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Water Security as a Normative Goal or as a Structural Principle for Water Governance

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1 Introduction

Arguing that water security is a new mantra to grasp and solve the so-called water crisis, international organizations and their partners often consider water security as a core notion of water governance strategies. Indeed, more and more policy-makers and national policies have a reference to water security (Bakker 2010; CGDD 2013) although water security has many acceptations (Bakker 2012; van Beek and Lincklaens 2014; Zeitoun et al. 2016). However, most academics and practitioners agree that the notion covers three main dimensions: the social one (basic needs and health), the environmental one (quality and quantity) and the approach on risk(s). Bakker, referring to Grey and Sadoff (2007) and Zeitoun (2011), gives a canonical definition considering water secu-

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rity as "*an acceptable level of water-related risks to humans and ecosystems, coupled with the availability of water of sufficient quantity and quality to support livelihoods, national security, human health, and ecosystem services*" (Bakker 2012, 914).

The water security literature developed over three main phases (Bakker 2012; Cook and Bakker 2012; Garrick and Hall 2014). The first phase started when the concept emerged in the 1940s, and lasted all the way until the year 2000 when significant research and publications put water security at the forefront of the international agenda (FAO 2000; GWP 2000). The second phase started in 2006 with the 4th World Water Forum (Mexico), which put water security at the top of the agenda. During this second phase, literature started linking water security to economic growth. It was under such circumstances that Grey and Sadoff (2007) published an innovative and seminal paper emphasizing the need for investments in both infrastructures and institutions to achieve a water-secure world. The third phase started in 2013 when UN-WATER stressed the necessity for compiling and analyzing indicators on water security. At the same time, the Organisation for Economic Co-operation and Development (OECD 2013) promoted a risk approach on water security that would assess vulnerability to water-insecure situations in order to stimulate policy-making. More recently, an alternative perspective, more integrative, emerged (Zeitoun et al. 2016). It takes into account the uncertainty of a narrow appraisal of water security (data collection and quality) to better face dynamics of social-ecological systems (SESs). Such a perspective is a base for considering simultaneously the strong variability of the dimensions of water security.

This chapter attempts to contribute to the latter perspective, especially by demonstrating the relevance of an integrative perspective and its possible implementation. Our two starting points are the following: first, water security remains an umbrella concept justifying a holistic approach of water challenges (Molle 2008; UN-Water 2013); and second, a water-secure circumstance is often considered as the reflection of a sustainable use of water. Water security is, therefore, mostly addressed as an objective to be reached. As the definition of a water-secure situation is still under consideration, and considering the lack of evidence on the causal relationship between water security and sustainability, this normative perspective

seems to be premature. The questioning that led to this publication is the discrepancy between the dramatic water crisis, which is occurring in the real world, and the use of an umbrella concept at the core of water governance in the epistemic world. Is it wise to use a recent ill-defined notion to streamline water governance and find a solution to the water crisis?

Most SESs involve both environmental and social spheres in the same chicken-and-egg syndrome; water governance and water security are no exception. Complexity and system dynamics are at play (Folke et al. 2005; Ostrom 2009; Duit et al. 2010). This contribution is grounded on this strong interdependency to propose a pragmatic perspective on water security (aiming at enhancing water governance). The literature mainly deals with the impact of water security on social aspects (development, growth, etc.), providing an anthropocentric view of water security. Consequently, water management aims at securing water systems. Biswas and Tortajada (2016, 19) claim that "*the world is not facing a water crisis because of physical scarcity of water. It is facing a crisis because of poor management of* water." This motivates us to shift the focus from water security to water governance: how water security helps to reinforce/reshape water governance, instead of asking which water governance leads to water security.

Our postulate is that efficient water governance spontaneously results in a water-secure situation. This axiom stands on two observations. The first one is that water security, growth and development are interlinked with governance as the greatest common denominator. The second one is that the so-called water crisis is a (water) governance crisis (OCDE 2013; Bakker and Morinville 2013; Biswas and Tortajada 2016). Consequently, rather than diluting energy in scrutinizing water security as a goal, we would recommend focusing on enhancing water governance, which seems an undoubtable source of, and solution to, the water crisis. We propose to refine the conventional approach of water governance by using water security as a management tool rather than as a goal. We explore the reciprocal relationship between regime integration and water security improvement. Integrating an institutional water regime means framing governance with the fewest inconsistencies and a wide range of regulated uses (Gerber et al. 2009; Bréthaut and Pflieger 2015; Bolognesi 2014). We argue that water security could be relevant as a tool for the

adaptive management of an institutional water regime. As a consequence, we offer the following two propositions:

Proposition 1: an integrated water regime spontaneously leads to a water-secure situation

Proposition 1 states that a water-secure situation is an output of integrated water regimes following an efficient management of existing potential rivalries. By spontaneity we mean that this achievement is reached even if not in the core of the policy goals of the regime (Young 2013). It supports the statement that management concerns prevail in the water crisis. Even if this proposition confirms that studies are worth being carried out, it has an axiom status for this chapter to emphasize the relevance of the second proposition.

Proposition 2: water security represents a crucial trigger for water regime evolution by anticipating

Proposition 2.1: issues in governance fitting and evolution
Proposition 2.2: new uses rivalries

This second proposition is the feedback loop of the first and remains unexplored in the literature.

In order to explore these perspectives, we use literature on water security (indicators and governance), as well as rational institutionalism such as institutional resource regimes (IRR) frameworks and new institutional economics theory (Menard and Shirley 2005; Vatn 2005; Gerber et al. 2009).

The chapter is structured around three main parts. In the first, we discuss quantitative assessments of water security. By doing so, we aim at emphasizing the real scope of water security and its limitations. We provide a critical outlook on water security measurement confirming to be careful when using water security in a normative perspective due to the non-systematic way measures are taken and communicated (black box). Based on this initial discussion, we open the black box exploring our two propositions. The second part highlights how water security could

spontaneously emerge from water regime integration (proposition 1). The third part focuses on the feedback loop to identify how water security could help in integrating water regime (proposition 2), by being combined with adaptive governance processes.

2 Measuring Water Security: Taking Stock and Main Limitations

2.1 Measuring Water Security

Water security measurements aim at assessing water security across the world to grasp the so-called water crisis. It contributes to giving insights on human-water interactions. There are more and more assessments of water security, but only a few are multi-criteria and most are built on their own conceptual framework, which can limit comparison. In other words, water security assessments suffer from a large methodological diversity, which can prevent or bring complexity to international comparison. Therefore, water security assessments are generally characterized by a high subjectivity, which can reduce the relevance of their normative use, especially when they are not counterbalanced.

The contributions to water security measurements can be sorted in three categories. The first category encompasses water (in)security-related risks. The second one focuses on environmental concerns (such as water quality and quantity). The third category links water security and governance.

Falling under the first category, recent research has a tendency of expanding from this delimitation. OECD (2013, 13) states that water security "*is about managing risks*," which can be detailed in the following two points. First of all, water-related disasters are growing in frequency as well as in impact inducing social and economic losses (CGDD 2013; Gersonius et al. 2013; Kundzewicz et al. 2014; Bolognesi 2015). As a result, better prevention and resilient strategies facing these new conditions are needed. It is expected that by reducing vulnerability to risks, livelihoods and development may increase (Rose and Liao 2005; Grey

and Sadoff 2007; Allan et al. 2013). Water security indicators are then used in many ways (Garrick and Hall 2014). Academics have previously focused on dense and large watersheds, however, recent progress in geospatial referencing and analysis can contribute to refining assessment to smaller scales (Lawford et al. 2013). Governmental and development agencies are credited for their ability to implement development policies referring to water security in dense and risky water basins, especially in Southeast Asia (van Beek and Lincklaens 2014; Sadoff et al. 2015). The business sector operationalizes water security metrics in supply chain assessment to prevent state failures in order to address water-related risks. The World Economic Forum (WEF) publications on global risks encourage businesses to internalize such risks. It is worthwhile to note that risk and probabilistic perspective frame these indicators and the underlying conception of water security. On the one hand, it is very handy for policy-making, facilitating the prioritizing of issues and measures. On the other hand, it appears reductionist in view of the very limited knowledge accumulated on SESs. (Garrick and Hall 2014; Zeitoun et al. 2016). Complexity and uncertainty challenge water security indicators (Simonovic 2009). Consequently, if risk perspective on water security would help identifying investment sequences to minimize exposure (Grey and Sadoff 2007; OECD 2013) it is of paramount importance to keep in mind these limitations.

The second category of metrics informs water security stressors (Vorosmarty et al. 2010; Lawford et al. 2013). Pollution and growth of water use are pointed out as two crucial triggers of water insecurity. Vorosmarty et al. (2010) show that 80 percent of the world's population is located in water-insecure areas and that 65 percent of biodiversity is located in threatened water bodies. Norman et al. (2013) suggest the Water Security Status Indicators, which open the door to multi-criteria indicators and aim at supporting policy-making at the local level.

The third category clearly articulates metrics with water governance questions. The Global Water Partnership (GWP 2014) surveys seven significant reports/papers linking water security assessment with governance issues. They all provide international comparisons (Chaves 2014; Lautze and Manthrithilake 2012; Mason and Calow 2012; ADB 2013; Dunn et al. 2013; Willaarts et al. 2014; Warner 2013). Figures 9.1 and 9.2

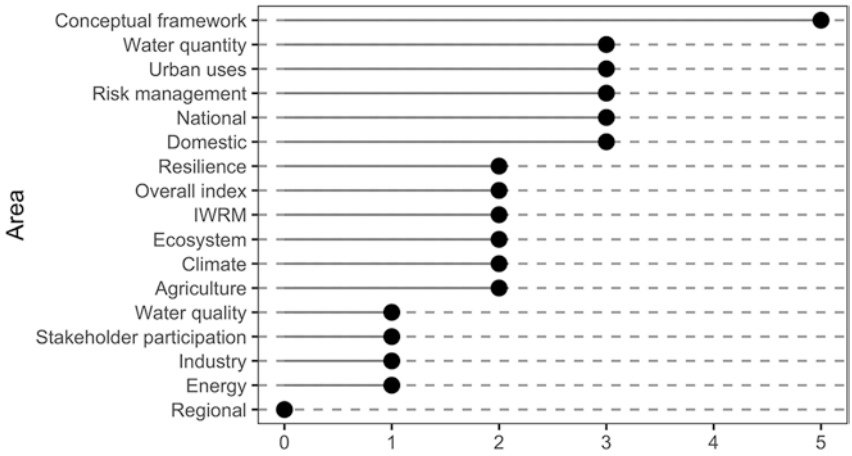

Fig. 9.1 Areas of concerns of water security indicators surveyed by GWP (2014). Source: Adapted from GWP (2014)

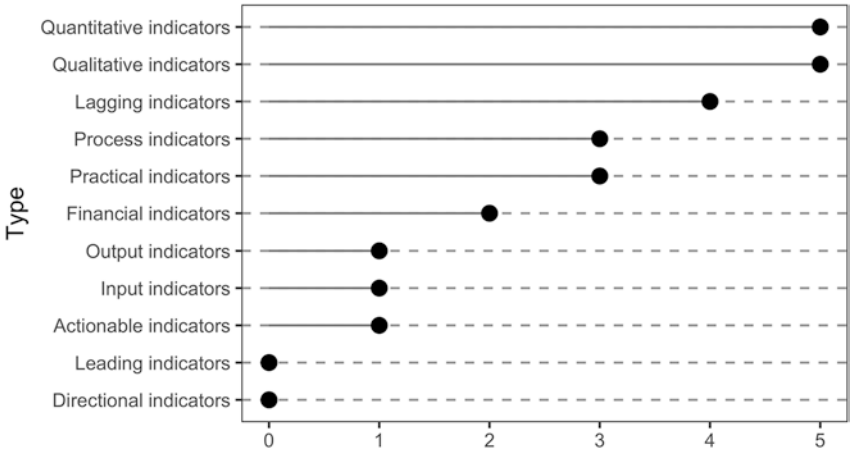

Fig. 9.2 Nature of water security indicators surveyed by GWP (2014). Source: Adapted from GWP (2014)

report the areas of concern and the nature of the indicators proposed by authors. Box 1 clearly shows the typology of the nature of indicators adopted by the GWP.

Box 1 Nature of indicators

- Quantitative indicators can be presented as numbers.
- Qualitative indicators cannot be presented as numbers.
- Leading indicators can predict the outcomes of a process.
- Lagging indicators present the successes or failures post hoc.
- Input indicators measure the amount of resources consumed while generating the outcome.
- Process indicators represent the efficiency or the productivity of the process.
- Output indicators reflect the outcomes or results of the process activities.
- Practical indicators interface with existing institutional processes.
- Directional indicators specify whether or not an organization is improving.
- Actionable indicators are sufficiently under an organization's control to effect change.
- Financial indicators are used in performance measurement and when looking at an operating index.

Source: GWP (2014, 3).

It appears that all water security assessments do not provide leading or directional indicators and solely Lautze and Manthrithilake (2012) set up input indicators. Lagging, process and practical indicators are globally preferred. This can be seen as a confirmation that, for most academics and policy-makers, water security constitutes a goal and not a tool. The most frequently covered areas, among seventeen indicators, are domestic, urban uses, water quantity and risk management, while industry, energy and stakeholders are often left aside. In terms of scale, indicators are all calculated at the national level, which looks consistent with the goal of finding water governance planning bearings. Each surveyed assessment goes with its own conceptual framework underlining that water security is not a "stabilized concept" ("nirvana concept"), even if it is often seen as a new mantra of water governance. This points out a crucial limitation of water security metrics. They do not converge, and one could assume that they could be tautological in the way they reflect a hidden definition of what authors perceived as good governance.

2.2 The State of Water Security Globally

Indicators provide information on the state of water security in different areas. By aggregating three consistent multi-criteria indicators (Lautze and Manthrithilake 2012; ADB 2013; van Beek and Lincklaens 2014), we aim at presenting the largest international comparison of water security possible. The previous section has shown that these three indicators offer the most robust appreciation of water security, both in terms of thematic and geographic extent. They cover the broadest area of concern through six to seven types of indicators. We focus on them to quantify water security across the globe. Such an exercise offers a good support to discuss water security indicators' quality and highlight associated uncertainty.

Figure 9.3 shows the main characteristics of each indicator. Considering forty-nine countries, the Asian Development Bank (ADB 2013) has the widest sample, followed by Lautze and Manthrithilake (2012) with thirty-three countries and van Beek and Lincklaens (2014) with twenty countries. All three indicators cover a large part of Southeast Asia and Oceania countries and van Beek and Lincklaens' (2014) also extends to a few other countries of each continent. It is worth noticing that ADB (2013) and van Beek and Lincklaens (2014) focus on the same five dimensions of water security (household, economic, urban, environment, resilience). Also considering household and environment, Lautze and

	Lautze (2012)	ADB (2013)	Van Beek et al. (2014)
Dimension	Household needs Food production Environmental flows Risk management Independence	Household Economic Urban Environmental Resilience	Household Economic Urban Environmental Resilience
Area	South-East Asia Oceania	South-East Asia Oceania	Asia Oceania America Europe Africa
Main summary statistics	N=33 Mean : 3.09 Min : 1 Max : 4 Std : 0.76	N=49 Mean : 2.43 Min : 1 Max : 4 Std : 0.71	N=20 Mean : 2.55 Min : 1 Max : 4 Std : 0.88

Fig. 9.3 Summary statistics of selected water security indicators

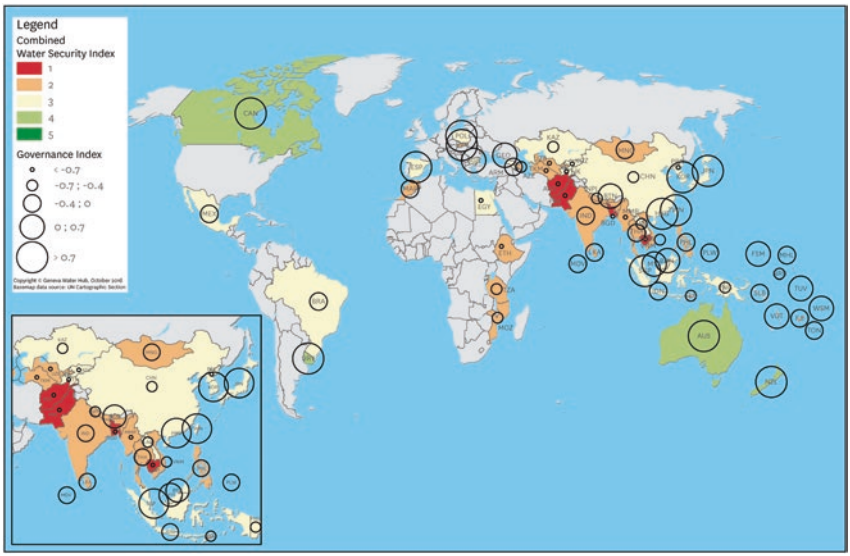

Fig. 9.4 Overview of water security globally

Manthrithilake (2012) prospect different aspects as well (food, risk, independence). Combining these three water security indicators leads to a large overview of water security in the world (Fig. 9.4).

The density plot (Fig. 9.5) presents the structure of these three different water security assessments. On the x-axis is the total score of each country, not the final indicator, and the y-axis reports the distribution of countries according to their score. This figure highlights significant divergences among the three indicators, reinforcing the need to use water security statistics cautiously. ADB and GWP (van Beek and Lincklaens 2014) show a similar structure, while Lautze and Manthrithilake (2012) present a much more secure situation with greater variations among countries.

These observations are confirmed by the summary statistics. Lautze and Manthrithilake's rating presents a more water-secure world than ADB (2013) and van Beek and Lincklaens (2014). This is not solely induced by the different samples considered, but also by the different methodology, which have an impact on results. As an illustration, Lautze and Manthrithilake rate Vietnam, Thailand and the Philippines with 3.4,

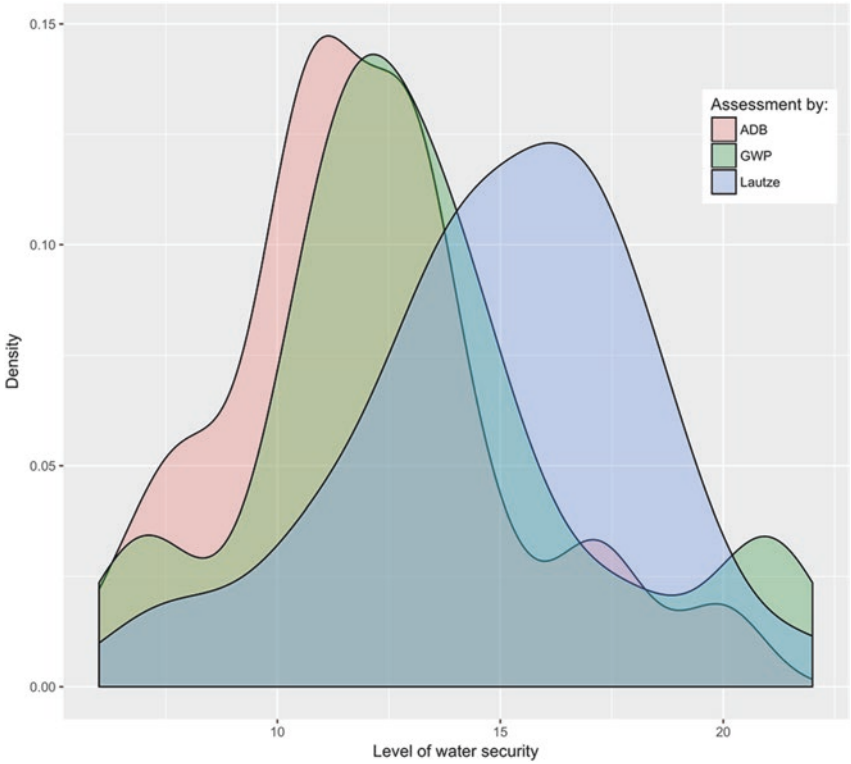

Fig. 9.5 Variation in water security assessments

while ADB's rating reaches only 2.2. Kyrgyzstan is another interesting example. ADB (2.6), Lautze and Manthrithilake (3.6) and Van Beek et al. (2.2) rates imply significant differences in final scores, respectively 3, 4 and 2 (on a scale from 0 to 5). This is of paramount importance since according to Lautze and Manthrithilake there is not much concern with water security in Kyrgyzstan, while Van Beek et al. conclude on an alarming situation. It underlines to which extent water security metrics are not stable and highlights the risk of using water security in a normative manner. The concept should therefore be used with caution. Such variations among indicators advocate for a unified and global assessment of water security. Finally, it appears that the smaller the sample the greater the

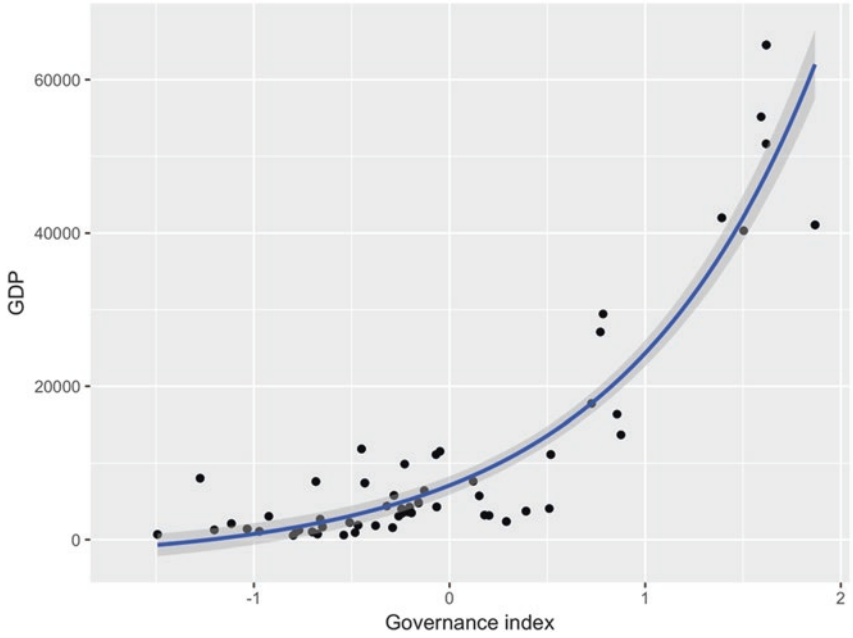

Fig. 9.6 Relation between governance quality and GNP per capita

standard deviation. This can be explained by the heterogeneity of the sample, which is erased by its size.

van Beek and Lincklaens (2014) cover a wider area than Lautze and Manthrithilake (2012) and ADB (2013), contributing to a larger diversity in sampling cases. The three indicators mostly focus on Southeast Asia and Oceania countries, i.e., regions that have contingencies impacting on water security assessment. The most significant ones are development patterns and climate and hydrological characteristics. Figure 9.6 plots the development patterns of the sample according to governance "quality" in 2015, measured by the Worldwide Governance Indicators (WGI)[1] and level of wealth, (GDP current dollars, from the World Bank). Countries with weak governance and poverty issues constitute most of the areas covered by the three water security indicators. In parallel, the graph illustrates the strong relationship between governance

quality and GDP. The selection of sample countries can influence the interpretation of water security issues. Indeed it is well known that low development stage contributes to weak water governance (Saleth and Dinar 2005; Ménard and Saleth 2013). Climate and hydrological characteristics are the second specific characteristics of the sample. In reference to the Köppen-Geiger climate classification (Peel et al., 2007), selected countries are mostly under equatorial or arid climate conditions inducing high variability in water precipitations favouring floods and droughts. Such conditions favour water insecurity, more or less directly for each dimension. Additionally, Bolognesi (2015) demonstrates that these regions combine structural characteristics that considerably increase vulnerability to water hazard and reduce water security.

3 Institutional Resource Regime and Water Security

3.1 Water Security and Governance Design

The first proposition states that an integrated water regime spontaneously leads to water-secure situations. It is very similar to the problem setting from the water security indicators' perspective. We want to grasp to which extent this reductionist approach of water security remains relevant. The proposition is based on the fact that water governance can be defined as a set of water-specific regulations and generic aspects of governance (Saleth and Dinar 2005). These generic aspects form an institutional matrix more or less favourable to development (North 2005); in our case, water security. Figure 9.7 links water security scores available from Lautze and Manthrithilake (2012), ADB (2013) and van Beek and Lincklaens (2014) with governance scores in 2015 or the latest available year, calculated from the WGI dataset. Figure 9.8 links water security scores with GNP per capita in 2015 or the latest available year.

Both plots illustrate a positive relation between water security, on one side, and governance index and GDP, on the other. It appears that the

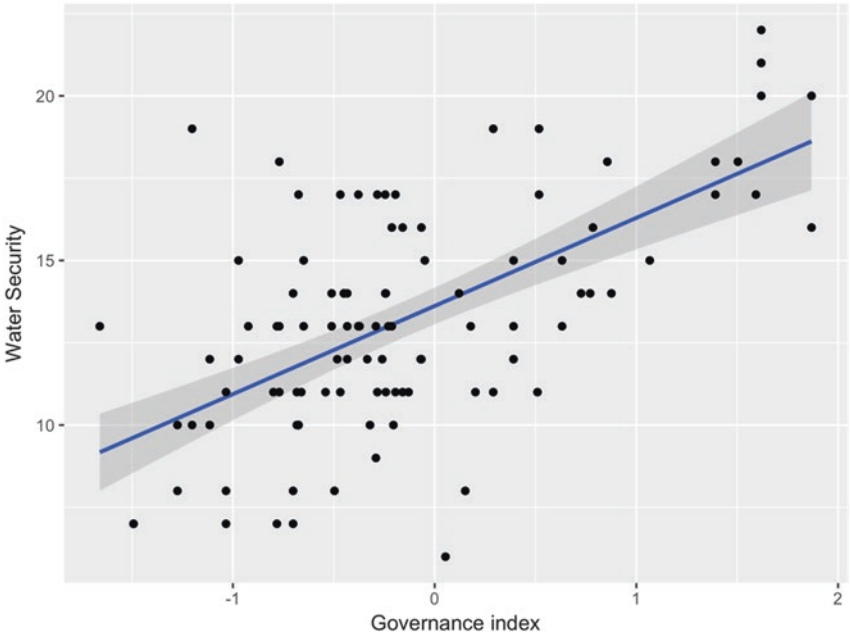

Fig. 9.7 Relation between water security and governance

relation is rather strong, even when considering residuals. Regressions confirm the observation (Fig. 9.9). Significance of regressors is high and adjusted R-squared limited to 0.37 and 0.32. In other words, governance and GDP are key triggers of water security, which tends to validate the relevance of the reductionist approach. At the same time, it highlights that this narrow focus on governance remains too simplistic to understand and implement water security. This confirms our first proposition: an integrated resource regime is a strong favourable terrain for water security, but, if necessary, it is not sufficient condition. The integrated resource regime notion refers to a governance setting where coherence and extent are high (Gerber et al. 2009; Bolognesi 2014), e.g., property rights and public policy are clear, not conflicting and covering a wide area of use rivalries. We now focus on how IRR could spontaneously enhance water security by increasing extent and coherence of governance.

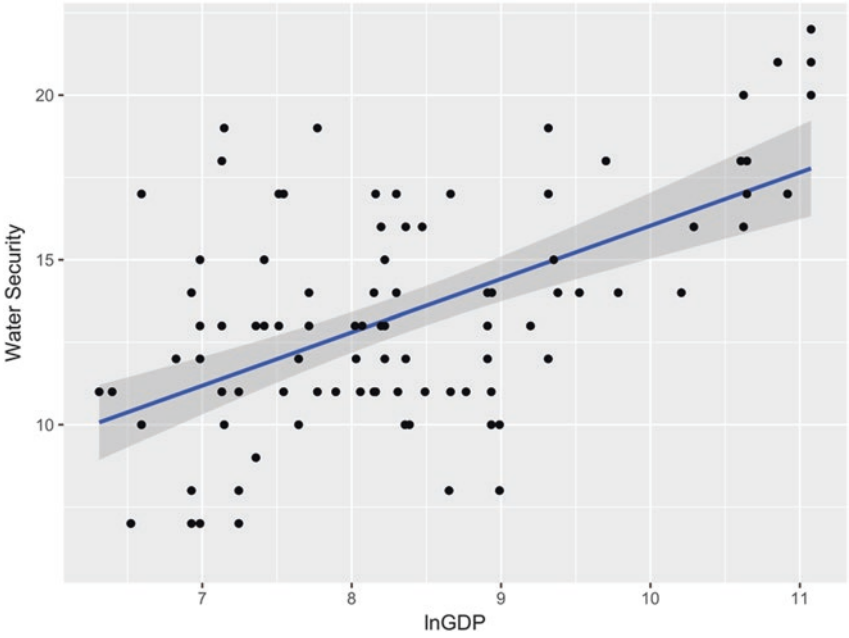

Fig. 9.8 Relation between water security and GNP per capita

	Dependent variable:		
	ln GDP	Water security	
	(1)	(2)	(3)
World Governance Index	1.281***	2.677***	
	(0.091)	(0.345)	
ln GDP			1.616***
			(0.243)
Constant	8.528***	13.617***	–0.129
	(0.074)	(0.281)	(2.044)
Observations	94	102	94
R^2	0.685	0.376	0.325
Adjusted R^2	0.682	0.370	0.318
Residual Std. Error	0.702 (df = 92)	2.787 (df = 100)	2.913 (df = 92)
F Statistic	200.079*** (df = 1; 92)	60.317*** (df = 1; 100)	44.331*** (df = 1; 92)

Note: *p<0.1; **p<0.05; ***p<0.01

Fig. 9.9 Governance, GDP and water security

3.2 Benefits of Governance Extent

The link between water security and regime extent is rather straightforward since water security issues spontaneously lead to extend regime, i.e., regulate new uses. The second hypothesis of an IRR framework supports this relation. It stipulates "*that the greater the threat to stability of a resource, the more it will be perceived as a relevant collective problem to be resolved and the more likely it is that attempts will be made to increase the extent of the IRR (new regulations for new uses)*" (Gerber et al. 2009, 807). By defining the pattern of coordination on collective water use problem, IRR extension should impact water security. As an illustration, Bréthaut and Pflieger (2015) highlight how water governance and use rivalries are intertwined. They relate new economic uses to collective problem definition and governance structure, processes they called *shifting territorialities*. Such shifting territorialities hardly contributed to defining and modifying water use in the case of the Rhône River, especially in terms of quantity and quality. That way governance spontaneously modifies patterns of water security in any given area.

Looking at IRR evolution on the long run leads to identifying four water governance phases in Europe and Switzerland (Reynard et al. 2000; Aubin 2007; Bolognesi 2014). Figure 9.10 relates collective problems with water regime planning in Switzerland between 1870 and today. Since 1953, water quality appears to be the main challenge that the Swiss water regime faces. The first phase focuses on economic uses and water-related risks. The second deals with water consumption. It is a period where water connections and water quality rises to high level, considerably increasing households' water security. Starting in the 1970s, the third phase reflects a reaction to environmental degradation and impulses a strong extension of the Swiss institutional water regime. Innovative acts have been enacted and incentivizing measures such as the polluter-pays principle adopted. The fourth phase reaffirms environmental focus and changes the water governance paradigm to eliminate earlier failures. The development of governance during the 1990s brings about a special focus on water quality, with around ten structural water acts. It contributes more to water regimes' coherence than to their extent, the latter being high since.

Periods	Collective problem	Property rights	Public policies
1870–1912 Protection from water	-Floods -Fish deaths	-Absence of national Law -Implementation of Federal State sovereignty (water and hydro-electricity)	Emergence of indep PP with 3 main goals: -flood protection -urban pollution -electricity
1912–1953 Economic exploitation of water	-Energy and food security	-Swiss civil code (1912): public and private waters separation -Implementation of PPP systems for hydro	Sectorial separation of PP: -protec against water -water exploitation -water protection
1953–1975 Protection of water quality (1)	Polluted waters	Restriction on specific uses	-Reinforcement of sectorial PP, esp. water protection -No regulation of agricultural non-point source pollution
1975–1991 Protection of water quality (2)	Polluted water	Extent to quality and quantity	-Efforts pursuit (2nd water protection act 1971) -Implementation of polluter -pays principle (1995)
1991–2008 Protection of the all hydrological system	-Qualitative and quantitave stresses on waterPol. -Storm related pollution -Dams and ecosystems -Agricultural pollution -Floods and climate change	-Reinforcement of disposal and use rights restrictions in 3rd water protection act (1991)	Sectoral policies nexus in Water act (1991)

Fig. 9.10 Evolution of collective problems and water governance in Switzerland since 1870. Source: Adapted from Reynard et al. (2000), Knoepfel et al. (2010)

The Swiss Federal Office for the Environment (FOEN) uses twenty-six water indicators that have the objective of assessing the status and trends of environment in the water area.[2] These indicators cover most of the scope of water security variables falling under the "driver, pressure, state and impact" classification. For instance, variables such as "production of hydroelectric power," "water use," "nitrate in groundwater" and "flood events" inform economic, household and environmental and risk dimensions of water security. They illustrate a positive impact of water regime extent on water security. As an illustration, in the late 1970s and early 1980s, one can observe a significant decrease of the concentration of hazardous substances, such as phosphorus or nitrogen, within water bodies (FOEN website, Björnsen Gurung and Stähli 2014). Along the national legislation, international laws could enhance the integration of water regimes. Recently, the Protocol on Water and Health, signed in 1999 and ratified in 2006, grasps all dimensions of water security and contributes to enhancing it while not mentioning the concept (FOEN 2013).

The extension of the Swiss water regime spontaneously improved water security in the country. Nonetheless, several challenges remain. Nowadays, five principal domains hamper Swiss water security:

- Nitrate in groundwater
- Organic trace materials in surface waters
- Plant protection products in groundwater
- Floods
- Temperature of watercourses

Traces of organic material in surface waters is a recent case where water security had the consequence of expanding the Swiss water regime. The Water Protection Act (1991) aims for a nationwide wastewater levy, but, because it fell short of expectations, on 3 March 2014 supplementary financial efforts were accepted to upgrade quickly 100 wastewater treatment facilities. This contribution should result in significant elimination of micropollutants. On the quantitative side, since the 1970s, flood frequency increased and the three most serious ones took place between 1999 and 2014. Consequently, flood-related damages remain considerable. In 2005, they exceeded three billion Swiss francs. Droughts are costly too. In 2003, their costs reached 500 million Swiss francs. Nevertheless, water security of the Swiss water regime is more vulnerable to qualitative issues than to quantitative ones (Volken 2012). Then, uncertainty on the changing context and on implementation success/failures will legitimate adaptive measures to recalibrate planning. The decision of the Swiss national council and the Swiss council of states' in March 2014 illustrates such a type of adjustment.

3.3 Benefits of Governance Coherence

Extension is the main channel by which water regime planning produces spontaneously positive output in terms of water security. The other way to enhance regime integration is coherence. National regulations still struggle to deal with coherence issues. Our perspective is that it is the actual specific governance area where adaptive governance proves to be relevant. This concept is advocating for an integrative perspective on

water security, and it refers to noise occurring in the relation between governance and water security (Figs. 9.7 and 9.8).

Unexpected disturbances can come up from implementation. For example, the difficulty to ensure credible command-and-control policies in polycentric SESs, the misalignment between public policies and organizational structures, and property rights allocations and cross-sectorial nexus (Menard and Shirley 2005; Ostrom 2010; Bakker and Morinville 2013; de Strasser et al. 2016). In practice, coherence issues mostly relate to cross-sectoral and multilevel unexpected impacts of a given regulatory item (Reynard et al. 2000; Aubin 2007; Knoepfel et al. 2010; Bolognesi 2014). The 1991 Water Act and integrated water resource management (IWRM) documents are examples of central policy planning that take into account coherence issues, but they stand out as isolated initiatives. Coherence remains a persistent challenge to long-term planning within institutional regime.

Authors of the Swiss research project PNR61 on sustainable water management provide valuable tables on intersectorial linkages (Lanz et al. 2014). Using such tables would enhance water regime coherence and result in more secure patterns of use. Matrices show how sectorial collective problems would affect other sectors from quantitative, qualitative, hydromorphological and ecosystemic or territorial perspectives. Conflicts, synergies and processes are detailed. For example, externalities of agriculture on others sectors are underlined and classified as very conflictual. Urbanization and industry appear less conflictual, but in regards of the specific water security issues of Switzerland, this relation could be better kept under review. Indeed, industrial uses and urbanization patterns contribute to dissemination of micropollutants in water. Resulting in local and short timespan impacts, urbanization and industry collective problems were classified as non-major sources of intersectorial conflicts.

We showed that water security should be a spontaneous output of integrated water regimes. It appears that, by consistently regulating a wide range of uses, integrated water regimes provide very favourable conditions to reach a water-secure situation. This tends to consolidate the first proposition. Nonetheless, this statement must be tempered as implementation issues or unexpected behaviours can remain in integrated regime. These two factors may interfere in the transition towards a water-secure situation.

4 Water Security and Adaptive Governance to Enhance Governance Integration

4.1 Water Security and Adaptive Governance

Proposition 1 has been confirmed as a structural trend. However, in the day-to-day practice of governance, we observed that implementation issues, among others, limit the robustness of the proposition. We firstly show that governance design is crucial to achieve water security but remains insufficient. Our second proposition outlines that water security could be a crucial trigger for water regime improvement by anticipating issues in governance fit (H.2.1) or new uses rivalries (H.2.2). To address this proposition, we adopt a more integrative perspective on the link between water security and governance. Special focus is given to the feedback relation between governance and water security, namely how water security perspective could support governance development. Integrative appraisal of water governance requires an insight to issues that articulate generic and specific governance components (Saleth and Dinar 2005; Ménard and Saleth 2013). The data noise in Figs. 9.7 and 9.8 may be mostly due to this articulation, context specificities and actors' behaviours resulting from inconsistencies in the institutional water regime. To grasp these phenomena, we stand on the Ostromian approach of governance crafting. Such approach states that adaptive governance would put in practice crafting within policy-making, and complement it to avoid maladjustments of governance design with local implementation.

The potential benefits of adaptive governance on water security have already been emphasized (Bakker and Morinville 2013; Pahl-Wostl 2016). In a nutshell "*water security approaches […] place the emphasis on the need for adaptive management, as a responsive approach that can reduce vulnerability and increase resilience in the context of evolving uncertainty*" (Bakker and Morinville 2013, 4). Our perspective is complementary. We shed light on the potential of water security to improve water governance by framing adaptive governance processes. More specifically, we argue that water security assessment could frame an adaptive governance process by providing stakeholders with pieces of reality and depicting general scenarios.

SESs involve complex interactions across nested scales between components, which reduce predictability of future outputs. If long-term planning designs key attributes of governance and defines tangible caps, adapting governance allows fine-tuning in respect of evolving constraints and contexts. "*There is a need to champion approaches to governance capable of supporting ecosystem management in a manner both flexible enough to address highly contextualized social–ecological issues and responsive enough to adjust to complex, unpredictable feedbacks between social and ecological system components*" (Chaffin et al. 2014, 55).

Adaptive governance is a form of bottom-up management of SESs that seeks to develop flexibility and adaptability, stands on self-organization of local actors and considers nested institutions both in time and scales. It is a deliberative and iterative process that allows focusing on adaptability rather than on performance per se; such a mechanism fits well with the uncertainty and complexity of SESs (Folke et al. 2005). It implies collaboration, experimentation and a holistic approach to resource management (Huitema et al. 2009). It is generally recognized that five items constitute adaptive governance: (1) stakeholders' involvement, (2) objectives definition, (3) management action, (4) models and (5) monitoring plans (Williams 2011). Water security appears very suitable to frame items 2 to 4, with possible positive outputs on water regime coherence and extent, contributing to put in practice proposition 2.

4.2 Benefits for Governance Coherence

Adaptive governance can enhance coherence of water regimes thanks to its diagnosis approach (cf. steps 2–4) and water security should be helpful to ensure that governance fits for purpose (Rijke et al. 2012) (proposition 2.1). Indeed, water security and its five key dimensions (household, economic, urban, environment, resilience/risk) are suitable to reach multiple objectives. First of all, as these dimensions and their interactions are simple, they facilitate the definition of objectives with a variety of stakeholders (even in a deliberative manner). Second, water security could deliver heuristic virtues to establish scenarios and clarify interdependencies among objectives, which would feed into participatory processes. Third, performance and coherence of governance options could be experimented

and assessed locally. Adaptive governance consists in combining these three advantages in an iterative fashion, which favours inclusion of context specificities and search for coherence.

Adaptive governance aims at involving local actors, framing the network differently from the classical hierarchical top-down process. Therefore, new actors could emerge and create a local leadership. It is proven that local leadership could be of paramount importance in facilitating local coordination and improving governance coherence (Gupta et al. 2010; Rijke et al. 2012). The Commission internationale pour la protection des eaux du Léman (CIPEL) case is an illustration for Switzerland. This commission focuses on the quality of Lake Geneva and advises contracting governments. Its scope is in line with most of water security dimensions. The CIPEL conducts in-depth analysis of governance and water-related issues, which leads to recommendations regarding the improvement of water quality. It plays a role to frame participatory process around Lake Geneva by providing stakeholders with information and facilitating their discussions. With that focus, water security attached to adaptive governance principles contributes to coherence of water regimes.

Involving stakeholders should benefit to water regime coherence in two other ways. First, it may fasten or anticipate identification of inconsistencies within the frameworks. In the case of the sediment flushing of the dam of Verbois (Switzerland) in 2012, public authorities held a public enquiry (Bolognesi and Bréthaut 2017). It resulted in a signed agreement between Switzerland and France to coordinate the flushing, with no inconsistencies in regard of use rivalries, technical constraints and existing legal frameworks. The flushing operated well with no disputes. The second main positive impact of stakeholders' involvement for water regime coherence is access to practical and local knowledge. It is clear that water use and related economic activities rest on strong technological and technical know-hows. Local and practical solutions could be unknown/not implementable by central policy-makers, which limit efficiency and/or simplicity of adopted solutions (Brown and Farrelly 2009).

Adapted governance provides a collective arena of measures helping to deal with such barriers. The case of Munich, Germany's drinking water delivery reform is symbolic of this opportunity. By opening the public

consultation and creating trade-offs with other sectors (mainly agriculture), the mayor of Munich engaged a reform that led to maintain cost of water, protect water resource and ecosystem and ensure social acceptability of the new organization (Krimmer 2010; Grolleau and McCann 2012). Swiss water regime should gain a lot in that perspective. As an illustration, operators that drive water services are multisectoral. They may be in a position to improve governance coherence by implementing technical novelty or to clearly display occurring interlinkages in such complex systems. Water security would contribute to frame trade-off consistently.

4.3 Benefits for Governance Extent

Adaptive governance framed by water security may have positive impacts on water regime extent (proposition 2.2). Water security forces to adopt a multidimensional perspective on water governance. It contributes to shed light on new areas of possible use rivalries. At the same time, participation induced by adaptive governance provides an arena to stakeholders that are usually out of the decision-making process. As we have seen, extent is the safest option to prefigure when planning evolution of water regime. Therefore, adaptive governance has less interest in that dimension than about coherence. Nonetheless, adaptive governance combined to water security could positively impact water regime extent. It is expected that enlarging participation guarantees taking into account new or forgotten use rivalries (Schultz et al. 2015). Increasing the number of stakeholders favours pointing out non-identified use rivalries. Information campaigns or involving civil society are generic tools in that respect.

5 Conclusion

This chapter shows that even if water security appears as a new mantra for water governance, cautious use is recommended. The current approach of water security, with both the assessment and governance perspective,

includes a normative standpoint: a water-secure world should solve the water crisis. Accordingly, water security becomes a target for water governance. Nevertheless, we argue that governance remains the key trigger of water crisis and that focusing on water security raises the risk to divert from water governance failures and functioning. We therefore elaborate on two propositions. The first proposition states that an integrated water regime spontaneously leads to a water-secure situation (proposition 1). The second proposition states that water security is an essential contribution of the evolution of water regime by anticipating issues in governance fitting and evolution (proposition 2.1) and new uses rivalries (proposition 2.2).

The chapter discussed the water security concept and emphasized the need for an integrative perspective (Zeitoun et al. 2016). The chapter defended the following main idea. Water crisis mainly results from governance issues. Consequently, it is of paramount importance to focus on governance per se. The question is rather how water security can support water governance improvement, than how to design governance to achieve water security. Most of the literature focuses on the latter question with the risk to diverting efforts. The great variations and disparities among water security assessments we observed strengthen our claim.

The analysis confirms our first proposition; it shows that measures of water security face high uncertainty because of data quality and knowledge of SESs. As a consequence, comparison of water security metrics highlights significant heterogeneity in evaluation. Besides, it appears that governance quality and level of wealth are key triggers of water security. The development of both coherence and extent of governance have positive impacts on water security, making the focus on governance even more relevant. We therefore explored the feedback loop, i.e., how water security can contribute to governance improvement (proposition 2). The combination of water security with adaptive governance has been identified as a promising source of water governance improvement, especially on the coherence dimension. We pointed out four key channels: (1) framing multisectoral and multilevel issues, (2) involving local knowledge, (3) creating leeway to adapt governance design to context specificities and (4) experimenting governance to ensure it fits for purpose.

Notes

1. The World Bank and the Natural Resource Governance Institute produce the WGI. The indicators assess six dimensions of governance (voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, control of corruption) and cover 215 countries over 1996–2014. We aggregate the value of these six dimensions to have a proxy of governance quality in the present study.
2. Indicators available at: www.bafu.admin.ch/umwelt/indikatoren/08605/index.html?lang=en

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