room accommodation complex in a protected forest.

Despite there being restrictions on buildings occupying more than 40% of any plot, this law is rarely followed. Rather, it is misinterpreted or ignored, with other land uses, such as pavement or pools, constituting "garden space". This concretization is a further disruption to the hydrological system, with the paving of surface increasing runoff and decreasing percolation of water through the soil. The twin impacts of this are flooding in times of heavy rainfall and impaired recharge of rivers, aquifers and lakes. This misinterpretation, ignorance or ignoring of the law also applies to large amounts of green spaces; Canggu, for example, consists largely of green belt space, yet building on farmland is extensive.

As a result, farming and permanent residents are losing out in the competition for water to the more powerful and influential tourism stakeholders. Whilst tourism stakeholders have the financial resources to invest in private water infrastructure, many households cannot afford the cost of a public water connection (Strauss 2011). In other cases, the government cannot meet the high demand for a connected water supply, up to 5,000 families in Denpasar are on a waitlist (Atmodjo 2010). This leaves an unregulated gap where local households cannot access public supply. Many have to resort to purchasing water from unlicensed and unregulated refill companies, the price of which has steadily increased and in some areas reached as much as Rp50,000 (US\$5.80) per gallon. Respondents who used this water reported higher incidences of diarrhea. One woman told us that *ulat* (an Indonesian word meaning maggots, worms or larvae) are visible in this purchased water. High infant mortality associated with poor sanitation, water and environmental conditions, is still very much prevalent in Bali. There are higher rates of diarrhea (13%) than Indonesia's national average (9%) (Suriyani, 2009).

Water is being extracted from aquifers at a rate that cannot be renewed by compromised watersheds. This loss of water regulation is contributing to extremes; severe water shortages for those who rely on hand dug wells, and flooding in certain areas that cannot cope with the runoff. The lowest, most vulnerable socio-economic groups, which have the least input into the processes of water management and degradation, are also the first and most seriously impacted in terms of livelihoods, health, well-being, and in the most extreme cases, loss of life. Women, who are least involved in the decision-making processes in this highly patriarchal society, bear the greatest burden; to fetch buckets and gallons of water, to eke out minimal supplies for cooking, washing, and cleaning and to care for sick children and elderly relatives with diarrhea.

DISCUSSION

Despite not having access to water consumption data, it is not difficult to infer that the island's water resources and the water providing ecosystem services are disproportionately benefiting a small privileged sector of Bali's community. At the same time water resources are in rapid

decline, the impacts of which are causing disproportionate suffering to community groups who are less able to affect change. These outcomes are the result of the particular characteristics of and interactions between socio-ecological components. We have found a few of these to be of particular note.

The decentralization of government to the numerous Regencies has contributed to increased competition and conflict for water resources and inhibited cooperation and information sharing regarding its management. Within the governance system, there is no way to ensure that local government departments create policies and regulations congruent with each other at Bali's Provincial level. Greater autonomy has meant that Regencies have to be self-sustaining, resulting in increased competition over sources of funding. Rather than being managed as a priority for human well-being, water is becoming increasingly commoditized to the disadvantage of local communities. While Ostrom identifies autonomy (which Balinese Regencies are privileged to have) as a prerequisite to the creation of appropriate collective choice rules, these particular circumstances are not conducive to their creation. Anderies et al. point out that "*nesting a set of local institutions into a broader network of medium- to larger-scale institutions helps ensure that larger-scale problems are addressed as well as those that are smaller*" (2004, p. 18). Similarly, Cummings et al. (2006) posit that everything including physical, temporal, and functional attributes of a SES must be considered at the relevant scale. This is a strong argument for managing Bali's water resources at the Provincial level, providing the opportunity for greater cooperation and coordination within and between watersheds. While a highly decentralized government can encourage more local participation and locally appropriate governance processes, divulging too much autonomy without the recommended "nesting" within higher institutions, renders the overall governance structure unable to handle cross-boundary issues through effective (policy supported) communication and coordination.

In this vacuum of governance, tourism stakeholders take advantage of the lack of monitoring and sanctions. They are not being held accountable for the degradation of watersheds, nor are they paying for their share of groundwater extraction. Furthermore, the refusal to pay for direct, or indirect, water consumption deprives local governments of the funding that could be used to manage and maintain water bodies and watersheds i.e. the maintenance of water related ecosystem services. In Anderies et al.'s socio-ecological model (2004), infrastructure features prominently and is particularly relevant in this analysis. At one end of the scale, tourism stakeholders can afford to install their own boreholes and free-ride in terms of their water consumption, when at the other end, the water supply to local users is being neglected. Public physical infrastructure is not being sufficiently provided, with inadequate extension of services to new users, poor maintenance of that which already exists and the engineering that provides tourism stakeholders with a superior water supply. This reflects similar water related issues in other contexts, where iniquitous public services are compounded by lack of certainty of the status of shared water resources, leading to competitive over consumption (Pailla 2011). These institutional shortfalls represent a significant driver towards inequity in this SES.

Bali's tourism industry renders some unique characteristics to the Users and how they interact with other components of the SES. With 5 million international and domestic tourists and 85% of the tourism industry belonging to non-Balinese, this is representative of a SES subject to the drastic transformations associated with tourism, including a much more transient, numerous and diverse population. From a tourist perspective, experience of water shortages is highly unlikely and their experience will be far removed from the reality of local Balinese. Among the numerous and diverse users, socio-economic status is highly differentiated allowing for similarly highly differentiated consumption patterns, compounded by lack of knowledge, monitoring, regulations and ultimately free-riding. These unevenly distributed benefits (and negative impacts) are in themselves a factor inhibiting the ability for self-organization (Agrawal 2002).

The interdependence (Agrawal 2002) of users is also questionable; while the local economy is dependent on the tourism industry, there is little to institutionally, economically or socially link accountability between users. Whilst both Ostrom and Agrawal suggest that high dependence by users is a criteria that favors self-organization, other factors make this extremely unlikely: Firstly, the numerous and incongruous set of users combined with the absence of adequate governance to facilitate monitoring and knowledge sharing between them; secondly, the unequal distribution of benefits and their cultural passivity (or lack of participation); and thirdly, the lack of knowledge regarding the extent of extraction and landscape transformation. Clear knowledge of how an activity might affect the SES is identified as an important criterion for self-organization (Ostrom 2009). Whilst Users may have a clear idea of their own activity, their knowledge of others' activities in relation to resource thresholds is extremely limited. Therefore, while the resource system itself can be characterized as complex and uncertain, the number and diversity of users who poorly communicate render the SES even more unpredictable.

Bali's SES has undergone and continues to undergo a process of continuous change. This analysis is a rudimentary snapshot of the dynamic and complex inter-relational socio-ecological and physical processes, which have already taken place to reach the current outcomes (See Table 1). It is clear that Bali parallels many other coastal island destinations where the tourism industry is a significant driver of change in fragile SESs, contributing to the erosion of its resilience (Adger 2005). With the declining availability of water resources, and the government's limited ability to provide a reliable water service, this alludes to an obvious vulnerability, particularly given predictions of delayed monsoons and reduced annual precipitation as a result of climate change (Adger et al. 2005; Naylor et al. 2006). Furthermore, the adaptive management that confers resilience in complex unpredictable systems (Pollard and du Toit 2011) is conspicuously absent in Bali's tourism and water nexus. While there are obvious signs that Bali's water resources are overstretched (falling water tables, reduced surface flow, water pollution, lost forest cover) there is no feedback loop in its institutional structures to create an appropriate response amongst Users or Governance groups.

CONCLUSIONS

As demonstrated from the above reinterpretation, the socio-ecological conceptual model can be practical for analyzing how tourism and broader socio-ecological features can affect water equality in a popular tourism destination. In the course of this paper, we have undertaken several important theoretical goals. From a tourism perspective, we have explored a novel way of analyzing sustainability issues. SES theory by nature doesn't allow for the subscription to over-simplistic measures of tourism sustainability, such as carrying capacity and limitations to the industry's growth. Rather it takes a nuanced approach to look at the multifaceted causes and consequences of tourism in the contextual circumstances within which it is constrained. It is an approach that promotes multidisciplinary analysis to examine what are in fact complex layers of contexts, actions and outcomes. From a SES perspective, we have begun to explore a new niche. This experimentation demonstrates the adaptability of the model to circumstances where issues of resource sustainability are notoriously difficult to analyse. Moreover, with the aid of well-established rules in CPR theory, we have identified several prominent characteristics of Bali's water and tourism SES that render it a particularly challenging system in which to foster cooperative action towards successful resource management.

In this particular analysis there were several SES characteristics of note. One is that the transience and fluctuation of resource users associated with tourism cannot be underestimated. Too many of Bali's water users are tourists and tourism investors/developers who can be said to consume water resources, but are not directly affected by water shortages. Added to Bali's already highly stratified society, its water users are too numerous and too diverse to allow for

effective and efficient communication and cooperation. In addition to limited knowledge of the ecology and availability of the Resource Units, this further impedes successful CPR management. A disproportionate number of Bali's water users are neither aware of water problems, nor is there sufficient institutional monitoring to gauge the extent of the water extraction and associated ecological change. The diversity and number of users who inter-communicate poorly are unaware of their cumulative impact on the Resource System. Without the relevant knowledge, it is extremely difficult for users to self regulate at the individual, community and regional levels. As identified by numerous other CPR studies, management of a particular resource must also take place at a scale appropriate to the Resource System. In Bali, the hydrological system (including catchment areas, aquifers, etc.) isn't constrained within the boundaries of Regencies, therefore management shouldn't be constrained to these autonomous institutions. What is needed is for this local decision making power to be coordinated and guided by institutions defined by the scale of the watersheds themselves.

The study has highlighted the factors that continue to inhibit Bali's SES resilience. Water flows and usage are inherently complex and unpredictable systems and the economic power of tourism compounds the uncertainty. Furthermore, cultural factors and weak governance, ineffective rule enforcement, a lack of monitoring and knowledge sharing, are combined with a diversity of User groups, many of which are transitory, to create an unstable and unsustainable SES. Moreover, there is a lack of feedback loops necessary for adaptive management.

This analysis has been the first step towards tailoring Ostrom's general framework for SES to examine water inequalities in tourism destinations. However, with this analysis being the first of its kind, it is difficult to form recommendations and conclusions on this study alone. Bali is certainly not unique in its experiences of mass tourism and water inequity. Furthermore other issues not mentioned here certainly affect water equality, for example pollution, water quality and sanitation (Nobel et al. 2012). It will therefore be essential to compare similar case studies in different countries, to explore the processes and outcomes taking shape and refine this SES model. This comparison would allow a more confident and rigorous analyses of similar focal SESs.

In this paper, we have begun to develop a preliminary conceptual framework. From this foundation, we will build on with more case study analyses in order to identify similar or divergent issues. This framework is certainly not intended to compete with the vast literature on water management or resource management in tourism destinations, but is intended as a further step towards a more holistic approach, with the integration of institutional, ecological and cultural components into the analysis of water and tourism disciplines.

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