Water Policy 23 (2021) 556–580

Who may use scarce water? An expedition into the normative basis of sustainable decision-making norms for sustainable water use

Anna Schlattmann[a,*], Na'ama Teschner[b] and Christina von Haaren[a]

[a]*Institute of Environmental Planning, Leibniz University Hannover, Herrenhaeuserstr. 2, 30419 Hannover, Germany*
**Corresponding author. E-mail: schlattmann@umwelt.uni-hannover.de*
[b]*Department of Geography and Environmental Development, Ben-Gurion University of the Negev, P.O.B. 653, Beer-Sheva, Israel*

Abstract

Water is becoming an increasingly contested resource. Today, the sustainability of water use is assessed with different indicator frameworks that usually refer to the Sustainable Development Goals (SDGs) or other norms. Classifying international norms and the subsequent indicators for assessment according to their legitimacy will increase the practical relevance of assessment results. The classification will enable addressees to differentiate between mandatory obligations in water management and additional more ambitious targets for decisions on sustainable water distribution. This study presents 11 standards for sustainable water distribution which have been classified based on legitimacy and specificity. A literature review identified relevant international norms that were subsequently classified. Suggestions for the implementation of the standards and priorities in assessment methods are discussed. Through the new set of standards, assessment results can transparently be communicated to policymakers, NGOs and business and support them to identify their obligations for sustainable water use.

Keywords: Assessment; International standards; Legitimacy; Sustainability; Water distribution; Water governance

Highlights

- Compiled standards can be used by decision-makers for the spatial assessment of the sustainability of water use.
- Classification of norms according to legitimacy and specificity points to governmental actors where further operationalization is needed to implement and monitor sustainable water use.
- In competing situations, water allocation between environment and food production remains unsolved.

doi: 10.2166/wp.2021.239

Introduction

Water is an increasingly contested resource because of climate change and growing user demand (Wallace *et al.*, 2003). In emergent conflicts, freshwater allocations between competing users do often not even consider the environmental dimension of sustainable water use, that is the water requirements to sustain ecosystem functioning (Rijsberman & Molden, 2001; Haines-Young & Potschin, 2010).

The crucial question is how to solve distribution conflicts. Different institutions, authorities, business and consumers may have different ideas about the importance, that is weight that should be assigned to the different water uses in order to establish sustainable water use. Particularly land-use policy and its local implementation can significantly conflict with water policy targets related to biodiversity and ecosystem functioning (Nguyen *et al.*, 2020). Therefore, an assessment method with transparent standards is needed to evaluate the sustainability of water use. Such assessment can support different types of actors in their decision-making process, improve land-use planning and reduce trade-offs. The indicators used in the assessment should fulfil the criteria of credibility, saliency, legitimacy and feasibility (van Oudenhoven *et al.*, 2018), and they should reflect environmental policy and relevant legal frameworks in order to enhance their application (Heink & Kowarik, 2010; van Oudenhoven *et al.*, 2018). Though legitimacy is considered crucial, it is rarely used as a criterion for the selection of indicators (*ibid.*). In the context of legitimate water use, legitimacy is understood as based on legal norms, which have been developed in legitimized ways. Such legal norms, in principle, have to be accepted by everybody as a societal consent even if individual interests stand against them.

When assessing water allocation, public authorities should use norms that have sufficient (legal) legitimacy to ensure that the resulting decisions represent, at least, the minimum public welfare. One fundamental norm forming the common understanding of just water allocation is to 'not cause significant harm' (Wegerich & Olsson, 2010). In order to avoid uncertainty about the interpretation of (legal) frameworks and possibly misleading indicators (Fukuda-Parr, 2014), norms that support water allocation decisions should be as specific as possible or 'quantifiable' (van Oudenhoven *et al.*, 2018). Clarity and specificity of norms increase their influence (Merry, 2011; Fukuda-Parr, 2014). However, specification is challenging because of the complexity of cases on which they have to be applied. Therefore, the norms for the evaluation of water use sometimes have to be operationalized for a specific context and in general should be applied in the spatial context of where the water-related decisions are made, such as an aquifer, catchment area or political unit. Such standards can be used as the basis of water sustainability assessment for different addresses, who can deduce consequences for water management from the assessment results. Furthermore, transparent indicators that are based on legitimated norms would allow for assessing the current state of implementation of international law by countries and their responsible institutions as well as the comparison between different countries.

Approaches to the sustainability assessment of water uses include the Water Footprint (Hoekstra *et al.*, 2011) and Planetary Boundaries (Steffen *et al.*, 2015). However, their applicability is limited by little or no transparency about the underlying values. The binding character of the assessment is not apparent.

Because water resources are a common good of global concern, international norms should be chosen as standards. The Agenda 2030 with the Sustainable Development Goals (SDGs) (UN, 2015) is a voluntary commitment for sustainable development that is not legally binding for the participating states (Biermann *et al.*, 2017). Rather than establishing new goals, the SDGs reflect existing, although

fragmented, international law within a new framework (Kim, 2016). This gives them a strong legitimacy, contrary to what may appear at first glance. However, the SDGs lack specification and prioritization and thus hold potential for conflict and are difficult to implement (*ibid.*). In particular, the water-related SDGs that address agriculture, biodiversity and human drinking water needs reflect potentially conflicting objectives without prioritization.

Against this background, the objective of this study is to develop a basis for the normative evaluation of the (spatial) sustainability of quantitative water allocation and uses. Present research and policy recognize the importance of ecosystem functioning as a condition for sustainable water use and development (Costanza *et al.*, 2014; Shah, 2016). Existing concepts elaborating on the sustainability of quantitative water use such as Planetary Boundaries (Steffen *et al.*, 2015) and the Water Footprint Sustainability Assessment (Hoekstra *et al.*, 2011) consider environmental aspects in their valuation schemes. However, the evaluation of sustainability of water use and water use limits are mostly defined by hydrological conditions and scientific knowledge on ecosystem water demands and refrain from referring to legal aspects of sustainable water use and allocation. Therefore, this study focuses on environmental aspects of sustainability on the global level and identifies international norms that serve as standards for spatial sustainability evaluations. These standards are characterized according to their legitimacy and specificity. The purpose of this study is to support public and private actors in water-related decision making; to improve the acceptance of decisions by giving them a legitimate basis; and to increase the transparency of compliance with international legislation. The results should complement water use assessment methods as well as increase their transparency and legitimacy. To this end, the following research questions were explored:

(1) Which international norms serve as a basis for the quantitative, water-related SDGs (Clean Water and Sanitation, 6; Life on Land, 15 and No Hunger, 2), and do these norms further legitimize and specify the provisions of the SDGs with regard to transparent standards for sustainable water use in agriculture?
(2) How can the identified norms be classified according to their legitimacy and specificity?
(3) How could the norms be applied in a transparent assessment?

The questions were explored in three sections: Firstly, a literature review investigated different water-related norms at an international level and norms were classified based on legitimacy and specificity. Secondly, a framework was developed that relates legitimacy and specificity. Thirdly, approaches for the practical implementation of the international water-related standards were proposed and discussed.

Methods

Identification of international water-related standards

The identification of international water-related standards was conducted through a review of international norms and related literature officially published in English. The review covered international legislation and agreements that meet our eligibility criteria but not the broad scope of informal norms and morals issued by non-state actors. Requirements to the reviewed norms were their time of adoption, their final version, their international validity and their formal agreement and codification

allowing their analysis and comparison (Supplementary Appendix 1). Thus, the review included international law, such as international treaties, conventions and agreements, and international customary law. Furthermore, the review included soft standards for sustainable water use, namely norms from formal frameworks based on state governmental consent. Soft standards (should) influence actions of the states, but have no legally binding force (Keller, 2008; Wolfrum, 2008). An example is the Dublin Statement on Water and Sustainable Development (1992). The time frame for the selected documents was 1948 (adoption of Universal Declaration of Human Rights) until 2018. Water-related norms were considered from 1966 where the adoption of the Helsinki Rules marked a turning point in the understanding of sustainable water use. Programmes or plans for a defined period needed to overlap with the period of the Agenda 2030 (2015–2030). The selection also included norms that are near official adoption.

The relevant norms were identified through a manual database search from May to September 2018 of three databases: the 'United Nations Information Portal on Multilateral Environmental Agreements' (InforMEA), the 'Transboundary Freshwater Dispute Database' (TFDD) and the 'International Water Law Project (IWLP) Database' (Supplementary Appendix 2). Normative documents indicating quantitative water issues or environmental concerns on water were selected. Doublets and interim documents were excluded. The remaining documents have been searched for norms that address directly or indirectly quantitative water issues and water assessments. Related documents that interpret or specify the original norms were also screened for their relevance. The relevant norms were reported within a table indicating their source (Table 1). The exact wording of the norms was reported for analysis and verification (Supplementary Material 1). The norms were paraphrased and grouped according to their issues and summarized in order to compile a set of non-repetitive standards. The paraphrasing included, in part, the interpretation of norms in order to reveal their substantive meaning for quantitative water use. Where interpretation was needed, relevant specialized literature was consulted. The review was conducted by one person.

Classification of norms according to legitimacy

As knowledge about legitimacy and specificity promotes the effective implementation of a norm (Fukuda-Parr, 2014), the authors developed a matrix that classifies the norms with regard to their legitimacy and specificity. The matrix can be understood as a two-dimensional graph that relates the degree of legitimacy to the degree of specificity of a norm in order to describe and to compare the norms' suitability for practical implementation.

Normative documents were used to build the classification of legitimacy. Using the rule that legally binding norms have stronger legitimacy than soft standards, two classes of the norms' legitimacy were differentiated and ranked with the aid of the specified literature.

The academic discussion on the term legitimacy is diverse (Bodansky, 2008; Wolfrum, 2008) and reflects what is called here different degrees of legitimacy. Besides the (legally) binding character of rules (Wolfrum, 2008), other criteria such as democratic legitimacy (Held, 1995), output-based legitimacy (Bexell & Jönsson, 2016) or organizational legitimacy (Donoher, 2017) and their combinations (Bernstein, 2011) are proposed. The authors conclude that the ideal way to legitimize norms is a democratic communication process that gives at least some liability or self-binding effects for governments and if applicable for other institutions. For the classification, a clear distinction between legally binding norms and non-binding norms is needed. Therefore, the authors chose the following classification on a

Table 1. Normative documents included in the review, their institutional bodies, year of adoption, legal form and final classification of legitimacy.

No.	Short name	Name of the regulation	Institution	Year	Form	Legitimacy
1	SDGs	Transforming Our World: The 2030 Agenda for Sustainable Development	United Nations General Assembly (UNGA)	2015–2030	Resolution	Medium
2	Declaration of Human Rights	Universal Declaration of Human Rights	UNGA	1948	Resolution	Medium
3	RES/64/292	Resolution on the Human Right to Water and Sanitation, A/RES/64/292	UNGA	2010	Resolution	Medium
4	HRC/15/L.1	Resolution on Human Rights and Access to Safe Drinking Water and Sanitation A/HRC/15/L.1	Human Rights Council (HRC)	2010	Resolution	Medium
5	Covenant CESCR	International Covenant on Economic, Social and Cultural Rights	UNGA	1966/1976	Convention (treaty)	High
6	General Comment No. 15	General Comment No. 15 to the International Covenant on Economic, Social and Cultural Rights: The Right to Water	Economic and Social Council (ESC)	2003	General Comment	Medium
7	General Comment No. 12	General Comment No. 12 to the International Covenant on Economic, Social and Cultural Rights: The Right to Adequate Food	ESC	1999	General Comment	Medium
8	WHO (2003)	Domestic Water Quantity, Service Level and Health	WHO	2003	Report	Interpretation
9	WHO (2013)	Technical notes on drinking water, sanitation and hygiene in emergencies	WHO	2013	Technical notes	Interpretation
10	Helsinki Rules	The Helsinki Rules on the Uses of the Waters of International Rivers	International Law Association (ILA)	1966	Resolution	Medium
11	MPAP	Mar del Plata Action Plan	United Nations Water Conference	1977	Conference outcome	Medium
12	Belgrade Rules	Articles on the Relationship Between Water, Other Natural Resources and the Environment (Belgrade 1980)	ILA	1980	Resolution/ Articles	Medium
13	Dublin Statement	The Dublin Statement on Water and Sustainable Development	International Conference on Water and the Environment	1992	Conference outcome	Medium
14	Agenda 21	Agenda 21 - Protection of the Quality and Supply of Freshwater Resources: Application of Integrated Approaches to the Development, Management and Use of Water Resources	UN Conference on Environment and Development Rio de Janiero	1992	Conference outcome/ agreement	Medium

15	Rio Declaration	The Rio Declaration on Environment and Development	UN Conference on Environment and Development Rio de Janiero	1992	Conference outcome/ declaration	Medium
16	Water Convention	Convention on the Protection and Use of Transboundary Watercourses and International Lakes	United Nations Economic Commission for Europe (UNECE)	1992	Convention (treaty)	High
17	UNCCD	Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification Particularly in Africa	UNGA	1994	Convention (treaty)	High
18	Watercourse Convention	Convention on the Law of the Non-Navigational Uses of International Watercourses	UNGA	1997/2014	Convention (treaty)	High
19	Campione Consolidation	The Campione Consolidation of the ILA rules on international water resources	ILA, Committee on water resources law	2000	Resolution	Medium
20	Berlin Rules	Berlin Rules on Water Resources Law	ILA, Committee on water resources law	2004	Codified international customary law	Medium
21	Law of TB Aquifers	The Law of Transboundary Aquifers	UNGA	2016	By committee adopted draft resolution	Medium
22	Ramsar Convention	Convention on Wetlands of International Importance especially as Waterfowl Habitat	UNESCO	1971/1975	Convention (treaty)	High
23	Res. VIII.1	Resolution VIII.1, Guidelines for the allocation and management of water for maintaining the ecological functions of wetlands (to Ramsar Convention)	Conference of the Parties (CoP)	2002	Resolution	Medium
24	Res.VIII.40	Resolution VIII.40, Guidelines for rendering the use of groundwater compatible with the conservation of wetlands (to Ramsar Convention)	(CoP)	2002	Resolution	Medium
25	Res. VIII.14	Resolution VIII.14, New Guidelines for management planning for Ramsar sites and other wetlands (to Ramsar Convention)	(CoP)	2002	Resolution	Medium

(*Continued.*)

Table 1. (*Continued.*)

No.	Short name	Name of the regulation	Institution	Year	Form	Legitimacy
26	Ramsar Strategic Plan 2016–2024	The Ramsar Strategic Plan 2016–2024, Resolution XII.2	(CoP)	2016–2024	Resolution	Medium
27	CBD	Convention on Biological Diversity	UNGA/(CoP)	1992/1993	Convention (treaty)	High
28	ABTs	The Strategic Plan for Biodiversity 2011–2020 and the Aichi Biodiversity Targets	(CoP)	2011–2020	Convention (treaty)	High
29	CBD WP inland waters	Revised Programme of work on inland water biological diversity	(CoP)	2004	Adopted decision	High
30	CBD WP forests	Expanded Programme of work on forest biological diversity	(CoP)	2004	Adopted decision	High
31	CBD WP mountains	Programme of work on mountain biological diversity	(CoP)	2004	Adopted decision	High
32	WFD	Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy (WFD)	EU	2000	Directive, European Law	(High; European Union)

Note: Legitimacy was defined according to the rules in Table 2.

two-level ordinal scale (Table 2): 1. A 'high' degree of legitimacy is assigned to legally binding norms, such as the Convention on the Law of the Non-Navigational Uses of International Watercourses (UN Watercourse Convention). 2. 'Medium' legitimacy represents norms that have a strong political commitment and have been formally adopted by governments. This is true for agreements like the Berlin Rules on Water Resources Law (International Law Association (ILA)) and the SDGs (UN). For application, each standard was assigned to the class of legitimacy according to its underlying sources. Where the standard is expressed through more than one norm, the highest legal status was used as a determinant.

International treaties and conventions are the main source of international law that expressed the consent of states about rules they must comply with (Wolfrum, 2008; Burchi *et al.*, 2009). These norms were assigned to the class of 'high' legitimacy. Optional or mandatory declarations, which have a treaty character or are bound to a treaty and signed by the Head of States, are legally binding and were also classified to be 'highly' legitimated. Interpretive declarations that clarify the meaning of a provision by a party and have no legal impact on the treaty (UN, 2012) were classified as 'medium' legitimated. Most independent declarations, resolutions and recommendations are political statements without any effect on international law. Therefore, such agreements laid down by UN institutions are the main source of 'medium' legitimated standards while conventions are highly legitimized.

Customary law is regarded as a special case of international law that is established when many states agree on a practice and consider it to be binding. The recognition of customary law is expressed through repeated acts or practices (Burchi *et al.*, 2009). International customary law is codified either by the International Law Commission (ILC) on behalf of states, resulting in legally binding treaties such as the UN Convention on the Law of the Non-Navigational Uses of International Watercourse (Watercourse Convention 1997), or through the interpretation of private organizations. The Helsinki Rules (1966) are the result of the ILAs' efforts to codify the legal aspects of international customary law in the field of water use. Although this codification and subsequent documents (Campione Consolidation 2000; Berlin Rules 2004) have not received legally binding status, they are indispensable for international jurisdiction 'constituting an authoritative restatement of customary international law' (Burchi *et al.*, 2009). Despite their important role for international jurisdiction, norms expressed in codified customary law that are not codified within legally binding conventions were classified as of 'medium' legitimacy.

Table 2. Classes of legitimacy of norms with their definition and possible types of norms.

Legitimacy	Sources for assignment to class
High	Statutory norms, expressed in international law: • Multilateral conventions and treaties • Optional or mandatory declarations with treaty character or bound to a treaty, signed by the Head of States
Medium	Soft standards expressed through strong political agreements that lack legally binding force: • Interpretive declarations • Independent declarations, resolutions, recommendations, comments being the result of diplomatic exchanges • General Comments to the Covenant on Economic, Social and Cultural Rights • Non-binding codification of international customary law • Conventions or regulations near official adoption (would change to 'high' once adopted and then being statutory norms)

General Comments to the International Human Rights treaties are considered as a special case of interpretation of international law with undefined legal nature (Roth-Isigkeit, 2012). Scholars' opinions regarding their legitimacy are controversial, ranging from legal irrelevance to binding interpretations of the treaty. Because the General Comments are not legally binding from a formal perspective (*ibid.*), they were classified as of 'medium' legitimacy.

Classification of norms according to specificity

The classification scheme for specificity ranks standards into three classes that range from quantified standards with 'high' specificity to general principles with 'low' specificity (Table 3). The measurability of goals or norms is an important feature for assessment and resulting decision making (Merry, 2011), particularly in environmental management and landscape planning (Smeets & Weterings, 1999). The incorporation of numerically quantified targets or thresholds is facultative because goal attainment may also be measured by relative numbers on ordinal scales. Spatially specific substantial qualitative or quantitative targets, deduced from qualitative general norms may replace generally applicable quantitative thresholds or targets (von Haaren *et al.*, 2008; Fukuda-Parr, 2014). A high specification can be achieved for the right to water for domestic vital needs which can be quantitively defined by summing up different physical and essential household water needs.

Norms classified as 'medium' specific provide attributes that should be considered in the indicator selection for assessments, but they lack concreteness for their case-specific deduction. This is true for norms that mention not finally defined terms as goals such as 'habitat or biodiversity protection'. With the attribute 'low' specificity, we classified norms or goals, which are very general and lack specifications for measurement and aspirational target levels of unambiguous indicators. A general claim for limits of fossil water withdrawals is an example for low specification. However, if terms were clarified through judicial comments or expert interpretations or if processes for further interpretation are described, a ranking to the next higher class was possible. Tables 2 and 3 are used to create hybrid classes such as medium-high if criteria of both classes are met and a clear differentiation is not possible.

Table 3. Classes of specificity of norms with their criteria for assignment.

Specificity	Criteria for assignment to class
High	• Indicators or proxies for quantitative measurement • Numerical or relative thresholds (for case-specific deduction) for target levels • Delineated time frame of goals (optional)
Medium	• Aspects to be considered when choosing indicators • Aspects to be considered when estimating target levels • Directly related norms prescribe further interpretation ↑
Low	• General norm or principle, no specification for indicators or target levels that enable measurement • No time frame of goals (optional) • Directly related norms prescribe further interpretation ↑

Note: (↑) indicates conditions that allow for the classification into the next higher class.

Results

International standards for sustainable water use

The search of the databases identified 32 documents with relevant norms (Table 1). The documents range from human rights treaties to water and environmental regulations. Most of the documents have been adopted by significantly more than 100 parties including governments and other organizations. The Convention on Biological Diversity (CBD) leads the ranking with 196 parties. The Watercourse Convention has the fewest signatures with 39 parties, though adopted under the head of the UN General Assembly. The analysis of the norms led to 11 non-repetitive international standards and four sub-standards for sustainable water use (Table 4). The results show that the norms of the SDGs reflect existing international norms that can be used to classify targets according to legitimacy and specificity. Eleven standards have 'high' legitimacy, and four standards have 'medium' legitimacy. Six standards are 'highly' specified, five are of 'medium' specification and two are of 'low' specification. Another two standards were classified as 'medium-high' specific as they meet criteria of both classes. Besides these standards, the reviewed regulations express directly or indirectly technical requirements that should be considered in spatial assessments such as multiscale temporal and spatial approaches. The analysis of the norms revealed that the concept of sustainable water use must consider: water availability, the human right to water, water requirements for ecosystem functioning and for biodiversity and transboundary water allocation.

Available water

The concept of sustainable resource use is found in SDGs 2.4, 6.4 and 15.1. Similarly, most of the normative documents that were reviewed include the concept of the sustainable use of water resources, particularly the idea of sustainable withdrawals (UNECE, 2013). This concept is based on the understanding that resources use should 'meet[s] the needs of the present without compromising the ability of future generations to meet their own needs' (World Commission on Environment and Development, 1987) (Brundtland Report). The renewable water resources, generated through precipitation within an area, should determine the volume of water that can be sustainably used within a basin (Guidelines for the allocation and management of water for maintaining the ecological functions of wetlands, Res. VIII.1). The use of aquifers with little or no contemporary recharge is not specifically limited. The Berlin Rules tolerate extractions from these sources. Nevertheless, experts recommend that such aquifers should be regarded as 'fossil resources' that should be used only within the limits of maximum permissible withdraw rates compatible with sustainable aquifer management defined for each case (Boyle & Mehlem, 2004). Emerging technology can generate 'alternative water resources' (Berlin Rules) through desalination, artificial aquifer recharge and waste-water treatment and reuse.

Human right to water

The SDGs 6.1 and 6.2 directly express the human right to water and sanitation. SDGs 2.1, 2.3 and 2.4 reflect the right to food and related access to productive resources.

The individual right to water and food is expressed in the right to an adequate standard of living and to realize health and well-being (RES. A/HRC/15/L.1). Further international agreements restate and

Table 4. Normative standards for application in water use sustainability assessments deduced from the reviewed regulations and proposed approaches for their implementation.

Standard	SDGs	Sources	Legitimacy	Specificity	Approaches for implementation
Water availability					
1. Water resources are used sustainably, implying that the available water volume within a basin is limited through renewable water resources, where precipitation is the input value.	2.4; 6.4; 15.1	Water Convention (Art. 2); Watercourse Convention (Art. 3.1); Berlin Rules (Art. 7); Agenda 21 (no. 18.36), Dublin Statement (P1); Rio Declaration (P4); UNCCD (Art. 8); Res. VIII.1 (Art. 20)	High	High	Total consumption must not exceed available water volume. Water consumption has to include industrial, domestic, agricultural and ecosystem water use.
2. Adaption of available water budget or water demand if alternative water resources are used.	(2.4)	Berlin Rules (Art. 40)	Medium	Medium	Subtraction of desalinated water/treated water from the amount of consumed water.
3. Definition of target value for max. allowable drawdown of fossil aquifers or application of the precautionary approach	6.4	Berlin Rules (Art. 40)	Medium	Low	Water withdrawal from fossil aquifers is unsustainable per definition: 'precautionary approach'.
Human right to water					
4a) Allocation of water to satisfy the human vital needs of the population living in each basin state has priority	6.1; 6.2; 6.4	Watercourse Convention (Art. 10); Berlin Rules (Art. 14); Law of TB Aquifers (Art. 5); General Comment No. 15 (no. 6)	High	High	
b) All people should have adequate quantitative domestic water supply to realize health and well-being.		Declaration of Human Rights (Art. 25); RES. A/RES/64/292 (Art. 1); CESCR (Art. 11–12); RES. A/HRC/15/L.1 (Art.3); General Comments no. 15 (no. 12); WHO (2003, 2013)	High	Medium-High	Minimum water supply should not fall short of 20 l/c/d in the medium-term and 50 l/c/d in the long-term (Figure 1).

5. Water supply should be reserved for food production (subsistence farming) to realize the right to adequate food meeting dietary needs and cultural standards that is not realized by other means.	2.1; 2.3; 2.4	Declaration of Human Rights (Art. 25); CESCR (Art. 11–12); General Comments no. 12 (Art. 6–15)	High	Medium	States can engage in multiple actions to ensure the right. A quantification of minimum water supply for food is not possible.
Water for ecosystems, their functions and biodiversity					
6a) Not cause harm to ecosystems and ensure minimum quantitative water supply to sustain ecosystems' functions and biodiversity, not restricted to any type or source of water resources, depending on ecosystem requirements	6.6; 15.1	Watercourse Convention (Art. 20); Water Convention (Art. 2); Law of TB Aquifers (Art. 10); Belgrade Rules (Art. 1); Rio Declaration (P2); Berlin Rules (Art. 8, 22); CBD (Art. 8); Dublin Statement (P1, P4); MPAP (Art. 36); Agenda 21 (no. 18.36, 18.40); Ramsar Convention (Art. 3); Ramsar Strategic Plan (goal 1.2); Res. VIII.14 (Art. 15); UNCCD (Annex I–IV); ABT (goal D)	High	High	EFRs to sustain aquatic ecosystems (e.g. Pastor *et al.*, 2014) and reservation of evapotranspiration (ET) required to sustain ecosystems should be subtracted from available water (Rockström & Gordon, 2001).
b) Ensure minimum stream flows in quantity and inter-annual dynamic to sustain aquatic ecosystems		Campione Consolidation (Art. 10); Berlin Rules (Art. 24); Res. VIII.1 (Art. 10, 20, 28); Res. VIII.14 (15)	High	High	
7. For recharging aquifers, in average withdrawals should not exceed recharge rates, exceptions might be allowed in the short term.	6.4	Berlin Rules (Art. 40); Law of TB Aquifers (Art. 5; 10, 11); WFD[a] Annex V	Medium	High	Indirectly incorporated in the assumption that consumption of available water respects groundwater recharge if considered in long-term.

(*Continued.*)

Table 4. (*Continued.*)

Standard	SDGs	Sources	Legitimacy	Specificity	Approaches for implementation
8a) Halt the loss of biodiversity through habitat conservation, especially those with special importance for biodiversity (threatened species, high biodiversity)	(6.6); 15.1; 15.5	CBD (Art. 1, 8); ABT (goals B, C, D); Ramsar Strategic Plan 2016–2024 (goal 3)	High	Medium	Wetlands, protected areas according to IUCN, Ramsar and Key Biodiversity Areas present areas where special evaluation should be undertaken:
b) Identify inland water ecosystems incl. wetlands and forests that have special importance for biodiversity and protect them with priority		CBD (Art. 8); ABT (goals B, C, D); Ramsar Strategic Plan 2016–2024 (goal 3); CBD WP inland waters (goal 1.2.2; 1.3.2); CBD WP forests (Goal 3, obj. 3f); CBD Annex I Nr. 1	High	Medium	I) Identification of potential groundwater-dependent ecosystems (GDEs) according to groundwater table depth and vegetation rooting depths (Eamus *et al.*, 2006). II) Identification of near-surface inflow dependence through DEM based hydro-shed modelling.
c) Mountain ecosystems with special importance for biodiversity and mountain areas adjacent to protected areas should be identified and protected with priority		CBD (Art. 8); CBD WP mountains (goals 1.1, 1.2)	High	Medium	
9. Wise use and protection of wetlands in particular of Ramsar sites, through water allocation in wetlands as closely as possible to the 'natural regime' established under current land cover, including water regime elements as historical patterns of flow, rainfall and groundwater supply, taking the precautionary approach where needed	(6.6); 15.1; 15.5	Agenda 21 (no. 18.40); Ramsar Convention (Art. 2, 3); Res. VIII.1 (Art. 10, 20, 28); Res. VIII.40 (no. 19); Ramsar Strategic Plan (goal 1–3); ABTs (goal D); MPAP (Art. 36 m)	High	Medium-High	

Transboundary water allocation					
10. 'Reasonable and equitable' water allocation of transboundary surface waters between basin states, defined through natural basin characteristics as geography, hydrography, climate, past, present and future socio-economic factors	6.5	Helsinki Rules (Art. 5); Campione Consolidation (Art. 4); Watercourse Convention Art. 5, 6); Water Convention (Art. 2.2c); Berlin Rules (Art. 12, 13); Law of TB Aquifers (Art. 4, 5)	High	Low	Division of stream flow in two equal categories. First half is allocated as to entitle use of 50% of the flow generated within the country; second half allocated relative to proportions of water use of all basin states in the 1960s that represent socio-economic conditions of the industrialized society before intensification of water use of upstream countries (Beaumont, 2000).
11. The renewable aquifer recharge generated within a state's territory can sustainably be used by the state	6.5	Law of TB Aquifers (Art. 3)	Medium	High	See no. 6

[a]WFD is legally binding for EU member states, for global scope it cannot serve as argument for legal legitimation.

specify this right (CESCR, 1999, 2003; UNGA, 2010). The legitimation of the right to water is obviously very high. Achieving an adequate standard of living requires a sufficient amount of water to satisfy personal and domestic uses, including drinking, personal sanitation, washing of clothes, food preparation and personal and household hygiene (CESCR, 2003). International organizations such as the World Health Organization (WHO) and Food and Agriculture Organization (FAO) have estimated the required minimum water use (Figure 1). Their recent concepts are dynamic. Based on the current water supply, the concept indicates minimum values which should be raised to medium- and long-term targets. Twenty litres per capita and day (l/c/d) are considered as the absolute but not desirable minimum (WHO, 2003). Current water supply less than 20 l/c/d is considered 'insufficient' and should be raised to a 'basic service' of 20 l/c/d in the medium-term and to an 'intermediate service' of 50 l/c/d in the long-term. Water supply for people currently supplied with 20–49.9 l/c/d should stepwise be raised to 'intermediate service' and then 'optimal supply' of 100 l/c/d. An actual supply of more than 50 l/c/d should be maintained for the medium-term and should be raised to the 'optimal supply' in the long-term if needed. Summarizing, the long-term minimum target should be 50 l/c/d for everyone (intermediate service) and 100 l/c/d for the majority of people (optimal service) (WHO, 2003, 2013; Bos *et al.*, 2016). However, the WHO qualifies this statement by pointing out that it is impossible to proclaim explicit and universal values because the required minimum amounts vary significantly with the access to water (WHO, 2003). Thus, the stated minimum values cannot be legally binding (WHO, 2003; Bos *et al.*, 2016).

Furthermore, the human right to water encompasses the right to water for food. This right can be achieved through access to water resources for food production, in particular for subsistence farming of vulnerable groups. However, states can also engage in other activities that ensure food security (CESCR, 1999), and therefore, it is not possible to quantify the water requirement exactly. In this study, water requirements for subsistence farming are considered within the standard for domestic water use.

Water for ecosystems, their functions and biodiversity

The SDGs 6.6, 15.1 and 15.5 express the right of ecosystems to water. In particular, water-related ecosystems, such as forests, wetlands, rivers, aquifers, lakes and mountain regions, should be restored and protected to a level that ensures the maintenance of their functions and biodiversity.

Current water supply ranked in supply classes [l/c/d]*		Medium-term target dependent on current water supply	Long-term target dependent on calculated medium-term supply
≤ 19.9l	'insufficient'	'basic service' (20l/c/d)	'intermediate service' (50l/c/d)
20l – 49.9l	'basic service'	'intermediate service' (50l/c/d)	'optimal supply' (100l/c/d)
50l – 99.9l	'intermediate service'	maintain current supply	'optimal supply' (100l/c/d)
≥ 100l	'optimal supply'	maintain current supply	maintain current supply

*litre per capita and day

Fig. 1. Proposed medium-term and long-term targets for minimum water supply for domestic use. Based on: WHO (2003, 2013); Bos *et al.* (2016).

Likewise, the principle of 'no significant harm' and the claim to protect, restore and conserve ecosystems reflect the ecosystems right to water on a 'high' level of legitimacy (Table 4). In view of the controversial interpretation of the 'no harm' rule and its relation to the principle of 'equitable and reasonable utilization' (Utton, 1996; Caflisch, 1998), we support the suggestion that the principle of 'no environmental harm' should be treated as a separate standard, together with the obligation to protect, restore and conserve ecosystems (*ibid.*). However, the water-related regulations have to be seen in the context of further obligations to protect biodiversity such as the CBD or the Ramsar Convention.

For sustainable use, the amount of water supply to ecosystems must be sufficient to maintain 'ecological integrity' (Berlin Rules Art. 22) or 'viable structures, functions and species compositions' (UNECE, 2013). These provisions neither limit the required water supply to a certain type or source of water nor do they exclude terrestrial and semi-terrestrial ecosystems from that right. For surface water flows, the regulations are specific and demand that 'adequate stream flows' should be ensured in order to protect the ecological integrity (Berlin Rules; Campione Consolidation; (Res. VIII.1)). Minimum stream flows that consider inter-annual variations and further natural attributes have to express the 'controlling standard' for ecosystem functioning. Although the method to define the minimum flow is not specified in the Water Convention (Boyle & Mehlem, 2004), the 'Guide to Implementing the Water Convention' (UNECE, 2013) recommends that EU and non-EU countries consult the Water Framework Directive (WFD) for further specifications. In contrast, for soil moisture, the norms fail to specify limits or criteria. However, hydrologic ecosystem conditions related to groundwater are more specifically protected.

Natural and artificial recharge to and discharge from an aquifer should be sufficient to ensure the continuous functioning of the aquifer and aquifer-dependent ecosystems (Berlin Rules; The Law of Transboundary Aquifers (Law of TB Aquifers)). In other words, long-term average withdrawals should not exceed recharge rates (Boyle & Mehlem, 2004).

A major concern of the Agenda 2030 is habitat conservation for the protection of biodiversity (SDGs 6.6, 15.1, 15.5). The CBD and the Aichi Biodiversity Targets (ABTs 11 & 14) restate this concern with legally binding force. Three working programmes serve as legally binding implementation provisions, which designate priority sites for conservation, rehabilitation and restoration of biodiversity (Programmes of work on inland water, forest and mountain biological diversity (2004)). For the identification of priority sites for inland water ecosystems, the programme refers to: the ecosystems listed in Annex I of the CBD, the International Union for Conservation of Nature (IUCN) protected areas and to protected Ramsar sites. Although the programmes about forests and mountain ecosystems do not contain such explicit provision, they assume similar requirements for the selection of priority sites.

Moreover, the Ramsar Convention implies that the large amount of water needed to sustain a wetland should be considered in evaluation procedures in particular for areas protected by the convention. The need to preserve a water regime 'as closely as possible to the natural regime in order to maintain the natural ecology' (Res. VIII.1) specifies water requirements of wetlands. The Convention states explicitly that the estimated water requirements should also consider water regime elements such as historical patterns of flow, groundwater fluxes, rainfall and their inter-annual variability and current land use (Res. VIII.1). In situations where exact requirements cannot be identified, the precautionary approach should be applied (Res. VIII.1). On the international level, the determination of water allocation principles can be expected. However, they must be downscaled and translated into more specific water demands using adequate methods.

Transboundary water allocation

Physical water allocation in transboundary basins is vaguely addressed within general norms, and expert interpretations are contradictory. The present international water legislation holds two principles that are extensively discussed in terms of their intention, scope, prevalence and their practical implementation: the principle of 'equitable and reasonable utilization' and the principle 'not cause significant harm' (Caflisch, 1998; McCaffrey, 1998; Salman, 2007; Wegerich & Olsson, 2010; McIntyre, 2015). Both principles embody the 'the right to use water but at the same time acknowledges the duty to take responsibility for actions that might harm other states' (Beaumont, 2000). Utton (1996) suggests decoupling the two principles and forming separate standards: the principle of equitable and reasonable utilization should guide the amount of water allocated between states in the absence of any environmental harm. When significant harm to the environment occurs with respect to water quality and quantity issues, a state is obliged to exercise due diligence to avoid significant harm.

For the compilation of the standards, the authors followed this argumentation. United Nations regulations and codified customary law provide non-exhaustive lists of aspects to be considered when determining 'equitable and reasonable' utilization. Still, no guidance exists on how to weigh the relevance of these aspects. Although no priority is given to any aspect, in case of conflict special regard should be given to water requirements to sustain vital human needs (Watercourse Convention; Berlin Rules; Law of TB Aquifers) and to serve further water needs of the population in each basin state. All norms except the Water Convention also consider the natural basin conditions aspect for the allocation of transboundary waters. However, predominantly the non-binding norms specify this attribute in terms of geography, hydrography and hydrology, including the proportion of a basin within a country and related recharge and discharge, climate and further ecological or natural factors help to determine the sustainable water allocation (Supplementary Appendix 3). Further attributes for consideration that are claimed by most of the documents are economic and social needs of the basin countries and the protection of water resources. Their degree of specification and emphasis varies significantly according to the different documents.

Furthermore, any state can use the renewable recharge of independent aquifers that is generated within a state's territory in a sustainable manner (Law of TB Aquifers). This standard, however, is not legally binding.

Relation between legitimacy and specificity of the standards

A classification matrix was developed that shows the interplay of legitimacy and specificity of international standards (Figure 2). The classification shows that standards that enjoy consensus in the international community and that are comparatively easy to measure have high legitimacy and specification. Controversial and complicated issues are lacking in specification but particularly in legitimacy. Standards with high legitimacy and high specificity are: 1. 'Renewable water', 4a and b 'Priority for domestic water supply', 6a and b 'Water for ecosystem functioning including Environmental Flow Requirements' and 9 'Special water supply for wetlands'. The opposite, medium legitimacy and low specificity is assigned to standard 3 'Drawdown of fossil aquifers'.

The binding standards address the limitation of water use to renewable water resources, domestic water use including subsistence farming, surface water flows and environmental issues while groundwater issues are only addressed by non-binding regulations. Standards for the protection of ecosystems and

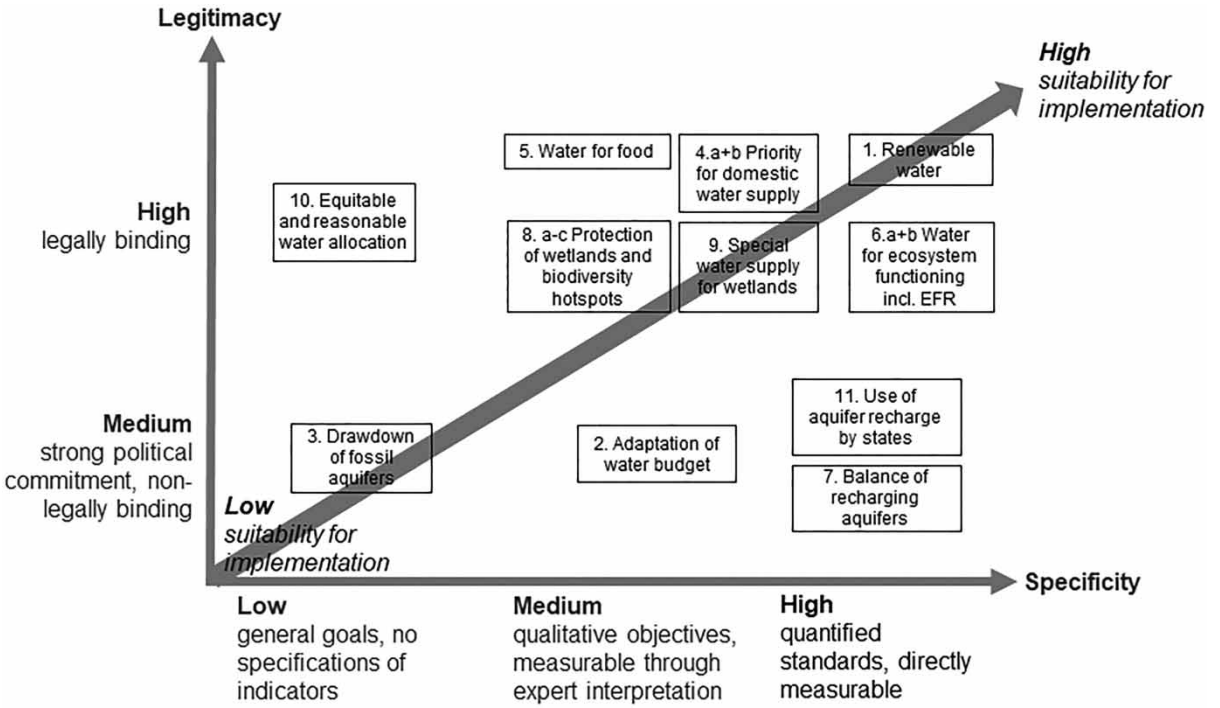

Fig. 2. Matrix presenting the characterization of standards based on legitimacy and specificity. The standards are numbered from 1 to 11 according to Table 4.

their functions are well represented in international norms. The requirement to preserve environmental flows is 'highly' legitimated (Res. VIII.1; New Guidelines for management planning for Ramsar sites and other wetlands (Res. VIII.14); Berlin Rules) and 'highly' specified. Nonetheless, the standards that directly address wetlands or areas of high biodiversity must be downscaled to the concrete case. Normative provisions that promote their implementation refrain from defining concrete requirements which is probably unavoidable because of the complexity of the specific ecological conditions in each case.

Discussion

This study analysed international norms in order to compile a set of standards that transparently describe conditions for sustainable water use that different actors can use in assessment procedures. With respect to the first research question, the findings show that existing international norms further legitimize and specify the SDGs. Many of the identified norms have similar objectives; therefore, the number of standards that actors should consider as mandatory core can be reduced to 11 standards and four sub-standards. The focus on the environmental and social perspective does not consider economic requirements, which are not legally binding but may introduce, for example, the demand for efficient water use. However, additional criteria reflecting stakeholder preferences can easily be added as long as they respect the limits set by the mandatory social and ecological water requirements.

The classification in Figure 2 supports the transparent communication of the evaluation results to any addressee. Different actors can apply binding standards in a spatial evaluation of water uses. Further criteria provide guidance about norms that are internationally agreed on, but not strictly mandatory. Nevertheless, the classification of norms is unable to reflect the fluid boundaries between classes of legitimacy and specificity. This is partly due to the fact that guidelines on the international level in some cases cannot be specified sufficiently to consider the variety of options that occur locally, in particular in the field of personal and food water requirements and transboundary allocation of water (Table 5). Food water requirements are for example influenced by availability and affordability of market products as well as societal and cultural aspects of water use that vary significantly (General Comment No. 12 and General Comment No. 15).

With respect to the second research question, we therefore conclude that the specification may be a task on a national scale or for subsidiary agreements (Burchi *et al.*, 2009). Nevertheless, this does not influence the legitimization and practical relevance of international norms. Very often specification requires no or only little additional normative input and can be done by scientists who adapt their approaches to national data availability. Nevertheless, for international comparability, scientific methods and any normative additions should be standardized, which is still a long way off.

Four legally binding standards have high specificity: 1. Use of renewable water resources only; 4a. Priority of domestic water use over other uses; and 6a + b. Ensure water to sustain ecosystem functioning, including Environmental Flow Requirements (EFRs). The majority of standards are specified to a medium or low degree. The characterization reveals that most standards addressing environmental issues as wetland conservation and protection of biodiversity are legally binding but not specified. The specification of the water requirements for ecosystems is challenging since this requires the definition of acceptable variations in water supply for the different water-dependent habitats. 'Ensure EFRs' is the single standard that incorporates guidance for implementation, but it does not prescribe specific standardized methods. Therefore, a variety of different approaches has evolved (Pastor *et al.*, 2014). In contrast, further water requirements, that is soil moisture and groundwater fluxes of (semi-) terrestrial ecosystems are only indirectly referred to, as they constitute possible attributes needed to sustain ecosystem functioning. Nevertheless, soil moisture is considered to have high importance for holistic water sustainability assessments (Rockström & Gordon, 2001). Although the ABTs and the CBD working programmes specify priority areas for biodiversity conservation, the pursued target level of ecosystem functioning and indicators for measurement are missing. Indicators based on evapotranspiration need further research but hold promise for use in assessments (Fisher *et al.*, 2017). Similarly, the literature recommends that the preservation of biodiversity should be considered when setting thresholds for the drawdown of groundwater (Boyle & Mehlem, 2004). The EU WFD exemplifies how 'good ecosystem health' can set the target level for sustainable water allocation. In the case of groundwater, indicators of quantity, timing and groundwater connection are applied on a legally binding basis. In contrast to recharging aquifers, international regulations do not yet specify acceptable drawdown of groundwater levels of fossil aquifers. The Berlin Rules are interpreted in a way that drawdown rates need to be defined that ensure 'sustainable water management' according to Article 7 which is subject to the state's view on defending and improving the environment for present and future generations (Boyle & Mehlem, 2004).

This study suggested measurable indicators for the majority of standards for practical application in assessments (Table 3). The indicators are sufficiently legitimated and specified in the fields of 'hard law' mentioned above. Others are based on non-binding interpretations of legitimate norms. The application

Table 5. Legitimacy and priorities of water demands of different users.

Water use	Legitimacy	Specificity	Priority	Unsolved questions causing conflicts
Personal and domestic	High	Sufficient	High	Water demand strongly depends on type of provision, and the min. required quantities cannot be precisely defined.
Ecosystem functions and biodiversity	High	Medium (*sufficient for specification for defined sites, on basis of principles*)	High (*for protected areas, implementation dependent on national policies*)	Standardized methods for downscaling principles to concrete areas, including biodiversity are missing.
Food production	Medium	Medium (*priority groups to be served, definition of adequate food*)	Medium to high (*depending on the concrete situation*)	High variety of options, too little guidance as to • Amount and distribution of production – role of market mechanisms • Adequate diets incl. cultural acceptability
Transboundary allocation	High	Low-medium (*possible factors for consideration*)	Medium	Standards give variety of options as to • Which factors should be considered when estimating equitable and reasonable use, ambiguity about weight and priorities • Minimum delivery of upstream users to downstream
Fibre, wood	Low (*but provide further ecosystem functions*)	–	Depending on national policies	Missing relation to standard for ecosystems maintenance, role of fibre production for other functions than production function has to be clarified.
Energy	–	–	Depending on national policies	Degree of contribution of energy production and industry to living standard and well-being cannot be estimated, impacts on society of alternatives not using water remain unclear.
Industry	–	–	Depending on national policies	

Note: Characterization based on priorities between the uses and currently unsolved questions help to define sustainable water use and to identify where further clarification is needed.

of standards is particularly challenging when multiple aspects and regionally differing demands must be considered. This applies to the personal right to water and the right to water for food production, water for ecosystems and the valuation of transboundary water allocation.

Interestingly for agriculture, only subsistence farming has legitimized water claims. Furthermore, water allocation priorities between the different water uses related to human rights still need to be defined (Table 5). Normative frameworks are more specific in the case of household water needs compared with biodiversity and subsistence farming. By this, the international legislation gives household water requirements an indirect priority (Windfuhr, 2013). In the case of food production, there may be an implicit assumption that market mechanisms will guide food production to those areas with sufficient water resources.

Furthermore, the substantive content of 'equitable and reasonable utilization' of water resources in transboundary basins is likely to mean different things to countries (Beaumont, 2000). The low specificity and manifold possibilities of interpretation of this norm raise doubts that the norm could become operational (Caflisch, 1998; Beaumont, 2000; McIntyre, 2015). However, the various regulations list different attributes that should guide 'equitable and reasonable utilization' and clarify that natural conditions, social and economic needs are all important. For practical assessment, experts have made non-binding recommendations that the allocation of river flow considers flow generation within countries and their historical water use in the 1960s (Beaumont, 2000; Table 3). The suitability of that date is debatable because most of the water agreements were made prior to 1960. This expert recommendation focuses on the Watercourse Convention and further norms and not on contracts between basin states. Bi- or multilateral contracts between basin states are generally older than these international norms and often contradict the current legal view on equitable and reasonable water allocation (Wegerich & Olsson, 2010).

The different degrees of legitimacy and specificity may cause their mutual influence. For instance, standard 10 (equitable and reasonable water allocation) has a high legitimacy but a low specificity. It seems that the lack of specificity in standard 10 could hinder the proper implementation of standards 1 (renewable water), 7 (balance of recharging aquifers) and of the not yet legally binding standard 11 (use of aquifer recharge by states). On the flip side, the high specificity of standards 1, 4, 5, 6 and 7 can help to specify to standard 10. Furthermore, standard 5 (water for food) has high legitimacy but remains ambiguous concerning the quantification of required water supply. In concrete allocation tasks, this fact may question the relation and priority compared with specified standards such as water for ecosystem functioning (6). For standards with high specificity but low legitimacy, it is recommended that the international community strengthens the corresponding norms through legally binding conventions. Raising the specificity of standard 5 or standard 10 on an international level is more difficult. However, the commitment to unambiguous attributes and priorities to specify the standards would be desirable.

All things considered, there is robust international legislation for protecting water resources, which can be downscaled in sustainability assessments to place-based evaluations of water use and distribution. In order to ease this process and make results more comparable, standards for the mapping and assessment process should be specified. This is not meant as a demand for one size fits all targets or thresholds, but as a request for guidelines for calculating how much water can be extracted for different regions under different conditions in individual cases.

Finally, we propose the transparent assessment of water use sustainability based on international legitimized standards by estimating the amount of sustainable usable water (standards 1 and 2) minus the water required to fulfil the sustainability standards as described in Table 4. This calculation respects the priority of domestic water consumption (standard 3) and the water requirements to sustain ecosystem

functioning and biodiversity (standards 5–9). The remaining amount of water is allocated between basin states according to standard 10 and can be used for other purposes such as agriculture or industry.

Conclusions

Environmental and social water requirements are considered in many international regulations. This study has developed a framework of criteria for sustainable water use that are classified according to legitimation and specification. We found that there is robust international legislation for protecting water resources, which could be downscaled in sustainability assessments to place-based evaluations. Methodological challenges occur, in particular, in quantifying concrete limits for water required for food production, water for ecosystems functioning and equitable and reasonable water allocation in transboundary basins. Most of these challenges are considered solvable. For domestic water use, a dynamic valuation approach is suggested that is based on the priority of water allocation for domestic uses. The definition of variations in water supply that are acceptable for the different water-dependent ecosystems should not only refer to the EFRs of aquatic ecosystems but also to groundwater connectedness and near-surface inflow dependence of (semi-) terrestrial ecosystems. Feasible approaches should consider groundwater table depths and allowable drawdowns, under which groundwater connectedness is maintained. Considering the general acceptance of the precautionary approach within environmental regulations (UNESCO & COMEST, 2005), we recommend that this principle is applied when exact water requirements are unknown, local data for hydrological calculations are missing or fossil aquifers are used.

This framework can be taken as a basis for the spatial assessment of the sustainability of agricultural water use. Moreover, the framework enables (governmental) actors to recognize where operationalization is needed on an international or national level. Furthermore, the spatial information can support authorities, NGOs, business and other public or private actors in decisions about water uses or allocations. The results can also be used as a yardstick for assessing the compliance of legal systems with international legislation of sustainable water use.

Conflict of interest

The authors declare that they have no conflict of interest.

Acknowledgements

Research was funded by the German Federal Ministry of Education and Research (BMBF) (grant number 02WGR1423D).

Data availability statement

All relevant data are included in the paper or its Supplementary Information.

References

Beaumont, P. (2000). The 1997 UN Convention on the Law of Non-Navigational Uses of International Watercourses: its strengths and weaknesses from a water management perspective and the need for new workable guidelines. *International Journal of Water Resources Development 16*(4), 475–495. doi:10.1080/713672536.

Bernstein, S. (2011). Legitimacy in intergovernmental and non-state global governance. *Review of International Political Economy 18*(1), 17–51. doi:10.1080/09692290903173087.

Bexell, M. & Jönsson, K. (2016). *Legitimacy of the UN Sustainable Development Goals?* Available at: https://www.statsvet.su.se/leggov/blog/legitimacy-of-the-un-sustainable-development-goals-1.298932 (Cited October 8 2019).

Biermann, F., Kanie, N. & Kim, R. E. (2017). Global governance by goal-setting: the novel approach of the UN Sustainable Development Goals. *Current Opinion in Environmental Sustainability 26–27*, 26–31. doi:10.1016/j.cosust.2017.01.010.

Bodansky, D. (2008). The concept of legitimacy in international law. In *Legitimacy in International Law*. Wolfrum, R. & Röben, V. (eds.). Springer, Berlin.

Bos, R., Alves, D., Latorre, C., Macleod, N., Payen, G., Roaf, V. & Rouse, M. (2016). *Manual on the Human Rights to Safe Drinking Water and Sanitation for Practitioners*. IWA Publishing, London, UK.

Boyle, A. E. & Mehlem, K. (2004). Berlin Conference Water Resources Law. In *Fourth Report of the International Law Association (ILA)*.

Burchi, S., Vapnek, J. & Popp, C. (2009). International water law. In *Law for Water Management: A Guide to Concepts and Effective Approaches*. Vapnek, J., Aylward, B., Popp, C. & Bartram, J. (eds.). Food and Agriculture Organization, Rome.

Caflisch, L. (1998). Regulation of the uses of international watercourses. In *International Watercourses Enhancing Cooperation and Managing Conflict: Proceedings of a World Bank Seminar*. Salman, M. A. & Boisson de Chazournes, L. (eds.). The World Bank, Washington DC.

Committee on Economic, Social and Cultural Rights, (CESCR) (1999). *General Comment No. 12: The Right to Adequate Food (Art. 11)*. Twentieth session of the Economic and Social Council of the United Nations, 12.05.1999. United Nations Economic and Social Council, Geneva.

Committee on Economic, Social and Cultural Rights, (CESCR) (2003). *General Comment No. 15: The Right to Water (Arts. 11 and 12 of the Convenant)*. Twenty-ninth session of the Committee on Economic, Social and Cultural Rights of the United Nations, 20.01.2003. (E/C.12/2002/11). United Nations Economic and Social Council, Geneva. doi:10.1111/1467-9922.53221.

Costanza, R., de Groot, R., Sutton, P., van der Ploeg, S., Anderson, S. J., Kubiszewski, I., Farber, S. & Turner, R. K. (2014). Changes in the global value of ecosystem services. *Global Environmental Change 26*, 152–158. doi:10.1016/j.gloenvcha.2014.04.002.

Donoher, W. J. (2017). The multinational and the legitimation of sustainable development. *Transnational Corporations 24*(3), 49–60. doi:10.18356/5dbad6d9-en.

Eamus, D., Froend, R., Loomes, R., Hose, G. & Murray, B. (2006). A functional methodology for determining the groundwater regime needed to maintain the health of groundwater-dependent vegetation. *Australian Journal of Botany 54*(2), 97–114. doi:10.1071/BT05031.

Fisher, J. B., Melton, F., Middleton, E., Hain, C., Anderson, M., Allen, R., McCabe, M. F., Hook, S., Baldocchi, D., Townsend, P. A., Kilic, A., Tu, K., Miralles, D. D., Perret, J., Lagouarde, J. -P., Waliser, D., Purdy, A. J., French, A., Schimel, D., Famiglietti, J. S., Stephens, G. & Wood, E. F. (2017). The future of evapotranspiration: global requirements for ecosystem functioning, carbon and climate feedbacks, agricultural management, and water resources. *Water Resources Research 53*(4), 2618–2626. doi:10.1002/2016WR020175.

Fukuda-Parr, S. (2014). Global goals as a policy tool: intended and unintended consequences. *Journal of Human Development and Capabilities 15*(2–3), 118–131. doi:10.1080/19452829.2014.910180.

Haines-Young, R. & Potschin, M. (2010). The links between biodiversity, ecosystem services and human well-being. In *Ecosystem Ecology: A New Synthesis*. Raffaelli, D. G. & Frid, C. L. (eds.). Cambridge University Press, New York.

Heink, U. & Kowarik, I. (2010). What criteria should be used to select biodiversity indicators? *Biodiversity and Conservation 19*(13), 3769–3797. doi:10.1007/s10531-010-9926-6.

Held, D. (1995). *Democracy and the Global Order: From the Modern State to Cosmopolitan Governance*. Stanford University Press, Stanford, Calif.

Hoekstra, A. Y., Chapagain, A. K., Aldaya, M. M. & Mekonnen, M. M. (2011). *The Water Footprint Assessment Manual: Setting the Global Standard*. Earthscan, London.

Keller, H. (2008). Codes of conduct and their implementation: the question of legitimacy. In *Legitimacy in International Law*. Wolfrum, R. & Röben, V. (eds.). Springer, Berlin.

Kim, R. E. (2016). The nexus between international law and the sustainable development goals. *Review of European, Comparative & International Environmental Law 25*(1), 15–26. doi:10.1111/reel.12148.

McCaffrey, S. (1998). The UN Convention on the Law of the Non-Navigational Uses of International Watercourses: prospects and pitfalls. In: *International Watercourses Enhancing Cooperation and Managing Conflict: Proceedings of a World Bank Seminar*. Salman, M. A. & Boisson de Chazournes, L. (eds.). World Bank Technical Paper 414. The World Bank, Washington DC.

McIntyre, O. (2015). The principle of equitable and reasonable utilisation. In *The UNECE Convention on the Protection and Use of Transboundary Watercourses and Lakes: Its Contribution to International Water Cooperation*. Tanzi, A., McIntyre, O., Kolliopoulos, A., Rieu-Clarke, A. & Kinna, R. (eds.). Brill. doi:10.1163/9789004291584_012.

Merry, S. E. (2011). Measuring the world: Indicators, human rights, and global governance. *Current Anthropology 52*(S3), S83–S95. doi:10.1086/657241.

Nguyen, Q. H., Tran, D. D., Dang, K. K., Korbee, D., Pham, L. D. M. H., Vu, L. T., Luu, T. T., Ho, L. H., Nguyen, P. T., Ngo, T., Nguyen, T. T., Wyatt, D. T. K., Aalst, A., Tran, M., & Sea, T. A. & B, W. (2020). Land-use dynamics in the Mekong delta: from national policy to livelihood sustainability. *Sustainable Development 28*(3), 448–467. doi:10.1002/sd.2036.

Pastor, A. V., Ludwig, F., Biemans, H., Hoff, H. & Kabat, P. (2014). Accounting for environmental flow requirements in global water assessments. *Hydrology and Earth System Sciences 18*(12), 5041–5059. doi:10.5194/hess-18-5041-2014.

Rijsberman, F. R. & Molden, D. (2001). *Balancing Water Uses: Water for Food and Water for Nature*. Draft Thematic Background Paper. Secreteriat of the International Conference on Freshwater 2001, Bonn.

Rockström, J. & Gordon, L. (2001). Assessment of green water flows to sustain major biomes of the world: implications for future ecohydrological landscape management. *Physics and Chemistry of the Earth, Part B: Hydrology, Oceans and Atmosphere 26*(11), 843–851. doi:10.1016/S1464-1909(01)00096-X.

Roth-Isigkeit, D. (2012). Die general comments des menschenrechtsausschusses der vereinten nationen – ein beitrag zur rechtsentwicklung im völkerrecht. The general comments of the United Nations Humans Rights Committee – a contribution to the legal development in international law. *MRM MenschenRechtsMagazin 17*(2), 196–210.

Salman, S. M. A. (2007). The Helsinki Rules, the UN Watercourses Convention and the Berlin Rules: perspectives on international water law. *International Journal of Water Resources Development 23*(4), 625–640. doi:10.1080/07900620701488562.

Shah, T. (2016). *Increasing Water Security: the key to Implementing the Sustainable Development Goals*. TEC Background Papers No. 22. Global Water Partnership, Stockholm.

Smeets, E. & Weterings, R. (1999). *Technical Report No. 25: Environmental Indicators: Typology and Overview*. Available at: https://www.eea.europa.eu/publications/TEC25 (Cited August 29 2017).

Steffen, W., Richardson, K., Rockström, J., Cornell, S. E., Fetzer, I., Bennett, E. M., Biggs, R., Carpenter, S. R., Vries, W. d., Wit, C. A. d., Folke, C., Gerten, D., Heinke, J., Mace, G. M., Persson, L. M., Ramanathan, V., Reyers, B. & Sörlin, S. (2015). Planetary boundaries: guiding human development on a changing planet. *Science 347*(6223), 1259855. doi:10.1126/science.1259855.

UN (2012). Treaty Handbook. United Nations, s.l.

UN (2015). *Transforming Our World: The 2030 Agenda for Sustainable Development*. Available at: https://sustainabledevelopment.un.org/post2015/transformingourworld (Cited July 21 2017).

UNECE (2013). *Guide to Implementing the Water Convention*. Available at: https://www.unece.org/index.php?id=33657 (Cited November 7 2018).

UNESCO & COMEST (2005). *The Precautionary Principle*. Available at: http://unesdoc.unesco.org/images/0013/001395/139578e.pdf (Cited November 27 2018).

United Nations General Assembly (2010). *Resolution Adopted by the General Assembly on 28 July 2010 64/292*. A/RES/64/292. The Human Right to Water and Sanitation. Sixty-fourth session of the General Assembly, 28.07.2010. United Nations, Geneva.

Utton, A. E. (1996). Which rule should prevail in international water disputes: that of reasonableness or that of no harm. *Natural Resources Journal 36*(3), 635–641.

van Oudenhoven, A. P., Schröter, M., Drakou, E. G., Geijzendorffer, I. R., Jacobs, S., van Bodegom, P. M., Chazee, L., Czúcz, B., Grunewald, K., Lillebø, A. I., Mononen, L., Nogueira, A. J., Pacheco-Romero, M., Perennou, C., Remme, R. P., Rova, S., Syrbe, R.-U., Tratalos, J. A., Vallejos, M. & Albert, C. (2018). Key criteria for developing ecosystem service indicators to inform decision making. *Ecological Indicators 95*, 417–426. doi:10.1016/j.ecolind.2018.06.020.

von Haaren, C., Galler, C. & Ott, S. (2008). *Landscape Planning: The Basis of Sustainable Landscape Development*. Bundesamt für Naturschutz (BfN, German Federal Agency for Nature Conservation), Leipzig.

Wallace, J. S., Acreman, M. C. & Sullivan, C. A. (2003). The sharing of water between society and ecosystems: from conflict to catchment-based co-management. *Philosophical Transactions of the Royal Society of London. Series B, Biological sciences 358*(1440), 2011–2026. doi:10.1098/rstb.2003.1383.

Wegerich, K. & Olsson, O. (2010). Late developers and the inequity of 'equitable utilization' and the harm of 'do no harm'. *Water International 35*(6), 707–717. doi:10.1080/02508060.2010.533345.

WHO (2003). *Domestic Water Quantity, Service Level and Health*. Available at: http://www.who.int/water_sanitation_health/diseases/WSH03.02.pdf (Cited January 4 2018).

WHO (2013). *Technical Notes on Drinking-Water, Sanitation and Hygiene in Emergencies*. Available at: https://www.who.int/water_sanitation_health/publications/2011/tn9_how_much_water_en.pdf (Cited October 8 2019).

WHO (2017). *Progress on Drinking Water, Sanitation and Hygiene 2017*. Update and SDG Baselines. Available at: http://origin.who.int/water_sanitation_health/publications/JMP-2017-report-final-highlights.pdf (Cited October 8 2019).

Windfuhr, M. (2013). *Water for Food. A Human Rights Obligation; How States Can Manage Conflicts Between the Human Right to Water and the Human Right to Adequate Food*. German Institute for Human Rights, Berlin.

Wolfrum, R. (2008). Legitimacy in international law from a legal perspective: some introductory considerations. In *Legitimacy in International Law*. Wolfrum, R. & Röben, V. (eds.). Springer, Berlin.

World Commission on Environment and Development (1987). *Our Common Future*. Oxford University Press, Oxford.

Received 16 November 2020; accepted in revised form 28 March 2021. Available online 28 April 2021