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ORIGINAL ARTICLE

Sustainability assessment of water governance alternatives: the case of Guanacaste Costa Rica

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Abstract Many new forms of water governance are emerging in response to economic and social needs and wants, as well as water-related problems such as scarcity, injustice, and conflict. However, there is little evidence on how sustainable these governance regimes are, which would be critical for making progress toward sustainable and just water governance. In this article, we present the results of a transdisciplinary multi-criteria sustainability assessment of alternative governance regimes for Guanacaste Province, Costa Rica. The assessment specifies differences between sustainable and unsustainable governance regimes, while also pinpointing how the current water governance regime performs in comparison to those alternatives. The findings indicate that those governance regimes with just and deliberative stakeholder involvement, secure groundwater reserves, and healthy dry tropical ecosystems were considered sustainable and just. In contrast, the current state of water governance was found to be at high risk of digressing toward unsustainable systems where rural communities lack rights and influence, where economies favor agro-industry and high impact tourism at the expense of rural livelihoods, and where water scarcity overwhelms weak governance. This assessment study clarifies water sustainability goals, asserts the need for transformational change, and offers a pragmatic foundation for actions toward sustainable water governance.

Keywords Sustainability assessment · Multi-criteria decision analysis · Scenarios · Community planning · Water justice · Central America

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Introduction

Sustainable water governance is a deliberative process that coordinates stakeholders' water-related activities in a way that ensures sufficient and equitable levels of social and economic well-being without compromising the integrity of life-supporting ecosystems (Wiek and Larson 2012). In other words, sustainable water governance is a process that guides people's efforts toward achieving water sustainability and justice goals. Previous research has identified general features of sustainable water governance (Rogers and Hall 2003; Pahl-Wostl et al. 2010; Wiek and Larson 2012) and assessed the (un-)sustainability of current water governance regimes (e.g., Larson et al. 2013; Kuzdas et al. 2014; Schneider et al. 2014).

In contrast to sustainable water governance ideals, in places such as rural Central America, ineffective governance has been found to be a root cause of many persistent

water problems (Kuzdas et al. 2015a). These water problems include harmful water conflicts, political and economic exclusion, and unjust water allocations (Kuzdas et al. 2015b). In response to such persistent water problems, as well as people's social and economic needs and wants, many different forms of water governance are being implemented in regions around the world. While previous research suggests that the gaps between *current* water governance and *sustainable* water governance are significant, we still lack specific understanding of how sustainable such alternative ways of governing water might be. This evidence is important for making progress toward sustainable and just water governance.

In Guanacaste Province in Costa Rica, for example, Kuzdas and Wiek (2014) identified a set of distinct governance regimes that are plausible alternatives to the current state in a participatory study with numerous stakeholder groups. However, there is little evidence on how *sustainable* these alternative governance regimes actually are and how they compare to the current state. Therefore, in this article, we assess the sustainability of those alternatives in comparison to each other and in comparison to the current water governance regime. We ask the following research questions:

- How do plausible governance regimes that are alternatives to the current state of water governance in Guanacaste Province perform based on accepted criteria of sustainability? How does the current state of water governance perform in comparison to those alternatives?
- What are the main gaps between sustainable and unsustainable governance regimes?

We adopted a transdisciplinary multi-criteria assessment approach to address these questions. This study offers a foundation for taking coordinated action toward sustainable water governance, while actively avoiding undesirable alternatives (Wiek et al. 2012; Kuzdas et al. 2014). Insights from this study are also useful for other regions facing similar challenges and pursuing similar transition efforts.

Case study background: water governance in Guanacaste Province, Costa Rica

Guanacaste Province, Costa Rica (Fig. 1), as well as the rest of Central America, has experienced rapid political and socioeconomic change in recent decades (Barten et al. 2002; Casas-Zamora 2011). From 1950 to 2011, Guanacaste's population increased nearly fivefold, to about 325,000 (INEC 2011). To meet the needs of this growing population, the Costa Rican government expanded significantly starting

Fig. 1 Guanacaste Province, Costa Rica

in the 1950s (Edelman 1999, p70; Booth et al. 2010). Many current water-related public organizations, including the Environment, Energy, and Telecommunications Ministry (*Ministerio de Ambiente*, *Energía*, *y Telecomunicaciones*, MINAET), were created and granted water management authority during this time. According to the constitutional law (Article 50), citizens have a right to a healthy environment. Water law in Costa Rica also prohibits private ownership of water resources. Consequently, most formal authority to govern water remains with the state (Rogers 2002). In rural areas, agencies such as the water utility (the Costa Rican Institute of Pipes and Sewers—*Instituto Costarricense de Acueductos y Alcantarillados*, AyA) often lack the capacity to meet water management responsibilities. In these cases, communities may organize co-managed rural drinking water associations that legally source and deliver water and collect water-user fees. Rough estimates suggest that over a thousand of these associations, known by their Spanish acronym ASADAs, are operating in the country (Madrigal et al. 2011).

Prior to the 1980s, many Guanacaste communities viewed the national government as a supporter of rural livelihoods. After the World Bank structural adjustment programs of the 1980s and 1990s, which resulted in reduced state presence and lowered public investments in rural Guanacaste, Edelman (1999) found widespread feelings of disengagement with the state among citizens. This shift in citizen attitudes was an important driver of organized farmer resistance toward the state in the 1980s (Edelman 1999). Much of this resistance originated in Guanacaste, with the Municipality of Nicoya being a stronghold. Decades of state-led neoliberal economic reforms have more recently facilitated a real estate boom in Guanacaste (from roughly 2000 to 2008), which has increased demands on water resources in the region. Today, agriculture and tourism continue to expand (Ramírez-Cover 2007; Warner et al. 2015) in a context where drier climatic conditions are expected in the near future (Anderson et al.

2008). Nicoya remains a hub for collective action in Guanacaste. Many collective efforts related to water in Nicoya involve the Commission for the Management of the Potrero-Caimital Watersheds (*Comisión para el Manejo de las Cuencas Potrero-Caimital*, PC Commission). Because of Nicoya's historical and cultural importance and its active stakeholder networks, it was selected as the primary base for this study.

Overview of the water governance alternatives (scenarios) for Guanacaste Province

We briefly summarize here the main content of the five water governance alternatives (scenarios) for Guanacaste (Kuzdas and Wiek 2014, pp. 185–190), which are being assessed below (the alternatives are also outlined in Table 1, which is discussed further in the "Research approach" section below). A variety of stakeholder groups in the region were involved in the development of these alternatives (see Kuzdas and Wiek 2014).

Alternative #1: "*Mandated to prepare*" shows a centrally controlled water governance scheme that aims to secure rural community well-being. With people trusting the government (i.e., high legitimacy) and few water problems that challenge the governance regime (i.e., less competition, water supplies are not decreasing), this type of governance scheme is able to successfully avoid harmful conflicts. Content in Alternative #1 included stories that were reminiscent of the early years of Costa Rican progressive democracy (prior to the 1980s). These years saw a far-reaching presence of a state government that sought to support rural, smallholder farmer lifestyles often through top-down mandates. In *Alternative #2*: "*Closed-door alliances*", ineffective water governance drives escalated conflict, environmental decline, and unjust water access schemes. In contrast to Alternative #5, escalated conflict here is due to the governance regime itself (rather than a challenging context). Some governance actors in this alternative take actions against the interest of rural communities. Content in Alternative #2 includes storylines that portray 'closed-door alliances' of government agencies, developers, and investors—reminiscent of recent Guanacaste water conflicts.

In *Alternative #3*: "*Responsive and engaged*" effective civil democracy, active regional leadership, and open decision-making processes positively reinforce each other. These governance drivers also facilitate legitimacy (e.g., people trust water governance) that in turn helps to promote accountability, which is conducive for improving water system knowledge and thus groundwater security. *Alternative #4*: "*Unnoticed in the background*" demonstrates how very efficient water infrastructure, combined with a low water allocation priority for ecosystems, allows for rapid economic growth. Alternative #4 depicts rapid population growth, well-maintained water infrastructure, and accessible good-quality water. These features allow for an economically prosperous situation that requires trade-offs that include a decline of natural systems and a less active or more apathetic role for environmental and civil society organizations (such as the PC Commission). In *Alternative #5*: "*Overwhelmed and out of touch*", the governing context (i.e., competition, poor water quality, dry conditions, etc.) overwhelms weaker governance schemes that lack leadership, accountability mechanisms, accessible decision-making, and civil engagement. This overwhelming situation that also features drier climates and unjust water access schemes curtails the prosperity for all but a few. Water governance that is overwhelmed by the challenges that it faces distinguishes Alternative #5.

Research approach

The assessment study presented here was embedded in a transformational research approach (Wiek et al. 2012). According to this approach, we first analyzed and assessed the current governance regime in Guanacaste (Kuzdas et al. 2014, 2015a). Then, based on the current state analysis, we constructed the alternative governance scenarios that are briefly introduced above (Kuzdas and Wiek 2014). Next, we assessed the sustainability of those alternatives (scenarios), in comparison to each other and in comparison to the current state, which is presented below. Here, we combine perspectives from a sustainability assessment of the current state (i.e., Kuzdas et al. 2014) with perspectives from sustainability assessments of future or alternative states (i.e., Schneider and Rist 2014). To do that, in addition to comparing the sustainability of water governance alternatives, we also pinpoint how the current state of water governance performs in relation to those alternatives. As a final step in this transformational research approach, we explored transition strategies that incorporated insights from all previous studies (cf. Kuzdas et al. 2013).

In the assessment study presented here, we adopted a multi-criteria decision analysis (MCDA) methodology. MCDA allows for a formal exploration of stakeholder's preferences for alternative ways of governing water, while also accounting for sustainability criteria. Contemporary MCDA applications typically emphasize stakeholder dialog and transparency (Munda 2004; Proctor and Drechsler 2006). A variety of MCDA applications have been used to address both general environmental problems (Lahdelma et al. 2000; Kiker et al. 2005) and water problems specifically (Messner et al. 2006). In some cases, MCDA has

Table 1 Comparing the content of water governance alternatives, including the assigned indicator values in each alternative

	Alternative #1	Alternative #2	Alternative #3	Alternative #4	Alternative #5
Title	Mandated to prepare	Closed-door alliances	Responsive and engaged	Unnoticed in the background	Overwhelmed and out of touch
Theme	Cautious	Deception	Innovation	Apathy	Disconnection
How water governance operates	Agency-led/top-down implemented mandate to prepare for water scarcity and secure rural communities vulnerable to climate change	Governance is dominated by unaccountable alliances of government agencies, developers, and investors; backdoor dealings are common	Responsive governance emphasizes local autonomy, coordination, and fit of policies, plans, and development to the dry tropical Guanacaste context	Governance deals with citizen apathy and environmental risk while staying out of the way of economic prosperity	Overwhelmed governance is out of touch with regional challenges while elites multiply landholdings in Guanacaste
Distinctive features	A highly controlled governance scheme that has the trust of local communities and avoids water conflict due to more accommodating contexts where scarcity and resource competition are not prevalent	Governance caters to interest-based alliances from outside of Guanacaste that intentionally circumvent due processes for water management/ development and that overlook rural rights and interests	Open, responsive, and deliberative water governance allows people to successfully navigate climate change impacts and avoid water conflicts	Efficient and technical water management buffers from risk; less active environmental leadership allows water governance to operate without public interest and without proper consideration of environmental issues	A challenging context of severe water scarcity overwhelms weak governance schemes that are poorly adapted to regional contexts and that are disconnected from local groups
Storyline	The ever-present nature of the central government	Organized community opposition, resistance	Problem solving, confidence, trying new ideas	Economic progress, technical water management, failed demand management	The return of the *Latifundio*, power imbalances, water politics, power politics
Indicator values in alternatives					
1A	4 (very healthy)	2 (degraded)	3 (healthy)	2 (degraded)	2 (degraded)
1B	30 % natural forest cover	40 % natural forest cover	30 % natural forest cover	20 % natural forest cover	10 % natural forest cover
1C	1 (low risk)	2 (medium risk)	1 (low risk)	2 (medium risk)	3 (high risk)
2A	4 (very efficient)	2 (inefficient for many)	3 (efficient)	4 (very efficient)	2 (inefficient for many)
2B	3 (recharge exceeds extraction)	1 (unknown)	3 (recharge exceeds extraction)	2 (extraction exceeds recharge)	2 (extraction exceeds recharge)
3A	40,000 Ha	35,000 Ha	50,000 Ha	70,000 Ha	90,000 Ha
3B	4 (balanced mix)	3 (more small farms than industrial farms)	4 (balanced mix)	2 (mixed, but small farms find it difficult to compete)	1 (nearly all farms are industrial farms)
3C	$35 million	$80 million	$25 million	$40 million	$7 million
3D	3 (important for a diverse economy)	2 (the economy depends on tourism)	3 (important for a diverse economy)	3 (important for a diverse economy)	1 (tourism is not important)
4A	2 (sometimes open)	1 (closed)	3 (open)	2 (sometimes open)	1 (closed)
4B	2 (centralized)	2 (centralized)	3 (polycentric)	1 (fragmented)	1 (fragmented)
5A	3 (fair)	1 (unfair)	3 (fair)	2 (sometimes fair)	1 (unfair)
6A	2 (somewhat effective)	1 (ineffective)	3 (effective)	2 (somewhat effective)	1 (ineffective)
7A	3 (many decisions)	1 (no decisions)	3 (many decisions)	1 (no decisions)	1 (no decisions)
7B	3 (somewhat easy for some)	2 (difficult)	4 (easy enough)	2 (difficult)	1 (nearly impossible)

been combined with other methods, such as scenarios or system analysis (Straton et al. 2011; Bausch et al. 2014).

The MCDA application in this assessment has two important features. First, we integrated *comprehensive sustainability principles* into the assessment to ensure consideration of key normative social issues such as intra and inter-generational equity in addition to technical or environmental criteria (Gibson 2006; Sheate et al. 2008;

Binder et al. 2010). Using comprehensive sustainability principles as a basis to select criteria is fundamental to sustainability assessment methods (Ness et al. 2007). Secondly, we used *systemic governance alternatives* that contained consistent cause and effect structures. Alternatives that make logical sense allow people to easily understand and compare those alternatives with each other and with the current state (Wiek et al. 2009).

Previous research in the region that vetted sustainability principles with stakeholders was the foundation for the selection of indicators for this assessment (i.e., Kuzdas et al. 2014). Local stakeholders were already using the results of that previous research and the associated sustainability principles, which afforded us, as researchers, the trust of and credibility with stakeholders. As a first step to this assessment, we worked with members of the PC Commission to select 15 indicators in two iterative working group meetings. At the time, members of the PC Commission included representatives from government agencies, the Municipality of Nicoya, ASADAs, agriculture, and a local university. To avoid bias in selecting indicators, we first used the sustainability principles originally developed in Gibson (2006) (and later specified for assessing water governance regimes in Wiek and Larson 2012) as a reference to ensure that all relevant aspects of sustainability were accounted for (i.e., Binder et al. 2010). We then used previous research, which clarified water problems in the region (i.e., Kuzdas et al. 2014) to help narrow the initial selection of indicators to a number that was feasible to work with in a workshop setting (see discussion of linking current state research with studies of alternatives in Wiek and Lang 2015). Due to the regional- and community-level composition of stakeholders who participated in the indicator selection process, the selected indicators are best suited for assessing water governance at this level. This supports the study's practical purpose to serve as a tangible foundation for action at the community level. Table 2 summarizes the research steps and who was involved.

Final indicators were selected to promote transparent deliberation over key challenges for water governance (Gasparatos et al. 2008), and they accounted for water governance and its outcomes *regionally*. Indicators were meant to encourage participants (in the subsequent workshop) to consider what different indicator values could mean for their particular community.

We then defined indicator *values* for each of the five governance alternatives (Kuzdas and Wiek 2014) presented above ["Overview of the water governance alternatives (scenarios) for Guanacaste Province"]. Indicators were assigned a value for each of the alternatives in two working group meetings with the PC Commission (see Table 1). The assigned indicator values reflect "what is going on" in a given alternative. Indicator values for the *current state* of water governance in the region were also finalized in this process. Overall, the selection of indicators and defining indicator values for each alternative helped ensure that the *decision problem* was properly structured for the MCDA (Hajkowicz and Higgins 2008).

We used a compromise-programming algorithm to formally identify and compare how well each alternative performed against accepted sustainability criteria. The algorithm was written by Straton et al. (2011), who modified the original equation proposed by Zeleny (1973). The functional form of the algorithm is:

$$u_j = \left[\sum_{i-1}^{m} wi \left(1 - \frac{f_i^+ - f_{ij}}{f_i^+ - f_i^-} \right)^c \right]^{1/c},$$

where f_{ij} is the value of indicator i in alternative j; f_i^+ is the best value (sustainability target) for indicator i; f_i^- is the worst value (farthest from the sustainability target) for indicator i; wi is the weight for indicator i and is based on the rank of indicator importance, highest possible weight (dependent on the number of indicators being used), and a normalized value of c; m is the number of indicators; c is a parameter that reflects the importance of the distance from the sustainability threshold (which in this case we left at one for all indicators, so that all deviations from the most sustainable values are weighted equally); and u_j is the resulting utility score of an alternative state j.

The utility score (u_j) indicates how close an alternative is to being ideal and sustainable, with a 1.00 utility score being the most preferable/sustainable and a 0.00 utility score being the least preferable/least sustainable. The algorithm assumes that the distance between indicators' actual values and their ideal values determines stakeholder's preferences for alternatives. We used the term *sustainability targets* in this assessment to refer to the value or range of values (of the indicators) that could be considered ideal and sustainable (cf. Wiek and Binder 2005). This helped frame the deliberation. This equation allows for simple visual comparisons of results using a pre-built spreadsheet and spider diagrams. This simplicity helped us to effectively communicate the assessment in workshop settings in rural Guanacaste without ready access to advanced computer programs and equipment. We included the current state in the MCDA as one of the 'alternatives.' This allows for formal comparison of the assessed alternatives with the assessed current state.

In March 2013, we convened 46 participants for a stakeholder workshop in Nicoya. Participants were mostly senior representatives from local governments, national agencies, agricultural and tourism organizations, universities, community groups, and environmental groups. Participants included community leaders, agency directors and

Table 2 Summary of methods and who participated

Step	Participatory component	# Of participants	Participating organizations
Current state assessment[a,b]	Results finalized and distributed, March–April 2012	5	PC Commission
Scenario analysis[c]	Scenario building March 2012–March 2013	46	Environment Ministry branches, Environmental NGOs, PC Commission, Agriculture Associations, Universidad Nacional, ASADAs, Timber Business
Selecting indicators/ preparation	Working group meetings Jan–March 2013	5	PC Commission
Specifying indicator values for alternatives	Working group meetings Jan–March 2013	5	PC Commission
Assessment of alternatives	Workshop, March 2013 1. Ranking indicators 2. Selecting/justifying sustainability thresholds 3. Group deliberation	46	PC Commission, 6 agencies (Environment Ministry, Health Ministry, Agriculture Ministry, AyA, Irrigation (SENARA-Cañas/SENARA-San José), Education Ministry), ASADAs (11), universities, tourism associations, agriculture associations, municipal governments, community groups, environmental groups
Follow-up and post-assessment activities	Workshop (transition strategy building)[d] March 2013	46	Same as above
	Meetings April 2013/Aug 2013–May 2014 (monthly)	5	PC Commission
	Distribution of workshop results in region Aug–Oct 2013	5	PC Commission
	Interviews August 2013–Feb 2014	10	ASADAs, Environment Ministry, Community development associations, AyA, Environmental NGOs, PC Commission

[a] See Kuzdas et al. (2014) for details on the normative water governance assessment

[b] See Kuzdas et al. (2015a) for details on the water governance analysis

[c] See Kuzdas and Wiek (2014) for details on the scenario analysis

[d] See Kuzdas et al. (2013) for a summary of building transition strategies

managers, elected rural water administrators, scientists, and a local media representative. We invited participants based on previous research, which had identified key actors in the region, and in consultation with the PC Commission. Over 30 organizations and 18 communities (Guanacaste cities or towns) were represented. We organized the all-day workshop into three modules. The first module engaged participants with an introduction to the water governance alternatives and primed them to begin considering alternatives for water governance beyond the current state (Kuzdas and Wiek 2014). In the second module, which we present in this paper, participants assessed the alternatives. In the third module, participants developed action plans to transition toward sustainability targets in a process that was fitted to the results of the assessment module (Kuzdas et al. 2013). This third module included small group deliberations following a structured procedure to deliberate needed actions, leaders, the assets needed to act, expected barriers to success, and actions that could help overcome barriers.

After reviewing the indicators as a single group (at the beginning of the second module), workshop participants individually ranked the indicators according to their perceived importance for sustainable water governance in Guanacaste. Although many participants had already participated in the broader research project and were familiar with water governance and sustainability concepts, we reviewed the definition and principles for sustainable water governance with the group prior to the ranking. Instructional materials that defined sustainable water governance summarized the sustainability principles (used in previous research), and those that provided an overview of the broader project were also distributed to participants before the workshop. The average rankings from this initial activity helped determine the relative importance of each indicator, as viewed by workshop participants, for sustainable water governance. This step occurred immediately after the first workshop module so that the alternatives were fresh in participants' minds.

Fig. 2 Workshop participants worked in facilitated subgroups to identify and justify the sustainability targets for the indicators

While a group of researchers tabulated the indicator rankings, participants re-assembled into seven subgroups of six to seven people to deliberate, identify, and justify sustainability targets for each indicator (Fig. 2). We divided participants into diverse subgroups such that agency staff were mixed in with ASADA staff, private sector representatives, scientists, etc., while also considering the seniority of individual participants. A trained facilitator ensured constructive deliberation and a note taker documented the discussions of each subgroup. Two lead facilitators from the research team roamed and offered support when needed. The subgroups were free to discuss and modify pre-assigned indicator values for the current state. While some MCDA studies have focused more on how different people rank indicators (i.e., Stanton et al. 2011), in this application we focused more on the deliberation and identification of sustainability targets, which was in line with objectives and context needs. Following the subgroup work, we re-convened the larger group to discuss consensus on the indictor ranking and sustainability targets. With this larger group, we facilitated a discussion on the sustainability of each alternative in comparison to the current state and what people might do to address the differences. This final discussion prepared participants for the third module where they returned to their subgroups to develop action plans for transitioning toward more sustainable alternatives (Kuzdas et al. 2013).

Results[1]

Selected indicators and their values in the alternative governance regimes

For *Principle #1*: *Socio-ecological system integrity*, three indicators (1A–C) capture the general quality of relevant parts of environmental systems and acceptable levels of risk to those systems. *Principle #2*: *Resource efficiency and maintenance* includes indicators (2A, B) that are related to the efficiency of water infrastructure and groundwater integrity. Guanacaste water managers often deal with poorly maintained infrastructure and have limited ability to monitor groundwater reserves. Selected indicators are listed in Table 3, organized by sustainability principles. Specified indicator values for each alternative are listed in Table 1.

Indicators in *Principle #3*: *Livelihood sufficiency and opportunity* address agriculture and tourism, which are the two most important economic drivers in Guanacaste. After debate, indicators 3A–D were determined to best represent the general composition of agriculture and tourism in the province in a way that easily compared across alternatives and that would encourage place-specific discussion. The point here was to spur deliberation about what would be needed (i.e., planning processes, resources, capacity) to define more specific goals related to water management, agriculture, and tourism in different local places in Guanacaste. *Principle #4*: *Socio-ecological civility and democratic* governance includes indicators (4A, B) related to deliberative decision-making and coordination. *Principle #5*: *Inter/intra-generational equity* includes an indicator related to the fair distribution of benefits and risks of water allocation and use. One indicator for *Principle #6*: *Interconnectivity from local to global scales* focuses on the effectiveness of regional-scale water governance to mediate between national-level agencies and local groups. *Principle #7*: *Precaution (mitigation) and adaptation* includes two indicators (7A–B) that relate to long-term planning (i.e., more than one generation) and adapting to change through the modification of water policies.

Identified sustainability targets and ranked indicators

Sustainability targets for indicators in *Principle #1*: *Socio-ecological system integrity* reflect the need for restored dry tropical hydro-ecosystems in the region, which have been historically degraded. In justifying sustainability targets for *Principle #1*, participants considered water and healthy environments as a basic human right. For example, one subgroup concluded that risk to water quantity and quality should be low because, "…water is a basic need and is vital for life." Targeted values for indicators in *Principle #2*: *Resource efficiency and maintenance* were determined to be the highest levels of rural water infrastructure efficiency and groundwater protection. Participants noted the importance of these targets given the uncertain nature of many rural water supplies and the water-scarce, drought-prone context of the region. For example, one subgroup

[1] All quotations are originally in Spanish and translated into English by the authors. Parenthesized texts within quotations are clarifications inserted by the authors.

Table 3 Sustainability principles, indicators, their definitions, and defined value ranges

Principle	Indicator		Range of indicator values
Principle #1: Socio-ecological system integrity	1A	Condition and quality of freshwater habitat and species*,^	1–5 (5 = unaltered; 3 = healthy; 1 = completely degraded)
	1B	Condition and quality of terrestrial habitat (% native forest cover)+,*	1–100 % of land covered by natural forest
	1C	Risks to water quantity and quality+,*,^	1–3 (1 = low risk, 2 = medium risk, 3 = high risk)
Principle #2: Resource efficiency and maintenance	2A	Efficiency of water infrastructure+,*	1–5 (5 = most efficient, 1 = least efficient)
	2B	Balance of extraction and recharge of groundwater+,*	1–3 (3 = recharge exceeds extraction; 2 = extraction exceeds recharge; 1 = unknown)
Principle #3: Livelihood sufficiency and opportunity	3A	Hectares of irrigated agriculture+,^	0–100,000 Ha
	3B	Mix of small and large (industrial) farms*,^	1–4 (4 = balanced and competitive mix; 3 = substantially more small farms than large or industrial farms; 2 = mixed, but small farms find it difficult to compete with larger farms; 1 = nearly all farms are large or industrial)
	3C	State of tourism real estate market^	0–$100 million in foreign real estate purchases (residential tourism only)
	3D	An economy based on tourism^	1–3 (3 = important for a diverse economy; 2 = very important, the economy is dependent on tourism; 1 = not important)
Principle #4: Socio-ecological civility and democratic governance	4A	The accessibility and transparency of decision-making for water resources+,*,^	1–3 (3 = open; 2 = sometimes open; 1 = closed)
	4B	The extent of coordination in the management and planning of water resources+,*,^	1–3 (3 = polycentric; 2 = centralized; 1 = fragmented)
Principle #5: Inter/intra-generational equity	5A	The distribution of benefits, costs, and risks among stakeholders+,*,^	1–3 (3 = fair, 2 = sometimes fair; 1 = unfair)
Principle #6: Interconnectivity from local to global scales	6A	The effectiveness and legitimacy of the basin and regional scale of water governance+,*,^	1–3 (3 = effective; 2 = somewhat effective; 1 = ineffective)
Principle #7: Precaution (mitigation) and adaptability	7A	Decisions based on long-term (20+ years) planning horizons*,^	1–3 (3 = Many decisions; 2 = some decisions; 1 = no decisions)
	7B	The ease of modifying water policy and planning processes to meet changing needs and priorities+,*,^	1–5 (5 = very easy 1 = nearly impossible)

Sources for each indicator are indicated by +(scenario analysis/building in Kuzdas and Wiek 2014); * (assessment of current water governance in Kuzdas et al. 2014, 2015a); and ^(water conflict case studies in Kuzdas et al. 2015b)

noted, "There is a (current) deficiency in ASADAs ability to manage infrastructure, and studies about aquifer recharge and capacity are very far behind." Another subgroup also noted the high importance of stable groundwater reserves and concluded, "You can't spend what you don't have."

Indicators for *Principle #3*: *Livelihood sufficiency and opportunity* served as discussion points on what different indicator values mean for different local areas. Some participants felt the real estate market in their area was, "Out of control and subject to shady business deals." Other participants commented that, "Investment represents employment and development, but investment must be balanced and sustainable with the environment and community needs." In response to this comment, another ASADA representative from near the coast stated: "There are no established regional planning processes to define goals or development needs. Decisions [made by agencies] are not coordinated with ASADAs or community groups, so development might not fit with sustainable development or local community needs." All subgroups, including those with managers of the 28,000 ha^2 Arenal-Tempisque Irrigation District (*Distrito de Riego Arenal-Tempisque*, DRAT) in Guanacaste, the largest irrigation district in Central America, reached a consensus that "significantly more small farms than large industrial farms" would be more of a target, even more so than "a balanced and competitive mix" of small and large farms (indicator 3B). Smallholder farming, participants noted, is still a strong and a valued part of *Guanacasteco* culture.

Participants agreed that tourism was important for the region, but many community leaders were skeptical of widespread foreign real estate speculation and large-scale residential tourism due to their uncertain impacts on local water systems. This skepticism was due at least in part to visible water conflicts over tourism development and lacking transparency in development planning, which has fostered credibility issues over claims of sufficient water for new development. Although our focus in this assessment was on water issues, participants also brought up socioeconomic issues (e.g., low tourism industry wages, loss of land, increased prices) faced by some local communities that are close to these developments. Although we included targets related to regional agriculture and tourism in the formal assessment process, the point was not to fully define those specific targets, but to use those agriculture and tourism assessment components as a starting point to channel deliberation toward discussing those governance processes that could better deliberate and fairly address water development issues.

Well-coordinated governance where decisions were openly deliberated comprise the sustainability targets within *Principle #4*: *Socio-ecological civility*. Participants commented that, to be sustainable, governance must include mechanisms that meaningfully engage rural groups. For example, one subgroup noted, "When there is no communication (with local groups), communities end up being harmed." Participants in another subgroup concluded that "Sustainability depends on local water system capacity, so open and transparent negotiation processes that include local communities are very important." Another subgroup emphasized, "*Real* participation by rural groups" is an effort to differentiate from the unorganized participation schemes in water management and development that are common in the current state.

Participants unanimously identified just and fair distribution of water, its benefits and risks, as the targets for the indicator within *Principle #5*: *Inter/intra-generational equity*. For example, one subgroup noted that, "Because water is needed by all life, its distribution and allocation should be just." To achieve just water distribution in rural Guanacaste, participants saw effective and legitimate basin-level management as a key target within *Principle #6*: *Interconnectivity from local to global scales*. In the words of one subgroup: "Legitimate basin-level management helps ensure communities have a voice about how their water is managed." It was widely accepted among participants that climate change impacts were already being felt in the region. Accordingly, targets for *Principle #7*: *Precaution (mitigation) and adaptation* reflect the importance of long-term perspectives in water management and development. They also reflect the need for more flexible water policy frameworks—which have largely not changed in over half a century in Costa Rica—and for water management and development that accounts for local experiences, challenges, and context. To explain this need in comparison to the current state, one subgroup noted, "Right now there are three projects [new proposed laws or policy modifications] referencing water that have been stalled for 6 years in the [national legislative] assembly." Table 4 compares the identified sustainability targets with indicator values in the current state.

Standard deviations of the indicator rankings indicate that the relatively highest overall agreement (e.g., lower standard deviation scores) occurred with the most important (#1–5) and least important (#11–15) ranked indicators (Table 5). There was slightly more deviation within the middle ranked indicators (#6–10). Participants ranked indicators from *Principle #4*: *Socio-ecological civility and democratic governance* as #1 and #2, followed by indicator *2B*: *Balance of groundwater extraction and recharge* as #3. Indicators ranked in the top third (#1–5) were viewed by participants as very important and interlinked components of sustainable water governance in the region. For example, open and democratic decision-making (4A, B) should involve currently excluded rural groups which typically rely on vulnerable groundwater reserves (4A, 7B). Demand-side management and water conservation were deemed important to address currently taxed and poorly understood groundwater reserves, since there are limited options to expand supplies in many rural areas (2B). Flexible and responsive planning processes in water management are needed to meet the needs of a rural and semi-arid region in a climate change context where diverse groups rely on groundwater (6A, 7B). Moderately ranked indicators (#6–10) include key outcomes of water governance in the region. Many environmental (1B, C, A) and some social (5A) outcomes received this middle ranking. Economic outcomes (3A–D) were ranked in the lower third (#11–15), with tourism-related indicators occupying the two lowest positions.

Assessed water governance alternatives

Alternative #1: "*Mandated to prepare*" presented a largely centralized, but legitimate, governance regime that seeks to protect rural livelihoods through top-down control, much like the early years of Costa Rica's progressive democracy (prior to structural reform in the 1980s). *Alternative #1* performs well on outcomes related to environmental quality and on prioritizing the water-related needs of rural, smallholder agricultural communities over large-scale, high-impact tourism and industrial agriculture. *Alternative #1*, however, performs only moderately with the indicators that were ranked in the top tier (#1–5), especially those within *Principle #4*: *Socio-ecological civility and*

Table 4 The current state values and the sustainability targets of indicators

Indicator	Current state	Sustainability target	Summary of justifications from the workshop
1A: Condition and quality of freshwater habitat and species	Degraded in many places; healthy in others (2 or 3)	Healthy (3)	Freshwater ecosystems must be healthy to provide a sufficient quality and quantity of water. Many freshwater ecosystems in Guanacaste are still recovering from the impacts of virtually complete deforestation in past decades
1B: Condition and quality of terrestrial habitat (% native forest cover)	25 % (officially protected areas)	40 %[a]	About 25 % of the province is currently under a high level of official protection (and does not include tree plantation cover). But, there is still a significant lack of knowledge and protection of recharge areas for groundwater reserves. Between a third to a half of natural and native forest cover concentrated around key hydrologic zones might be sufficient to adequately protect water resources in the region
1C: Risks to water quantity and quality	Medium risk (2)	Low risk (1)	High risks to water quality allow for potentially negative impacts on the health of people and ecosystems.
2A: Efficiency of water infrastructure	Some efficiency (2)	Very efficient (4)	More efficient infrastructure allows for less water that is lost or wasted during sourcing, delivery, use, and post-use. Because of the drought-prone and water-scarce context, water should not be wasted due to inefficient infrastructure.
2B: Balance of extraction and recharge of groundwater	Unknown in many places (1)	Recharge exceeds extraction (3)	Stable groundwater reserves where recharge exceeds extraction are important for maintaining sufficient levels of water security, health, and quality environments. Because many rural groups rely exclusively on groundwater for their drinking water, groundwater sources should be conserved and well managed
3A: Hectares of irrigated agriculture	40,000 Ha (DRAT + Filadelfia + a little more)	35,000 Ha[a]	In December 2012, in the irrigation system in the DRAT (28,000 Hectares), demand exceeded available water supplies. No further hectares could be serviced. Conflicts and tension resulted. With more severe water scarcity expected in the future, further expansion of irrigation may not be possible (with current supplies and currently used technologies) without experiencing increasingly negative impacts. For the purposes of the workshop exercise, and for the reasons stated above, a target of slightly fewer hectares than the current state was chosen
3B: Mix of small and large (industrial) farms	Mixed, but small farms cannot compete (2)	Substantially more small farms than large/ industrial farms (3)[a]	A balanced mix of different size farms allows diverse economic opportunities. There is a historical and cultural preference for agricultural landscapes that contain substantially more small farms. This preference is reinforced by recent health and economic concerns over smallholders abandoning independent livelihoods to work on sugar cane plantations. The original purpose of the DRAT was to promote smallholder livelihoods and increase the economic opportunities for small farmers
3C: State of tourism real estate market	$50 million in (recorded) foreign real estate purchases (2005)	No more than $25 million in foreign real estate purchases[a]	2005 was in the middle of the real estate boom in Guanacaste, during which many water conflicts occurred (estimates were not available for more recent years). Participants favored tourism that had low environmental impact and was more visitor based. Participants felt this type of tourism, if mostly small scale, would be ideal given water- and employment-related concerns. For the purposes of the workshop exercise, and for the reasons stated above, a target of about half of the investment levels during the real estate boom was chosen
3D: An economy based on tourism	Very important, many Guanacaste economies depend on it (2)	Important for a diverse economy (3)[a]	An economy that is entirely based on one sector is vulnerable to shocks. Coastal areas in Guanacaste that economically depended solely on tourism felt very difficult economic impacts during the 2008 collapse of the real estate market. Situations like that should be avoided in the future to maintain community economic well-being
4A: The accessibility and transparency of decision-making for water resources	Sometimes open, but often closed (2)	Open (3)	An open and deliberative process to take decisions (and that is accessible to rural communities and attentive to their needs) is a necessary part of governance that can help to avoid harmful water conflicts. It is also conducive to better formulating goals/a shared vision for water sustainability and water development in the region

Table 4 continued

Indicator	Current state	Sustainability target	Summary of justifications from the workshop
4B: The extent of coordination in the management and planning of water resources	Centralized and often fragmented (2)	Polycentric (3)	Multi-level, multi-organization coordination in managing water can allow different stakeholders to provide meaningful input (i.e., monitoring, sharing info, local knowledge, experiences) into governing processes. This diversity can also help increase the capacity of local water governance to mitigate harmful conflicts and secure/conserve water resources by providing multiple avenues to obtaining resources, training, building leadership, etc
5A: The distribution of benefits, costs, and risks among stakeholders	Sometimes just, sometimes not (2)	Just (3)	A few people should not benefit at the cost of many without fair and just compensation. The social processes that determine appropriate risks, compensation, and distribution of benefits related to water resources management and development should also be fair and just
6A: The effectiveness and legitimacy of the basin and regional scale of water governance	Some effectiveness (2)	Effective (3)	Different places in Guanacaste require different governance focuses and different types of efforts that are tailored to local needs and conditions. This is especially important in unique tropical dry regions that lie outside the experiences of broader governing institutions and national-level water politics that are based in the capital region, which has different hydrological, geographical, and climatic conditions
7A: Decisions based on long-term (20+ years) planning horizons	Some decisions (2)	Many decisions (3)	Decisions that anticipate future opportunities and impacts could better support efforts to avoid unsustainable water resource development and help to make progress toward more sustainable futures. Caution and long-term planning horizons are important considering the high uncertainty and potential for climate change and drought
7B: The ease of modifying water policy and planning processes to meet changing needs and priorities	Difficult (2)	Easy enough (4)	Given climate change and other quickly changing conditions (i.e., political economy, commodity markets), the ability to create new water policies and to modify existing ones is required to meet community needs and secure environmental quality

[a] The purpose of including these indicators 1B, 3A-3D was not necessarily to define 'real' sustainability targets for the entire province, as certainly many other complex factors and perspectives would need to be taken into account. These particular indicators were included in the formal assessment exercise to provide an entry point to launch discussions on challenging issues and deliberate what different indicator values could mean for different communities

democratic governance. In a climate change future combined with increasingly globalized and integrated markets, this highly controlled and top-down governance regime would be inadequate in meeting many water sustainability goals despite its historical basis and its good intentions to secure rural community well-being. *Alternative #1* is thus moderately sustainable relative to the other alternatives (Fig. 3; Table 6).

Alternative #2: "*Closed-door alliances*" performs poorly. Low scoring indicators from the top tier (#1–5) reflect the inadequacies of the water governance regime portrayed in *Alternative #2*. The negative values of these indicators are mutually reinforced: closed decision-making does not include rural interests that rely on groundwater, groundwater is over taxed, and the coordination and trust required to secure groundwater reserves used by diverse groups is not present. Participants in the workshop noted that *Alternative #2* is eerily similar to recent water conflicts in Guanacaste, where closed-door alliances of agencies, developers, and investors have taken intentional actions against the interests of rural communities. The few positively evaluated aspects of *Alternative #2* relate to an increase in natural habitat (1B) due to less emphasis on allocating water to large-scale and industrial irrigated agriculture (3A, B). *Alternative #2* is thus an unsustainable governance regime (Fig. 3; Table 6).

Alternative #3: *Responsive and engaged* performs relatively highly in terms of its sustainability due to positive (rather than negative) reinforcement among the top tier (#1–5) indicators (Table 6). This positive reinforcement leads to a governing system that features engaged rural groups and open decision-making processes. These drivers of good governance support other positively assessed aspects such as legitimacy and trust, which helps boost the capabilities of local leaders and improves accountability. Trust and accountability are conducive to improved collective knowledge of water systems and thus also groundwater

Table 5 Descriptive results from the indicator ranking activity

Indicator	Rank	Weight (w_i)	Mean rank	Standard deviation	Median
1A: Condition and quality of freshwater habitat and species	9	0.037	8.06	3.73	9
1B: Condition and quality of terrestrial habitat (% native forest cover)	6	0.042	7.19	3.28	7.5
1C: Risks to water quantity and quality	7	0.036	8.26	4.45	7.5
2A: Efficiency of water infrastructure	10	0.033	9.08	3.56	9.5
2B: Balance of extraction and recharge of groundwater	3	0.071	4.23	3.53	3
3A: Hectares of irrigated agriculture	13	0.028	10.88	2.88	11
3B: Mix of small and large (industrial) farms	12	0.028	10.76	3.05	12
3C: State of tourism real estate market	15	0.024	12.71	3.20	15
3D: An economy based on tourism	14	0.024	12.40	2.42	13
4A: The accessibility and transparency of decision-making for water resources	2	0.075	4.00	3.10	3
4B: The extent of coordination in the management and planning of water resources	1	0.087	3.44	2.76	2.5
5A: The distribution of benefits, costs, and risks among stakeholders	8	0.035	8.65	3.07	9.5
6A: The effectiveness and legitimacy of the basin and regional scale of water governance	5	0.049	6.14	2.75	6
7A: Decisions based on long-term (20+ years) planning horizons	10	0.033	9.08	4.04	10
7B: The ease of modifying water policy and planning processes to meet changing needs and priorities	4	0.053	5.64	3.64	5

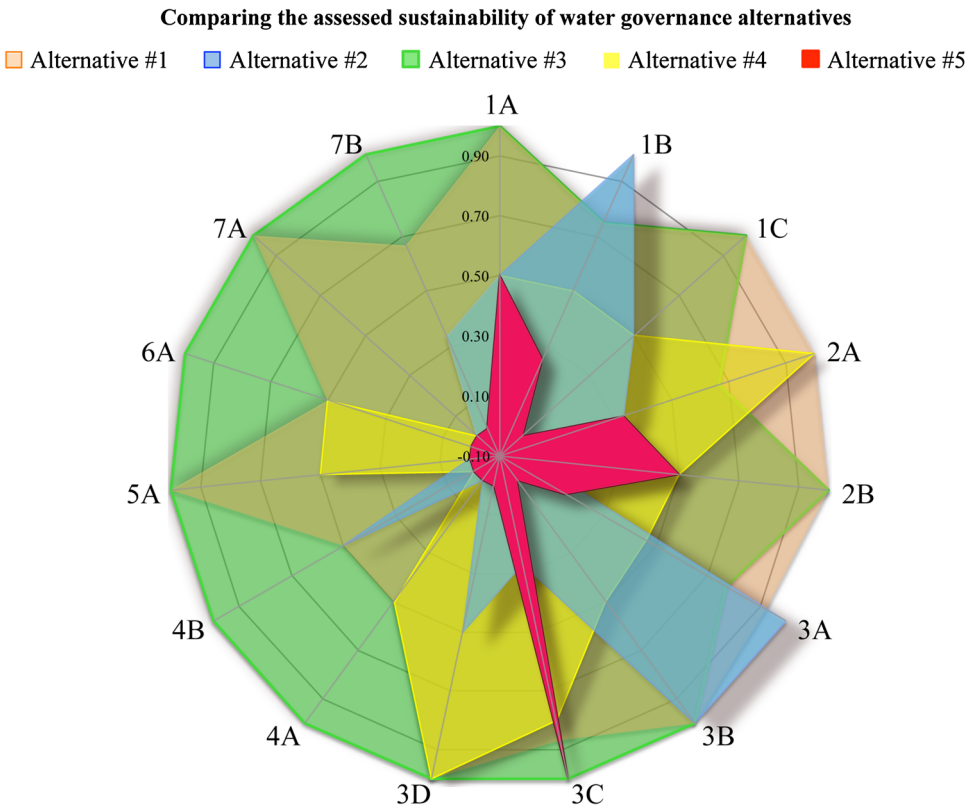

Fig. 3 Visualization of the assessed alternatives. Scale (−0.10 to 1.00) indicates distance from the identified sustainability target range. Note: the value −0.10 is included to display values of zero, which would otherwise not be visible in the diagram

security. Due to the challenging water-scarce context found in *Alternative #3*, some mid-tier indicators (rank #6–10) dealing with environmental outcomes perform moderately. *Alternative #3* is a relatively sustainable governance regime that effectively mitigates harmful conflict despite a challenging climate change context (Fig. 3; Table 6).

Alternative #4: *Unnoticed in the background* is a moderate- to low-performing governance regime. *Alternative*

Table 6 Resulting utility scores of alternatives and the current state

Position	Governance alternative	Utility score
#1	Scenario 3: Responsive and engaged	0.62
#2	Scenario 1: Mandated to prepare	0.52
#3	Scenario 4: Unnoticed in the background	0.29
#4	Scenario 2: Closed-door alliances	0.22
#5	Scenario 5: Overwhelmed and out of touch	0.10
(#3)	Current state of water governance	0.29

#4 features highly efficient water infrastructure, economic prosperity, a decline of natural systems, and less active or apathetic roles for civil society and community organizations. This apathy is related to the generally closed nature of decision-making, which in this alternative includes people not being interested in water issues or water management. Participants generally saw *Alternative #4* as portraying a traditional development trajectory of economic advancement and prosperity that, to be implemented, would require a 'taming' of currently active rural communities and a marginalization of environmental issues (Fig. 3, Table 6).

Alternative #5: *Overwhelmed and out of touch* is a poorly preforming governance regime. In this alternative, an overwhelming context (scarcity, inequality, poor water quality) devastates weak governance that lacks enabling leaders, accountability mechanisms, accessible decision-making, and a responsive civil democracy. Some participants noted that, despite the apocalyptic overtones, many themes in the alternative—such as an elite political ruling class, social injustice, and corruption—were consistent with current governance, especially at the national level. *Alternative #5* is an unsustainable water governance regime (Fig. 3; Table 6).

The sustainability of current water governance in relation to assessed alternatives

The sustainability of *current* water governance is moderate ($u_j = 0.29$) relative to the other alternatives with an assessment score identical to Alternative #4 (Table 6). The current state of water governance performs worse than more highly rated alternatives that feature deliberative governance schemes and engaged rural communities (Alternative #3) or alternatives that feature higher-quality environmental outcomes (Alternative #1) (Fig. 4). For example, one participant commented to the larger group that Alternative #3, "…is a future we should be walking toward." Others agreed that Alternative #3 was a good start for, "…a new vision for the region." Others were more cautious given persistent problems in the current state. For example, one participant commented that, "For this vision [Alternative #3] to become reality, we don't need intentions. We need decisions and actions."

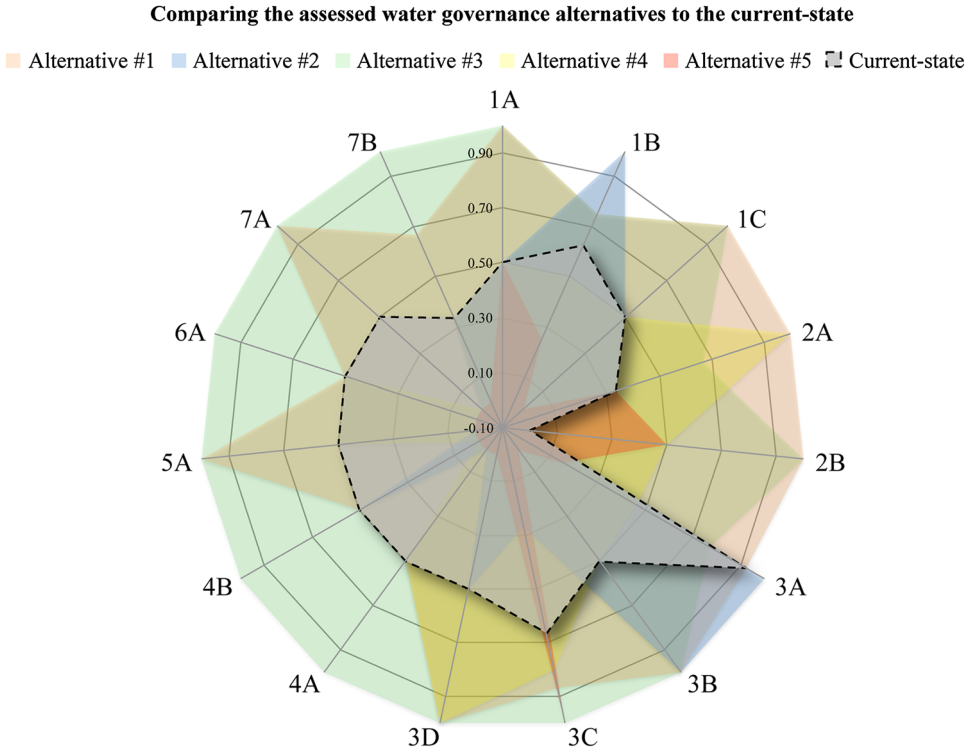

Fig. 4 Comparing the assessed current state with the assessed alternatives. Scale (−0.10 to 1.00) indicates distance from the identified sustainability target range. Note: the value −0.10 is included to display values of zero, which would otherwise not be visible in the diagram

While the positive alternatives provided optimism, participants were also concerned that the *current* water challenges they face in the region could become even more substantial, as in the narratives portrayed in Alternative #2 and #5. For example, some participants discussed how currently many rural communities rely on groundwater reserves that are poorly understood and potentially taxed (Indicator 2B). These communities have limited supply expansion options given scarcity and low financial capacity to drill new wells or transport in water. One participant commented that, "They (government agencies) don't know the status of water in (rural) towns, but they give (water use) permits without consulting with ASADAs." Given the limited involvement of rural groups in water governance, coordination issues (indicator 4A, B), and the difficulty in modifying water policies (indicator 6A, 7B) to promote conservation and demand-side management, participants viewed Alternatives #2 and #5 with real caution given their similarities with the current state. Overall, the assessment results show that current water governance is in a precarious position between sustainable water governance and completely unsustainable, undesired governance regimes.

Discussion

By comparing the sustainability of alternative governance regimes with each other and with the current state, the results demonstrate at least three main gaps between sustainable water governance and unsustainable alternatives. We found these gaps to be relevant for three reasons. First, they contain a number of important interlinked sustainability priorities that systematically determine how the alternatives perform against sustainability criteria. Second, in these three specific areas, the current state aligns precariously close to the undesirable and unsustainable alternatives. Third, these gaps help to define the specific barriers that must be overcome to make progress toward sustainable water governance in the region. Below, we explore these gaps and their implications for making progress toward sustainable and just water governance.

Groundwater management that respects scarcity

Groundwater management that respects scarcity is one gap that separates the current state of water governance from sustainable alternatives. In the current state, opaque decision-making over groundwater resources, combined with limited options (beyond groundwater) to expand rural water supplies in many areas, a context of drought, and little policy emphasis on water conservation, reinforces groundwater challenges. Many semi-arid developing regions face similar groundwater challenges (Giordano 2009). In contrast to the current state, participants at the workshop valued well-coordinated groundwater management, secured and conserved groundwater supplies, and deliberative decision-making processes that meaningfully engage rural groups who rely on groundwater sources.

Discussions during the workshop highlight some specific barriers people face in addressing groundwater issues. For example, one participant expressed frustration, stating, "In Guanacaste, people destroy aquifers because of money, and our (government) does nothing." These conversations point to two opposing visions for groundwater in the region. On the one hand, some groups prioritize groundwater conservation, often to ensure its use for community drinking water or ecosystems. On the other hand, other groups believe there is sufficient groundwater to support larger-scale economic development. At the core of this friction is the contested accuracy and legitimacy of the, often government agency-led, studies used to justify developing groundwater reserves (i.e., Kuzdas et al. 2015b). Pathways to overcoming this barrier will need go beyond only producing new technical information on groundwater availability and focus on more inclusive processes to actually *create* that information. These types of inclusive processes can improve the accuracy and legitimacy of information used in groundwater-related decisions while also helping to ensure water allocations and use fit within a water-scarce context.

Democratic governance and capacity

Participants at the workshop concluded that many places in Guanacaste lack legitimate and transparent planning processes that could build a shared vision of water sustainability in their communities. Participants from communities on the Pacific coast, especially in places where high-impact tourism and real estate development projects are prevalent, were quick to point out that they have had little input in those projects. Other studies have noted similar deficiencies in nearby coastal areas (Sánchez-Jiménez et al. 2014). However, some workshop participants questioned the ability of some communities, especially co-managed water management organizations, to independently implement new inclusive processes that could effectively plan for sustainable and equitable development. They noted specific barriers such as a lack of deliberative spaces (e.g., meeting places), logistical challenges (e.g., transportation), communication issues, and local tensions over new development (often due to limited capacities to manage those tensions) in some areas. Participants also noted that places where this capacity was low, such as in smaller coastal communities, tended to also

be experiencing greater pressure from development. Such comments suggest that the distribution of public administrative and technical support to water co-management organizations is not necessarily aligned with need. To illustrate this, a participant from an ASADA stated: "It is said that the government supports [rural communities], but most of the time it doesn't. That is why the ASADAs have to consent to some development projects, because sometimes [developers] will make material or economic donations and [those donations] can be a quick [or temporary] solution to problems."

All participants agreed that democratic governance was an integral part of a vision for water sustainability. However, there was strong deliberation on whether some areas were actually prepared to implement democratic governing processes in a way that could meet sustainability goals. Limited and variable human capacities were identified as barriers to addressing this particular gap. Pathways to overcoming this barrier might focus on ways to shift attention and investment (of water management resources) toward the human processes of planning and deliberating water resource conservation, development, its benefits, and its risks, rather than only emphasizing the placement and operation of hard water infrastructure. Notably, not all water co-management organizations in Guanacaste lack human and technical capacities. Accordingly, one *initial* step toward meeting this need in some areas could be to explore sourcing administrative resources, leadership, and support from nearby, better resourced communities and co-management organizations, thereby avoiding traditional vertical lines of hierarchy in water management that provide only minimal support to some areas in need (Kuzdas et al. 2013).

Justice, restored relationships, and organized citizen opposition

Workshop participants favored tourism that had low environmental impact and that was more visitor based. Participants felt this type of tourism, if mostly small scale and if it formed part of a diverse economy, would be ideal given water- and employment-related concerns. In contrast to participant's ideal, however, in the current state, broader political economic trends have favored higher-impact and large-scale tourism development and real estate prospecting. Many participants questioned this current state model of tourism due to perceived environmental impacts and unjust distribution of economic benefits. There was also a large difference between what participants favored in agriculture and the less desirable trends in the current state. All seven subgroups in the workshops favored "significantly more small farms," even more so than a "balanced and competitive mix" of smaller and larger farms. In Guanacaste, as in many regions, larger farms are outcompeting small farms. This particular concern in Guanacaste entails the smallholder farmer abandonment of agrarian-based livelihoods (due to a combination of economic barriers and water management schemes) to work on sugar cane plantations, often for substantially less income and greater exposure to health risks (Warner et al. 2015).

While there are certainly water efficiency issues in agriculture and tourism that matter for water sustainability (i.e., the first gap, groundwater management that respects scarcity), when discussing these particular aspects of water resource development, workshop participants often focused on another systemic issue. Participants considered many poorly assessed governance and economic indicators in the current state to be related in some way to the erosion of rural people's trust in the state and its water politics. For example, in reaction to Alternative #5, which portrays an elite few (e.g., latifundios) disproportionately benefiting from water, one participant explained that, "Latifundio is not about land today, it is about political power and decision-making from [the capital] San José. It has not been eliminated but remains in disguise." Another participant noted that, "Elite groups are associated with big developments and [they] use the water that should be meant for small farmers." In sum, many participants were weary of injustices in how water resources are developed and allocated in the region, and they were especially concerned about this when considering climate change impacts and futures with less available water. In these discussions, many questioned whether they could trust broader-level water politics and state-led decision processes to fairly allocate Guanacaste's decreasing water supplies in a way that benefited Guanacaste communities and their environment.

These discussions illustrate the disconnect between, on the one hand, a vision of secured water supplies governed by inclusive democratic processes that is held by many rural groups, and on the other hand, political economic trends and water politics that have led to a current state that many rural groups view to be conflicting with that vision. This disconnect is also seen in Guanacaste's water conflicts, which have been found to mostly involve local groups taking action against the state, rather than against other water users (*Programa Estado de la Nación* 2013; Mata-Blanco 2014; Kuzdas et al. 2015b). Local perceptions of state support for, or at least inaction to address this disconnect, has historically solidified rifts between rural groups and the state (i.e., Booth et al. 2010). Many workshop participants felt that one important pathway for making progress toward a sustainable state would involve reconciliation processes between rural water co-management organizations and national-level public organizations that dictate water policy, investment, and development.

However, the entrenched marginalization of some rural groups in Guanacaste water politics presents challenges to moving forward on such a path of reconciliation (Warner and Kuzdas 2015). While there is an apparent need for peace-building and collaboration-building processes, workshop participants were quick to point out the simultaneous need to be proactive in more effectively influencing water politics through expanded citizen-based challenges against interests that overlook rural Guanacaste's wellbeing (i.e., Nastar 2014). For example, some participants explained the need for communities to better organize to provide an "Instrument of defense against environmental destruction". Adding to this, a group of ASADAs commented, "We have to force [agencies] who manage water to get involved with [rural] communities." In other words, pathways to water sustainability should involve more focused efforts to build peace and restore collaborative relationships to confront complex water challenges. But, to fully realize water sustainability goals in Guanacaste, these efforts also need to consider strategic citizen-based challenges and political influence strategies meant to overcome deeply entrenched barriers and interests.

Conclusions

The assessment identifies the sustainability of alternative ways of governing water and pinpoints how (un-)sustainable the current state of water governance is in comparison to those alternatives. The assessment helps clarify water sustainability priorities for communities who placed high value on deliberative and just governance, secure groundwater reserves, and healthy dry tropical ecosystems. However, we found significant risk of digressing toward completely unsustainable alternatives where rural communities lack rights and influence, where economies favor agro-industry and high impact tourism at the expense of rural livelihoods, and where water scarcity overwhelms weak governance. Results of this assessment assert the need for systemic change toward sustainable water governance in the region. To help realize change efforts, we identified gaps where there is need for attention and action. Groundwater management that respects scarcity was one gap that, to address, will require not only a shift toward water conservation paradigms, but also a renewed focus on building capable democratic processes. Implementing such new processes though is complicated by broader-scale water politics that often overlook rural water co-management organizations. Such political barriers suggest the need for collaborative reconciliation processes between rural groups and public water organizations. But, they also suggest potential limitations to collaborative processes in the region, which to overcome may require organized citizen-based challenges and political strategy against interests that threaten water sustainability and justice.

The specific gaps between sustainable alternatives and the current state or unsustainable alternatives indicate multiple and interconnected pathways to sustainability, as well as many barriers at different scales. More work is needed to fully unpack these pathways. This future work might include developing coordinated action plans and transition strategies for navigating these pathways, achieving sustainable water governance, and avoiding undesirable alternatives. Moving forward in iterative processes that emphasize strategy, action, and learning will be an important component of such solution-focused efforts. In that direction, this assessment offers valuable support for people in challenging regions such as rural Central America who are pursuing transitions toward sustainable and just water governance.

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