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World Water Assessment Programme

Sustainable Development Goals

UN WATER

Report of the Inception Meeting on

World Water Development Report 2021

19-20 September 2019

UNESCO Programme Office, Villa Colombella, Perugia, Italy

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1 INTRODUCTION

Thirty-three professionals from twenty-four member and partner agencies of UN-Water gathered at UNESCO World Water Assessment Programme (WWAP) Secretariat on 19-20 September to discuss the content and structure of the United Nations World Water Development Report (WWDR) 2021.

Following the decision at the UN-Water Senior Programme Managers meeting in February 2017, the WWDR 2021 will be dedicated to the theme **"Valuing Water"**. The **objective** of the workshop was to reach a common understanding on the scope, overall content and general structure of the WWDR 2021 and on the modalities for its production, including task distribution among committed Lead Agencies and Contributing Agencies.

2 SUMMARY OF DISCUSSIONS

Thursday 19 September 2019

OPENING AND WELCOME

WWAP welcomed the participants and presented the objectives of the meeting and agenda, designed to be highly interactive, including through dynamic breakout group discussions (see Annex 1). WWAP recalled that the WWDR is coordinated and produced by the UNESCO World Water Assessment Programme (WWAP) in close collaboration with UN-Water members and partners and external experts.

INTRODUCTION TO THE WWDR 2021: THEME AND BACKGROUND DOCUMENTS

WWAP introduced the WWDR 2021 by building on the condensed literature review (Annex 2), the draft 'storyline' (Annex 3), and an initial compilation of potential 'main messages' (Annex 4). These background documents prepared by WWAP, constituted the discussion material for the workshop by describing the theme and scope of the WWDR 2021, highlighting technical considerations and illustrating sources of information.

The WWAP Expert on Valuing Water presented a summary of the three background documents, which benefited from many comments and inputs provided over previous consultation process with the UN-Water Members and partners:

1. The **'literature review'**, which provided an overview of the theme based on a literature review of pertinent, recent publications from UN agencies, international organizations, academia and others.
2. The **'storyline'**, which introduced a flowing narrative to guide the development of the report. The storyline describes the context (i.e. the 'value' of water to society for sustainable development); an approach based on four different 'perspectives' of valuing water (water resources, water services, other socio-cultural aspects, and economic production); the current landscape and challenges of valuing water; and potential responses and best practice solutions.
3. A list of preliminary **'main messages'**.

The presentation highlighted the complex nature of the theme and the potential difficulties and challenges in framing the subject in a way that encompasses various, often diverging viewpoints. Indeed, 'valuing water' can mean different things to different groups of stakeholders and, while advances have been made on this topic over the past thirty years, efforts to develop a comprehensive overview addressing each of these perspectives has proven to be limited and/or insufficient. In particular, challenges remain to incorporate values into water governance and management. While the High Level Panel on Water (HLPW) has charted a set of principles and potential pathways for valuing water, this framing is yet limited at operational level.

During the plenary discussion, the importance of integrating the concept of 'valuing water' into governance, planning and management was highlighted, as was the need to transform political processes and financing mechanisms in order to facilitate investment flows. It was also proposed that the report examine water allocation in terms of 'relationships' among stakeholders through water. Interconnections amongst perspectives were considered particularly important; 'magnifiers' like water scarcity, benefits to peacebuilding, contribution to climate change adaptation, were suggested to be taken into account.

BRAINSTORMING – CRITICAL ISSUES

Based on the topics, ideas and information emerging from the Background Documents, participants explored the potential scope of the report and the most critical issues to be highlighted, as well as to debate over divergent views in valuing water and how these differences might be approached. Participants split up into four groups: the main points of their discussions are presented below.

GROUP 1

The participants discussed the ways in which the WWDR is taken up and used, and the associated impact. They noted that different audiences could be targeted in different ways, with specific two-pager briefs to promote use. They suggested that the WWDR 2021 should capture and integrate the 'people perspective' conveyed by the key message 'nothing about us, without us', and that this should become a key message of the report. People must be able to recognize themselves in what is written in the report. The connection to the 2030 Agenda should be clearly pointed out, including the lenses of people, planet and prosperity, which could form another approach for the report perspectives. It was observed that because values can change both spatially and over time (e.g., Japan case, and with climate change), the spatial-temporal character of values should be considered in the report. An overview and inventory of methodologies for measuring different ways of 'valuing' of water should form part of the content, addressing both those that are currently in use and under development. The publication should report what works and what does not work. There should be an emphasis on new and experimental methodologies. Methods for addressing both tangible (and measurable) and intangible or non-measurable factors should be covered. Measurable, economic aspects of value are important in water allocation, for example. The invisible aspects need to be identified and highlighted, giving them increased attention. The Principles of the High-level Panel on Water need to be addressed in terms of the extent to which they are working and practically what they will look like when operationalized.

It was felt that the report should separately address four perspectives, namely economic, environment, cultural (including indigenous and spiritual), and social, as well as their interlinkages. Environmental flows were noted to represent the intrinsic values of ecosystems and associated social aspects. It was noted that social-cultural aspects needed to be further broken down. Some social values will apply across the board. Some cultural issues will be more specific to a place. For example, the four well-being aspects of the New Zealand Maori bridge European and Maori world views. It was noted that a clear distinction needs to be made in the report between valuing versus pricing. The element of valuing water for peace is essential, including human security, cooperation in conflict areas, and migration fluxes.

GROUP 2

The group suggested that the section of the report on the various ways in which water can be valued should not be too expansive, as no one will dispute or challenge that these various values exist. Further, while the five Bellagio Principles of the HLPW could be revisited, there is no added value to having the report simply be a deeper or expanded version of the principles; the report should aspire to go further and take a different approach, it should go beyond values in terms of the physical allocation of water to sectors, to encompass relationships with water. A valuable contribution of the report could be the provision of a methodology or framework that decision-makers can use to help them weigh up and balance these different (sometimes competing) values of water in decision-making. Social Return on Investment (SROI) could be one helpful framework to use in this context.

The Human Rights to Safe Drinking Water and Sanitation is a potential anchor for framing the conversation ("because this is a human right, governments need to value water differently than they do now") but should not be the dominant focus. It was noted too that the Human Rights to Safe Drinking Water and Sanitation apply to individuals, not countries, and while the only human rights explicitly mentioned in Agenda 2030, they are the only human rights not actually in the UN Charter. The group felt that both rights to water and duties with regards water should be addressed. Growing alignment of the Human Rights to Safe Drinking Water and Sanitation and IWRM was recognized. There is a need to look at the frameworks which drive political actors, including the two water conventions and REDD. It should not be forgotten that political and policy decisions around water are usually rooted in boundaries and ownership. Also, it was noted that further reference should be made to the SDG commitment to 'leaving no one behind, to continue to progress the goals of WWDR 2019 and further consider how to ensure participation and include those left behind. The need to identify ways to define and include previously excluded stakeholder groups was mentioned. The importance of understanding how to incorporate the ways in which values influence the decisions made was raised (e.g. related to gender differences, level of poverty, education level, economic status, cultural background) as was the need to draw on social and psychological arguments for more balanced decision- making. For instance, women make decisions differently from men. In addition to considering the values of water in water allocation and the prioritization of use, it is important the report consider other aspects such as the positioning of communities with respect to their relationships with water and the values they attribute to it.

The group proposed to avoid a silo approach of dividing water into different sectors when considering values. The report must not, however, become a report solely on interlinkages. Valuing water should be addressed as a whole, i.e. through an holistic approach. The group discussed the value of water both as an economic good (public, private) and as a human right. It was considered important to address valuing water in a way that might not lead to assigning a price, but to safeguarding and stewarding it. The balance between considering water as a political and as an economic good was explored, observing that decisions on value are fundamentally political. It was discussed that price is fundamentally a function of supply and demand - water inevitably flows to highest demand and highest value (usually in a monetary sense). Supply is often structured to feed that demand, but that landscape is changing (e.g. urban migration). Decision-makers usually want to cut through the conversation and immediately go to the point of "what does it cost?" Thus, decisions tend to be fundamentally political decisions, even if economics drive the politics. A case example from Argentina was discussed, where privatizing water led to a reversal 12 years later with the re-nationalization of water. It was considered important to clarify the distinction between valuing and pricing; the common tendency is to move directly to assigning a dollar amount to amounts of water used. Water valuation should not increase any inequalities. There is a financial value for ecosystem services and a growing willingness to pay for them; wetland case examples exist. Services to the ecosystem are less developed, not acknowledged, and not paid. Water resources should be valued at catchment level, but also within political boundaries. In the context of agriculture as a perspective, it was noted that forestry and fisheries should be considered in addition to crops. Supply chains and water footprints were raised as topics. In terms of cultural values, which were considered important to include, water influences people's sense of direction. Megacities and deltas were suggested for other areas of focus in the report. The links to climate change and land were also raised.

The group identified several resources that could be harnessed for the report. These included: the REDD policy framework (but with care not to focus too exclusively on such commitments to other policies); the substantive set of background documents that supported the final two-pager document of the Bellagio Principles (which, while presently a useful foundation to consider, reflected a negotiated political outcome); network of faith-based organizations; the UNESCO Heritage team, to help address the cultural values of water and make the link to their work; and the World Water Forum (6th World Water Forum in Marseille) report on cultural values of water.

GROUP 3

The executive summary needs to be very carefully crafted, as high-level decision makers rarely read more than two pages. The report should not be overly complicated, focusing on broad topics, and needs only convey one to a few strong messages. The report should be based on response measures (the term 'solutions' should be avoided). It should prioritize the issues to be covered. The introduction should immediately outline the two or three key messages that will make policy and decision makers think differently about valuing water. There should be a single overarching message, to invest in water and recognize its different values. It will be important not to make the report too prescriptive (which runs the risk of discouraging the target audience), as everybody has a role to play. Rather, it should bring forward country examples of possible ways to go about valuing water. In-depth treatment of the complexity of water should be undertaken, through reference to good and bad practices, practical ideas, and examples of case studies. The report should prioritize what it focuses on, and not try to cover everything. It should take a positive approach to the messaging, framing and narrative, in terms of values and positive benefits and implications, for instance for health and food. It should illustrate the changes in values of water over time, and contrast those values from the past with present and potential future values. The report needs to go deeply into values, and should carefully incorporate bad case studies from which we can learn.

While it was agreed that economic arguments are needed to sensitize politicians, it was felt that the report must go beyond monetary value. It should also convey a sense of urgency, to respond to the question of why valuing water is an important topic to discuss at this point in time (e.g., for reasons of water insecurity, scarcity, pollution and climate change). The relevance of the report to the target audience, including 'influencers', needs to be clear. The report needs to make connections to the SDGs and to consider competing aspects and tradeoffs among sectors, as well as synergies. It should also go beyond only SDG6. Water should be presented as a connector and not as a sector. The added value of synergies should be shown, and the advantages of looking at the topic through nexuses. Objective mention should be made of the spatial and temporal (including upstream-downstream) dimensions of value. Attention should be given to 'magnifiers' such as droughts and floods, and their costs; droughts were noted to be some four times more costly than floods due to their slow onset characteristics. Droughts and drought resilience are gaining increasing attention now, with a inter-governmental working group having been formed. The distinction needs to be made between different kinds of water, such as domestic water and transboundary water. The different values of surface and groundwater must be considered. Valuing water is an instrument for inclusiveness, to help make sure none are left behind. The roles of education and investment should be mentioned in this context. Aspects of social and behavioral change must be included, such as the cascading effects of wasting water. In the report, there should be reflection on who needs to value water differently. For instance, at country level the Ministries of Water are experiencing difficulties in making their cases heard, for Ministries of Finance to increase levels of investment in water.

GROUP 4

The group proposed an inspirational approach to the report, including its centrality to the SDGs and as a contribution to the UN Decade on Ecosystem Restoration. The sense of urgency and of being at a cross-roads in terms of the timing of the report need to be conveyed. Suggestions for day-to-day implementation approaches (non-prescriptive) should be included. The group proposed a tentative basic report structure around the following perspectives: water resources, WASH, sociocultural values and interests, and economic production. Given the difficulty of coming up with a universal definition of value, cost, price, etc., a useful approach would be to define the key terms in each chapter as understood by the lead authors. The challenge of equating fundamentally different types of values across perspectives was discussed. Distortions and discrepancies that result in disparities between groups of people were discussed. The overarching role of politics was considered a key topic.

The report could address water and markets, willingness to pay plus subsidies, and their effects on efficiency. Cost is associated with what the users pay for a unit volume of water. However, this is far from reflecting the financially accurate price of water itself and of service provision. It also varies widely based on location (e.g. privileged versus underprivileged areas). The group discussed subsidies, underlining that these should not be seen as a hindrance, while noting that they may become costly and counterproductive depending on how they are utilized. For example, large infrastructure loans of development banks in the developing world may result in users being excluded. The actual costs of projects were mentioned, and tradeoffs between price and value discussed. While improved water resources provide co-benefits, the indirect effects of water on values should be considered. For example, water that is low in quality (e.g. polluted, contaminated water might affect land prices and health, bringing about decreases in both. It was noted that the fact that over 90% of all consumptive water is used for irrigation in water-scarce regions is forcing a deeper assessment of values.

Indigenous approaches should be covered (including sets of intrinsic values, spiritual values) and explored as to the ways they could usefully guide us or be applied in the modern world. The values held by and roles of Canada's First Nations and the native tribes from the US in water quality and water quantity management is one useful practical example. There was some discussion, however, as to the extent of relevance of some of these kinds of approaches. The discussion on cultural issues led to the example that in New Zealand, rivers are central to the world view and belief system of the Maori people, and communities have inextricable cultural links to local rivers. In one instance, as a result, one of the rivers has been assigned the same legal rights as a person, as is also the case for the Ganga and Yamuna tributary of India. Concerning indigenous practices, some might not be suitable for implementation at a larger scale. However, given the fact that the reserves where the indigenous people live, lie in areas that are close to headwaters or areas that are rich in land resources, involvement of indigenous communities in decision-making is important.

Some members expressed the need for ecosystems approach to have a higher visibility in the coverage of the Report. Water resources are crucial both in terms of development and restoration (and in terms of both social and environmental aspects). In fact, the UN General Assembly declared the UN Decade on Ecosystem Restoration on March 2019 "to massively scale up the restoration of degraded and destroyed ecosystems as a proven measure to fight the climate crisis and enhance food security, water supply and biodiversity (https://www.unwater.org/the-united-nations-general-assembly-declare-2021-2030-the-un-decade-on-ecosystem-restoration/)." Social, hydrological and ecological connectivity with respect to protection and restoration should be covered, as per the new approach to wetlands and water adopted by the Ramsar Convention on Wetlands.

DISCUSSION ON PERSPECTIVES TO VALUING WATER

Participants were invited to explore four major 'perspectives' on valuing water, to assess whether these can be appropriate and useful to guide the structure of the WWDR 2021.

FOUR MAJOR PERSPECTIVES ON VALUING WATER

1. **Water resources** in terms of sources of supply (e.g., surface or groundwater abstractions, desalinated, reclaimed/treated/recycled wastewater, etc.). This perspective can lend itself to a volumetric quantification based on costs associated with source protection (e.g., ecosystem conservation/rehabilitation, maintaining environmental flows); the capture, storage, abstraction, and transportation of the raw resource; and its ultimate return to the environment (after treatment as appropriate), each of which can be expressed in terms of value/m3 or cost/m3. The additional cost of any negative impacts to the source and the environment (e.g., in terms of water quantity and quality, impacts on biodiversity, pollution from the return of partly/untreated wastewater, etc.) may potentially be factored-in, as can positive co-benefits (e.g., the value of flood mitigation as a result of reservoir construction and maintenance).
   This perspective is directly related to access to the resource (e.g., water allocation and water rights) and ownership (e.g., water as a common good vs. private ownership) and encompasses most environmental considerations.

2. **Water services (drinking water and sanitation – WASH)** can also lend themselves to volumetric quantification based on the cost of pre-use treatment, storage and distribution, post-use treatment and disposal (notion of full-cost recovery). Co-benefits of access to WASH (e.g., poverty alleviation, savings in health costs, increased workforce productivity and income, improved access to education, etc.) can also be factored-in in a quantifiable way (e.g., estimated cost-benefit ratio of 5.5 for improved sanitation and 2.0 for drinking water). There are also intangible benefits that add value to WASH (e.g., improved quality of life), but these are much more difficult – if not impossible – to quantify.
   This perspective is directly related to the Human Rights to Safe Drinking Water and Sanitation and is thus very much 'people-centered'. The different realities, restrictions and opportunities that exist between urban, peri-urban and rural communities should also be taken into account here.

3. **Socio-cultural values associated with water** (based for example on religious beliefs, quality of life, heritage, artistic values etc.) are very difficult – if not impossible – to quantify, but that does not imply such values can be ignored. This perspective may encompass aspects other perspectives (e.g., importance of 'beautiful' or 'pristine', natural environments; dignity in access to safe drinking water and sanitation, religious meaning/importance of certain water bodies etc.), but it is inherently subjective and will vary considerably among groups and even among individuals within similar groups.

4. **Water used as 'inputs' to various economic sectors** (e.g., agriculture, energy, industry, etc.) can also lend itself to volumetric quantification in similar fashion as the two categories above (i.e., cost of capture, use, treatment and disposal; indirect costs associated with environmental impacts, etc.). But, there is an additional quantifiable value than can be added as a function of the economic productivity associated with various water uses, that can be expressed in terms of profit/m3 or in the case of agricultural yield, 'crop/drop'. Other qualifiable co-benefits may include income and job creation, and/or local, regional and national economic growth (e.g., GDP/m3), although the quantification can be more difficult.
   This perspective is directly related to economic development but also pertains to food and energy security.

The different reflections in relation to the perspectives of valuing water and the potential structure of the 2021 WWDR can be summarized as follows:

Regarding the overall structure, participants stressed the need to think through the focus and target of the WWDR. WWDR primarily targets policy and decision makers, but this report was seen as an opportunity to reach out beyond the water community. To this end, the "5 Ps" approach: People, Planet, Prosperity, Peace, Partnerships, was considered by some to be more aligned with the Agenda 2030, more user-friendly and accessible to the broader audience, rather than the proposed structure (water resources, water services provision, sociocultural values, economic production sectors).

It was recognized that the four perspectives proposed is not the only way the report could be structured, but that it could be a useful way to organize and to fit in all the other important elements. Participants suggested that the report should not only present different perspectives, but also provide guidance to help balance across these (sometimes competing) values in decision-making. Regarding the methodology, it was discussed that the report should define the system transitions pursued, as well as why water is currently not being valued and how this issue can be addressed, to help frame a methodology that would then allow to incorporate the different sub elements into it.

Representatives of some organizations stressed the importance of addressing the value of water for cooperation, with reference to transboundary cooperation and water as an asset for peace. Moreover, it was suggested that the following topics should be included: water reuse, quality of water vis-a-vis allocation, and water-dependent jobs.

Some participants considered that attention should be paid to: *who determines the value and cost* of water, as, for instance, users do not often determine the costs; *who decides*, looking at decision-making and governance processes; and *who owns*, and how ownership affects the value. It was stressed that women and men might value water differently. Even when the most vulnerable groups are represented, their voices are not necessarily heard, which prevents them from meaningfully contributing to decision-making mechanisms.

In line with the 2030 Agenda, a shift was suggested in terms of language and narrative, from 'basic services' to 'safely managed services'. Finally, participants noted that the spatial and temporal dimensions of valuing water should be considered in a more objective way and how these affect population growth and climate change should equally be factored in.

RELATING TOPICS/ISSUES TO THE DIFFERENT PERSPECTIVES TO VALUING WATER

The different working groups discussed further specific topics and issues to be included under each of the perspectives, or important issues that could be missing. Following the different group discussions, key messages were shared in plenary, a summary of which is presented below.

1. Water resources and ecosystems

Participants considered that the environmental value is still being much defined from its anthropocentric uses and that the biophysical perspective should be incorporated more strongly. They noted that it would be important to distinguish water resources vis-a-vis water bodies, including the consideration of water resources as living entities supported by case studies of rivers granted the same legal rights as human beings (for instance in New Zealand and Ecuador). It was suggested to showcase what has occurred in those contexts in order to achieve that recognition, as well as which communities were involved in the process. The cost of restauration of ecological systems was considered to be frequently avoided and important to be taken into account.

The importance of political will and of improving the health of ecosystems on the global agenda was brought up. Participants questioned who is representing the voice of the ecosystems and what is the decision-making process. They noted that between the voice of the economy vs the ecological voice the former is usually louder than the latter. An example from the Three Gorges Dam was shared to illustrate how upstream and downstream users can have different values, and that these can change in time to become more ecological. It was noted that perspectives in terms of valuing water may also change in accordance with climate change (floods vs drought).

Innovation and technologies have an important role to play addressing monitoring gaps. It was considered that the report could call out and challenge the innovation community to cover measurement gaps; for instance, the measurement of fluxes and flows, or sensors being developed by some countries to help capture heavy metals pollution.

2. Water services (drinking water and sanitation – WASH)

The discussions focused on: the value of water in terms of water services; the potential measurement of such values; how can valuing water can lead to improve outcomes for sustainable development; useful scalable solutions; and, any existing gaps.

Overall, participants agreed that this perspective is people centred in relation to basic services, and there is a strong need to build the economic and political case to invest in WASH, particularly in the long term. On the former, the problem was posed on how to measure the intangible value of water, and on the latter how to value water that can serve as a tool to achieve the 2030 Agenda and the SDGs. An immediate reaction emphasized developing indicators, such as the SDG's key performance indicators, with disaggregated data focusing towards poverty alleviation, health benefits, increased levels of education and workforce productivity.

The importance of having efficient and effective regulatory frameworks was highlighted. In this regard, a human rights-based approach was suggested as a starting point. Another argument highlighted the role of local markets and hybrid financial models to build strong cases and enact good water governance. Of course, there are key issues to bear in mind as the return of investments, affordability rates, willingness to pay, network infrastructure, among others. Lastly, the value chain in the context of water services was considered. Not only technology and innovation but likewise big data and utilities data could help find solutions to value water and help rural and urban settings, including investing in the treatment of wastewater and sanitation services. In the end, there is need to take into account the real value for the user, the government and the environment.

With respect to tariffs, it was argued that there are different sort of models around water tariffs, which take into account the cost recovery and long term projections, although they may clash with social corporate responsibility principles or even with nature cycles and policy processes .

As per the intangible use of water, it was stated that it can be measured through benefits that add value to WASH, for instance improved 'quality of life' and 'better life' indexes developed and currently used in the United Kingdom, assessing the contribution that water resources/rivers makes to people's wellbeing and happiness. Government departments should take into consideration this approach for urban and rural planning, health programmes, education and workforce benefits, etc. in the long run and break implied vicious cycles that prevent from factoring in the intangible value of water for people.

3. Socio-cultural values associated with water

The group considered the current structure of the report and the 5 Ps approach to be complementary but different from a communications point of view (all aspects find a place in both approaches, but the sense is that the 5 Ps are more public engaging and useful to reach out beyond the water sector). Participants considered that format and structure of the WWDR are not two different discussions; they are indeed interlinked. It was suggested that a new type of format - more interactive, using hyperlinks, offering a variety of entry points – could be considered. A simple proposal was advanced by a volunteering taskforce of participants during the plenary of Day 2.

Participants mapped perspectives that could be included under this dimension: human identity, indigenous perspectives, gender, owners, users, belief systems/worldviews, cultural heritage (tangible and intangible), tourism/leisure, arts, disabled persons, spiritual, faith based, sense of place, aesthetic, ethics, ritual, youth, dignity. Concern was expressed that none of these perspectives would be addressed extensively if all are bundled together. A suggestion was made that there should be an overarching introduction with some boxes highlighting different perspectives.

Participants exchanged on the difficulty of valuing something that is taken for granted and reflected on the need to make visible the social and cultural values of water as well as which methodologies would support this elevation in visibility (e.g. qualitative surveys).

The group also noted the overlaps between the social dimension and WASH. They considered the issue could be what aspects are quantifiable and what aspects (cultural) require a different methodology based on a participatory process (tangible vs intangible values). Discussion revolved around the socio-cultural perspective being mainstreamed throughout the report or a stand-alone chapter on the socio-cultural dimension (or both). Socio cultural values are an entry point for many users and can be the interconnection with all the other aspects/themes of the WWDR. Finally, storytelling was found particularly important in this section of the report as a communication tool.

4. Water used as 'inputs' to various economic sectors

The group reflected on the value of valuing water and underlined the cost of inaction to valuing water which manifests itself in terms of low efficiency in water use, degrading water quality, decline in ecosystems etc. While talking about value of water, price and charge are other terms that are introduced often ambiguously. Clearly, value of water is well beyond its price. Moreover, the entire value chain should be looked at, from producer to end user (for instance, water footprint). In agriculture sector, crop per drop perspective is moving towards nutrient per drop in line with food security concerns.

Valuing water can trigger developments in terms of innovations/technologies; for instance, improved irrigation schemes, efficient technology, leading to less food waste, less pollution, etc. The discussion revolved around measurement and indicators on valuing water: for instance, through energy consumption (how much energy is used to supply water), risks for the private sector as a result of flooding.

The group reflected on how valuing water from an economic perspective has an impact at the policy-making level. On the other hand, incentives and subsidies need to be carefully designed and implemented as the recent WB report showcased, subsidies are directed to those who do not necessarily need it. Talking about water use in agriculture, sustainable intensification of agriculture requires that indirect value of water is included in the discussion, as well. To enforce improved water efficiency in agricultural water use (irrigation), evaporation models are being tested (in a pilot project in China) to determine actual water use. This, in turn, can be used to develop subsidies or penalties. The industry usually does not pay full value of water as raw input. However, where water is taken into consideration in financial planning is in risk and insurance evaluations. Polluter pays principle is what most businesses are concerned about. This is why zero discharge is a concept that is relevant to industry sector. Economic and administrative instruments are in place. However, there is the need to enforce existing policies. Education in water domain is a key to fill the capacity gap: In the next 10 years, there will be 1 million jobs in water sector which will not be filled.

CONTENT STRUCTURING

Taking into account the WWDR Generic Structure as decided in 2012 (See Annex 5), the next exercise aimed at morphing the proposed content from the 'perspectives' into the Generic Structure to form the basis for the Table of Contents for the report.

During the discussion, participants stressed the need to define upfront what valuing water means, differentiate between valuing and pricing and outline what the Bellagio principles mean in practice. It was also suggested that the introduction include an analysis of why water is not being valued and the trade-offs with other sectors.

A common understanding was that the report should be solutions oriented and not so dedicated to outlining the challenges. The importance of regional perspectives was raised and WWAP clarified that, as for every edition of the Report, these would be integrated following a discussion with the respective Economic Commissions to seek their contributions and case studies.

Several participants expressed their concern that a silo approach should be avoided and that a division amongst sectors would not adequately reflect IWRM and nexus issues. Some proposed that each chapter would illustrate the interconnections, interlinkages between different values and perspectives.

At the conclusions, a few participants suggested that the report should include some methodological guidance on how to value water, like a "blueprint" approach , which could bring important value added to the report, and could be presented as a 'tool' towards the beginning of the report (following the definition of valuing water). However, the proposal did not explain what this blue print would entail.

Finally, it was suggested that greater attention be dedicated to the value of water for peace, migration, and in conflict settings.

Friday, 20 September

RECAP DAY 1 AND OBJECTIVES FOR DAY 2

WWAP summarized some of the key points from the discussions the previous day. These included the distinction between pricing and valuing water; how to define tangible and intangible values; water connections and synergies with other sectors, as well as competing aspects or possible trade-offs. Valuing water can help governments to be inclusive to leave no one behind, and to make gender transformative processes. The question of the measurability of water values was posed, as was the need to assess which methodologies are available, and share both best practices and those that failed. It was also highlighted the key role of valuing water to contribute to peace, not only through cooperation but also by increasing people and communities' resilience. Finally, the proposal of the '5 Ps' to strengthen alignment with SGs and the one to include the blueprint were recalled.

PRESENTATION OF DRAFT TABLE OF CONTENTS AND DISCUSSION

The draft Table of Contents (ToC) integrating comments from the previous day was presented, followed by a discussion.

Some participants recalled the proposal of including a "blueprint" or 'guidance tool' as an important contribution the report could make, as it is yet very unclear how to tackle the multiple values of water for decision-making processes. Some UN members expressed concern that developing a blueprint on valuing water would be too prescriptive and might generate a political reaction by the UN Member States. In case of adoption, it should be carefully framed and its intent clarified. Such an issue, if considered necessary by a relevant number of UN Water members and partners, needs to be looked at and possibly developed by a dedicated working group in UN-Water. Thus, the proposed 'blueprint' will not be a specific chapter, but could possibly be referred to in the Report. WWAP will follow up on that with UN Water.

Comments included to demonstrate in the introduction the consequences of not valuing water appropriately (e.g. Aral Sea, Syria). Valuing water as an asset for peace was considered to be a stage setting issue rather than conclusive and was therefore suggested to be moved towards the initial parts of the report. This could include the role of water in conflict prevention and the links to the related UN taskforce. Some considered peace to be a social and cultural value of water, and that could be included in the related Chapter.

Several participants highlighted the need to promote an integrated approach (water as a connector) and to help water allocation decision-making. It was also proposed that the report further takes into account the relationships aspect, for instance between different value systems, including indigenous. Questions included how does the use of new technologies, big data and artificial intelligence change the value of water.

The discussion then focused on the suggestion to develop the WWDR contents in a more interactive and digital format to reach different target audiences, including next generations. It was proposed to begin planning for a gradual change to an e-book format for the WWDR. The e-book would allow dealing with nexus and cross-functional issues, through different entry points and could potentially avoid replication. It can also include interactive graphics and video clips, which would appeal to a wider range of people, while still including the depth of content.

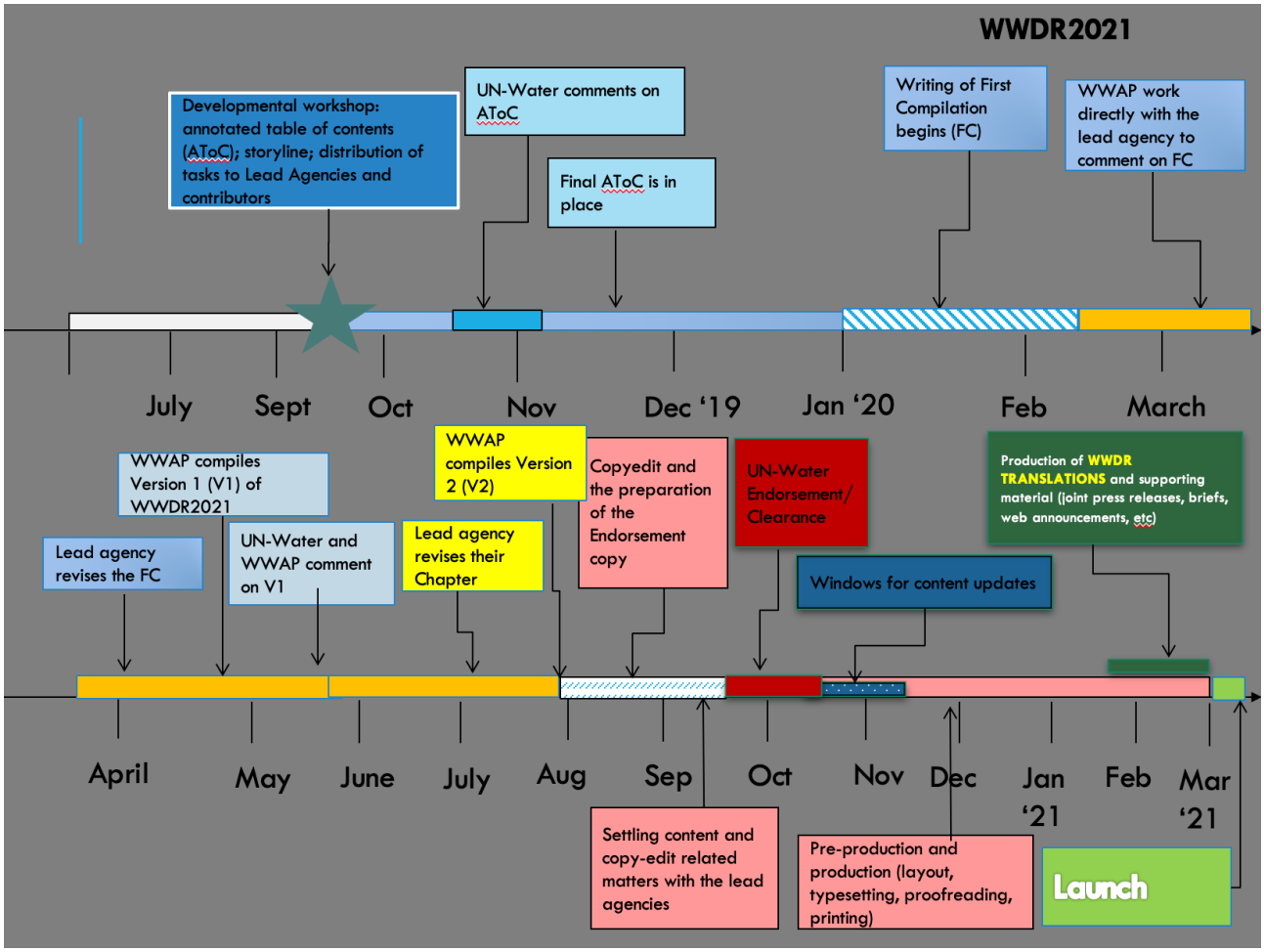
Comments to the proposal considered that it could be a very good complement to the current report and related materials, as both approaches are not mutually excluding. WWAP staff informed that a more interactive format must be carefully planned ahead of time, and have a dedicated funding and staff for its production. While the interactive format is very attractive for many reasons, the current format still seems very appropriate for global dissemination. The Secretariat also recalled the efforts of producing the Report and related materials in a number of languages (11 language editions for the Executive Summary), making it an important challenge to produce a more interactive version in time for the launch during World Water Day. In order to move forward in a feasible way WWAP suggested to internally preparing a proposal with budget for a correct evaluation.

PRODUCTION WORK-PLAN

The WWDR production calendar was presented (see below), describing how the 18-month process has little room for delays and thus highlighting the critical importance of meeting deadlines for contributions, comments and submission of draft sections and chapters.

The different responsibilities were outlined, whereby WWAP assumes overall quality assurance and writes a number of Chapters of the Report, and the lead agencies invest time and necessary human resources in substantiating the discussion in the chapter. Content preparation begins early January 2020.

WWDR PRODUCTION CALENDAR



COMMITMENTS FROM LEAD AGENCIES AND CONTRIBUTORS

The roles and responsibilities of the two basic categories of contributing agencies (Lead Agencies and Contributing Agencies) were also presented:

1. **Lead Agencies** (LAs) are responsible for the production of a substantive part of the report (one large stand-alone section, one entire chapter or more). This implies that LAs write parts of the Report and coordinate and compile the input from Contributing Agencies (see below). Text and other materials produced by the LAs have to be submitted to the WWAP Secretariat in line with the production calendar.
2. **Contributing Agencies** (CAs) work in close cooperation with a Lead Agency and/or with the WWAP, and directly provide clearly referenced input in the form of short pieces of text, tables, boxes, figures, practical examples and case studies.

Several Agencies volunteered to take the lead (as LA) and/or contribute to various chapters as identified in the Table of Contents. Several UN-Water Members and partners expressed their preference to wait for a more mature table of contents to better assess their contribution.

These agencies and those that did not have a representative at the workshop are welcome to add/revise their commitments as part of the ToC review/comment process, which is expected to begin in early November.

A draft skeletal Table of Contents (Annex 6) provides a view of the general structure of the report, integrating comments exchanged during the plenary discussion as well as the proposed leads and contributors, which are presented in alphabetical order. Final assignments will be agreed upon between the volunteering agencies and WWAP, based on the final structure and content of the Annotated Table of Contents (AToC) and how these align with the particular fields of expertise of the volunteering agencies and their available resources (i.e. time and qualified staff).

KNOWLEDGE SHARING

A number of additional recent and forthcoming reports and publications – beyond those already identified in the Background Documents – were identified by the participants, who were requested to send weblinks of these documents to WWAP for tabulation.

Beyond the exchange of publications , participants also shared relevant international events in the coming years that could be strategic opportunities to disseminate the main findings of the Report , namely: the World Water Forum in Senegal in 2021; Expo Dubai 2020 which will include a one day event to discuss the WWDR; and the 2021 UN High -Level Meeting on water.

CONCLUDING REMARKS

UNESCO WWAP Coordinator thanked all participants and informed that the Minutes of the workshop would be shared shortly, while the final draft of the Annotated Table of Content will be shared in October for review and comments. He thanked everybody for the significant contributions during the intense 1.5-day workshop and the very productive and constructive atmosphere. This provides the basis for jointly working on an important report that might have significant impact on policy and decision making in the future.

3 ANNEXES

ANNEX 1 - WORKSHOP AGENDA

Wednesday 18 September 2019

19:30	Apericena (ice-breaking buffet dinner) at Villa Colombella

Thursday 19 September 2019

9:00 - 9:30	**Opening and welcome** *Purpose of the meeting; objectives and scope of the WWDRs; agenda; introduction of participants ('tour de table')* Facilitator: Stefan Uhlenbrook
9:30 - 10:00	**Introduction to the WWDR2021 Theme and Background documents** *Main messages; 'perspectives' to valuing water; current challenges and potential responses (as presented in the background documents); introduction to breakout session #1 (main messages)* Facilitators: Rebecca Tharme Rapporteur: Rick Connor
10:00 - 10:45	Breakout Session #1: **Brainstorming – critical issues** *Based on the topics, ideas and information emerging from the Background Documents, participants are invited to explore the potential scope of the report and the most critical issues that could be highlighted in the report. This may also stimulate debate over divergent views in valuing water and how these differences might be approached.*
10:45 - 11:00	**Coffee break**
11:00 - 11:40	Plenary: **Reporting back from groups on critical issues** (5 min reporting + 5 min discussion per group) *A representative of each group shares the most significant issues that emerged from the discussions.* *(This is not to be a recap of the entire discussion.)* Facilitator: Rick Connor Rapporteur: Rebecca Tharme, Laurens Thuy
11:40 - 12:45	Plenary: Discussion on **perspectives to valuing water** *Participants are invited to explore potential broad 'perspectives' to valuing water under which more specific topics and issues can be positioned (including clear dichotomies in viewpoints).* Facilitator: Rebecca Tharme Rapporteur: Natalia Uribe, Paola Piccione
12:45 - 13:45	**Group Picture and Lunch**
13:45 - 14:00	Plenary: **Instructions for Breakout Sessions 2 & 3** – Relating topics/issues to the different perspectives.
14:00 - 14:45	Breakout Session #2: **Relating topics/issues to the different perspectives to valuing water.** *Participants breakout into small groups to focus on a particular perspective and discuss which issues/topics would be most critical to address from that perspective.*
14:45 - 15:30	Breakout Session #3: **Relating topics/issues to the different perspectives to valuing water.** *Participants breakout into small groups to focus on a particular perspective (different from the earlier session) and discuss which issues/topics would be most critical to address from that perspective.*
15:30 - 15:45	**Coffee break**
15:45 - 16:45	Plenary: **Reporting back from breakout groups** (10 min reporting + 5 min discussion per group) *The Chairs and/or Rapporteurs of each the breakout sessions present the outcomes from both groups.* Facilitator: Michela Miletto Rapporteur: Natalia Uribe, Paola Piccione
16:45 - 17:45	Plenary: **Content structuring** *Morphing the proposed content from the 'perspectives' into the Generic Structure (see Annex 1) to form the basis for the Table of Contents for the report.* Facilitator: Rick Connor Rapporteur: Engin Koncagul, Rebecca Tharme
17:45 - 18:00	**Wrap-up of Day 1** Facilitator: Stefan Uhlenbrook
18:45	**Bus leaves Colombella to dinner venue**
20:00	**Dinner in Perugia city center**
18:45	**Bus returns to Villa Colombella**

Friday, 20 September 2019

9:00 - 9:45	Plenary: **Recap Day 1 and Objectives for Day 2** and discussion *A draft ToC is presented, followed by a period for questions and comments.* Facilitator: Michela Miletto Rapporteur: Rebecca Tharme, Engin Koncagul
9:45 - 10:30	Plenary: **Production Work-plan** *The WWDR production calendar is presented and explained. The WWAP production team (as well as participants who have worked directly on the WWDR) will also share experiences and lessons learned in the past, all for the purpose of increasing the efficiency and effectiveness of the production process.* Facilitator: Engin Koncagul Rapporteur: Rick Connor
10:30 - 11:00	**Coffee break**
11:00 - 12:00	Plenary: **Commitments from Lead Agencies and Contributors** *Based on the draft ToC, agencies who are interested in taking the lead in developing (and writing) chapters/ sections of the WWDR 2021 are identified. It will be discussed how they can operationalize their contributions and inputs in accordance with the production Work-plan.* Facilitator: Engin Koncagul Rapporteur: Stefan Uhlenbrook
12:00 - 12:30	Plenary: **Knowledge sharing** *Participants are invited to identify relevant background literature and key reference material (particularly reports, published or soon-to-be, and solutions-oriented case studies – be they successful or not), data and indicators, available as well as data and information gaps, which could be useful for the lead agencies and the contributions.* Facilitator: Engin Koncagul Rapporteur: Rick Connor
12:30 - 13:00	Plenary: **Recap of Workshop outcomes, way forward and closure** Facilitator: Stefan Uhlenbrook Rapporteur: Natalia Uribe
13:00 - 14:15	**Lunch**
14:30	**Shuttle departs for Fiumicino airport (Rome)**

ANNEX 2 - WWDR 2021 LITERATURE REVIEW

Literature review for UN World Water Development Report 2021

Final Draft for Discussion, August 2019

Valuing Water

This scoping document presents an overview of 'Valuing Water' based on a limited literature review of pertinent, recent publications from UN Agencies, International Organizations, academia, and others. It is intended to help guide content development for United Nations World Water Development Report 2021 (WWDR2021) for policy and decisionmakers in the water domain and related sectors.

Table of CONTENTS

1 ESTABLISHING THE CONTEXT

1.1 The Intrinsic and Full Value of Water to Society

The intrinsic value of water and its essential role and relevance in all aspects of life are undisputed. Simply put, water is life. "It is a fundamental condition of human survival and dignity, and is the basis for the resilience of societies and of the natural environment" (Global High-Level Panel on Water and Peace, 2017, p. 11). Moreover, unlike other natural resources, water has no substitute. The right to safe and clean drinking water and sanitation, recognised by the United Nations General Assembly in 2010 (UN Resolution A/RES/64/292) as a "human right that is essential for the full enjoyment of life and all human rights" essentially stems from this basis.

As individuals, we also intuitively recognise that water is "more than a substance: it carries multiple values and meanings" (UN/World Bank High Level Panel on Water, HLPW, 2017a, p. 1). Our cultural heritage, world views, codes of ethics, faiths, genders, and established norms frame our relationships with water, influencing our perspectives and the ways in which we think about and value this natural resource (Johnston et al., 2012; Bakker, 2012; Krause and Strang, 2016). Different cultures, societies, and communities around the world, including Indigenous peoples, understand and define the value of water in quite different ways, according sometimes divergent values to the resource and its uses that may be hard or even inappropriate to attempt to reconcile.

Irrespective, water that has been secured for different uses provides for the socioeconomic development of countries worldwide (World Water Council, WWC, and Organisation for Economic Co-operation and Development, OECD, 2015). Water is widely recognised as an extremely valuable resource: for basic human needs, such as drinking and washing; for smallholder and commercial farmers alike, who depend on it to grow and sell crops; for industries and businesses that need it to cool machines, spin turbines, and produce goods; for the cultural rituals of people and their wellbeing; and, not least, for the environment in its own right and for its sustained quality as a source of natural capital for society to draw on. It is fair to say though that while appreciation of the value of water is growing, our ability to value it and to incorporate its multiple values into water governance and management has been inadequate (Garrick et al., 2017).

As the drivers of water scarcity and hence, human water insecurity, have accelerated apace, water has similarly grown in importance in terms of its essential and diverse values to society. This growth has placed more attention globally, regionally, and at basin and local levels on how we, as a society, value our water, why, and to what end purpose. It has underlined a pressing need for more a more balanced, transparent, inclusive and nuanced characterization and reconciliation of water's diverse values from many different perspectives (HLPW, 2017a).

1.2 Principles for Valuing Water to Achieve Sustainable Development

Creating a foundation for future efforts

Valuing water has been a longstanding theme of great relevance to development, and one challenged by the recognition that there is no single value of water nor single way to measure its value. "Efforts to value water have advanced over the past 30 years" (Garrick et al., 2017, p. 1003), however, generating a wide range of experiences and approaches for doing so. They have ranged from willingness to pay approaches for drinking water and ecosystem services, to modeling efforts to identify water values (e.g., using hydro-economic models), through to participatory processes that capture water's diverse cultural benefits. There has been a particular focus on 'valuation' (within the 'value' framework and 'valuing water') for which an extensive, decades-long body of literature and of case experience exists from which to draw (e.g., including on environmental, distributional, and traditional values that may not necessarily be revealed in prices in a market system). While the use of such valuation methods placing monetary values on non-monetary factors has facilitated dealing with trade-offs among certain values, it has been acknowledged further guidance is needed on how to deal with trade-offs across the full catalogue of values. It is also noteworthy that stakeholders possess their own systems of valuing water in instances where a formal system is lacking, presenting opportunities for better understanding how people at present value water.

Regardless of progress made, some lack of clarity remains apparent as to the concept of valuing water and many consider it to be complex and contentious, owing to water's biophysical, political, sociocultural (including gender) and economic characteristics. Dichotomies in viewpoint persist, and debate continues as to how best to capture and place due attention on the value of water. Pragmatic efforts to recognize, properly measure, and reconcile water's full range of benefits seem to remain quite dispersed on the ground.

There is little doubt though that in the global context of the Anthropocene, fraught with political insecurity and with social, economic and environmental challenges manifest on an unprecedented scale (World Economic Forum, WEF, 2019a; WWAP, 2019) "Valuing water means valuing our future" (Website of the Value of Water Campaign, 2019; http://thevalueofwater.org/the-facts/waters-value, p. 1). Certainly, the value given to water is at the heart of the United Nations' 2030 Agenda for Sustainable Development adopted in September 2015 (UN, 2015) and the 17 Sustainable Development Goals (SDGs) designed as an integrated set of global priorities to achieve it (Stockholm International Water Institute, SIWI, 2018). The transformative change required for humanity to deliver on this Agenda within the planet's sustainability boundaries for water and other resources (Gerten et al., 2013) is predicated on capturing the value of water as fully and appropriately as possible. Valuing water is thus a shared societal responsibility for everyone, whether acting as "governments, municipalities, businesses, farmers, civil societies, communities, or as individuals" (HLPW, 2017a, p. 2).

Principles for valuing water

The HLPW's 2017 Valuing Water Initiative to chart the principles and pathways for valuing water presents "a global opportunity to rethink the value of water" (Garrick et al., 2017, p. 1003). The HLPW (2017a, p.2; 2017b) identifies five fundamental Bellagio Principles for valuing water, as quoted here:

Recognize and Embrace Water's Multiple Values

1. **Identify and take into account the multiple and diverse values of water to different groups and interests in all decisions affecting water.** There are deep interconnections between human needs, social and economic well-being, spiritual beliefs, and the viability of ecosystems that need to be considered.

Reconcile Values and Build Trust

2. **Conduct all processes to reconcile values in ways that are equitable, transparent, and inclusive**. Trade-offs will be inevitable, especially when water is scarce, and these call for sharing benefits amongst all those affected. Inaction may also have costs that involve steeper trade-offs. These processes need to be adaptive in the face of local and global changes.

Protect the Sources

3. **Value, manage, and protect all sources of water, including watersheds, rivers, aquifers, associated ecosystems, and used water flows for current and future generations**. There is growing urgency to protect sources, control, and prevent pollution and address other pressures across multiple scales.

Educate to Empower

4. **Promote education and public awareness about the intrinsic value of water and its essential role in all aspects of life.** This will enable broader participation, water-wise decisions, and sustainable practices in areas such as spatial planning, development of infrastructure, city management, industrial development, farming, protection of ecosystems, and domestic use.

Invest and Innovate

5. **Ensure adequate investment in institutions, infrastructure, information, and innovation to realize the many different benefits derived from water and reduce risks**. This requires concerted action and institutional coherence. It should harness new ideas, tools, and solutions while drawing on existing and indigenous knowledge and practices in ways that nurture the innovative leaders of tomorrow.

These broad principles underpin and pave the way for a necessarily more operational and explicit articulation of best practice-experience in ascertaining and maximizing the benefits to be gained from water. Unlike most other valuable resources, however, the true value of water has proven elusive. As a result, this vital, precious resource is not appropriately reflected in terms of political attention, water resource governance and management, or financial investment in most parts of the world. This not only leads to inequalities in terms of people's access to and benefits from water resources and water-related services, but also unsustainable use and degradation of the quantity and quality of water supplies, with negative impacts on environmental conditions and all facets of socioeconomic development. Remaining largely under-recognised and unaccounted for, these cascading negative impacts of water scarcity, flooding,

pollution, biodiversity and ecosystem services declines, and other aspects of environmental degradation strongly underscore the need to change the way we value water (Damania et al., 2017). The fundamental purpose of recognizing the true value of water and more comprehensively accounting for it in development lies in avoiding such impacts and reversing negative feedback loops where they occur, thereby helping ensure the sustainability of water resources now and for future generations; the upcoming 2021-2030 UN Decade on Ecosystem Restoration (declared by the UN General Assembly, 1 March 2019) presents a significant opportunity.

Learning how best to achieve such steps is important in the efforts to advance integrated water resources management (IWRM) as an adaptive change strategy (WWC, 2018) and improve decision-making. It could help bring about the collaboration needed across sectors, communities, and nations to manage water more effectively - presenting a transformative opportunity to convert risk to resilience, poverty to well-being, and degrading ecosystems to sustainable ones. It has been argued that a key reason for limited successes in attaining IWRM and in water governance is the omission of a full representation of the values of water. The gradual convergence in the fields of human rights and IWRM could lend support in this regard (UNDP Cap-Net/WaterLex/ Water Governance Facility (WGF) SIWI/REDICA, 2017). Awareness has grown within the human rights community that water management is fundamental to the realization of a range of human rights, and similarly, water-management practitioners have become increasingly aware of the crucial importance of water in key human rights domains. Values thus potentially can and should be attributed to all the main perspectives and dimensions of water. As observed in WWAP (2012, p. 277) “Unvalued water leads to an uncertain future”.

1.3 Proposed Approach for the World Water Development Report

For the 2021 WWDR, the proposal is to focus on opportunities and challenges to determining the multiple values of water as viewed through the lenses of several broad perspectives (as illustrated in the scoping overview), examining each of them across social, economic, and environmental domains. These perspectives, and potential solutions to valuing water for them, are proposed to include the following: (1) the water resource, including surface water and groundwater quantity, water quality, and ecosystems; (2) the human rights-based, people-centric perspective of water services provision (WASH, drinking water, sanitation and hygiene), addressing provision and the use and patterns, livelihoods and cultural norms around usage of the supply of these services;and (3) various other sociocultural values; and (4) the economic production sectors’ perspective (food and agriculture, energy, and industry).

The report could start by addressing addressing how value is being attributed to water in each instance, using which measures and approaches, and with what degree of success (as defined through benefits achieved, costs, and trade-offs and type and severity of risks incurred or avoided). An attempt will be made to identify what is not yet valued, but could be, as well as the reasons and potential constraints. The real costs of under-valuing or not valuing water will be explored in different contexts. Unintended consequences of the ways in which water is currently valued in various economic sectors could be highlighted, as well as the benefits of nexus approaches. Implications of changes in the balance of values among uses and sectors, including the shifts in values occurring across sectors over time, such as from agriculture to cities, and from traditional economic sectors to the environment, could be explored.

One of the WWDR’s objectives could be to ascertain which are the most commonly adopted (and potentially scalable) solutions for valuing water, given the kinds of challenges and opportunities outlined, including through current and emerging best practices in water management, governance, and finance. Insights and guidance will be generated for formulating potential valuation approaches (direct values, e.g., monetary value; indirect measures, e.g., positive/negative impacts and co-benefits; and qualitative values, incl. intangibles) for various groups of actors. The report could also serve to outline how a more comprehensive, balanced inclusion of water’s values could potentially unlock additional benefits from water supply and sanitation services and water resources management and mediate trade-offs under SDG Goal 6, and other water-related SDGs. This could include identifying the least valued aspects of water and any associated implications in terms of achieving targets. Finally, there are expected to be important gaps in areas such as data and monitoring, potentially constraining any future action agenda on valuing water.

2 VALUING THE WATER RESOURCE - A PERSPECTIVE

Water has recognised value in creating benefits throughout the hydrologic cycle and associated value chains (WWAP, 2012). Increasingly, it is also being recognised in terms of intimate interconnections with society (the socio-hydrological cycle; Sivapalan et al., 2012; Krause and Strang, 2016) and socioecological systems and their ecohydrological interactions (Arthington et al., 2018; Section 2.2). Water underpins the resilience of natural and human systems (SIWI, 2018). "Resilience is the ability of societies, economies, human and natural systems to respond and adapt to shocks and stresses and to transform when conditions require it. The ability of freshwater systems to cope with current and future stresses is fundamental to any prospect of sustainable development" (SIWI, 2018, p. 3).

2.1 The Water Resource

Water resources are traditionally valued in terms of the sources of supply, including: surface water or groundwater; abstractions and consumptive uses; desalinated sources; and reclaimed, treated, and recycled wastewater. Quantitative data on the resource are available through various portals (e.g., FAO AQUASTAT database: www.fao.org/nr/water/aquastat/data/). Robust water measurement, modelling, and accounting collectively constitute the foundation for water valuation, and a necessary enabling step towards valuation and sustainable development of water resources (Garrick et al., 2017). "The limitations in our knowledge about "the volume, flux, and quality of water in lakes, rivers, soils, aquifers, and human-constructed storage and distribution facilities are remarkable given the importance of water" (Garrick et al., 2017, p. 1003). Persistent gaps in water usage data conceal evidence of waste (e.g., an estimated 32 billion m^3 leaks from urban water systems each year), inefficiency, misallocation, and widespread theft, all of which seriously hamper water management institutions (Garrick et al., 2017).

Volumetric quantification based on the costs associated with the capture, storage, abstraction, and transportation of the raw resource, as well as its ultimate return to the environment can each be expressed in various terms, such as cost per m^3 (and increasingly also in terms of measures of efficiency, productivity, and intensity of use; Section 4). The additional cost of negative impacts to the source and the environment (e.g., in terms of altered flow regimes, lost biodiversity, and pollution from return of partly or wholly untreated wastewater) potentially could be factored-in, as could positive co-benefits, such as greater climate resilience through increased water storage. The value of water is expected to continue to increase with shrinking supplies and increasing demands (both affecting aspects of resource scarcity). It therefore will also differ from one place and development context to another. Distinctions between consumptive and non-consumptive uses of the resource, as well as between supply and demand are important and need to be clear.

Valuing different types of water

Freshwater or good-quality water is the predominant consideration in the water-value proposition. In contrast, the valuing of other types of water – urban wastewater, greywater, agricultural drainage water, saline water, water in deep geological settings, fog water – usually receives little to no attention. The value of water resources of these other types needs to be addressed. In addition, the resources each type of water contains or their associated benefits should be valued: nutrients, organic matter, and energy, in the case of urban wastewater and greywater; salts and nutrients, for saline agricultural drainage water and groundwater; minerals, for water in deep geological settings; and fog water harvesting as a green technology supporting community development (particularly for women and girls).

Other factors to consider

Values of the water resource are also reflected through other important factors, such as access to the resource, including through ownership (e.g., water as a common good, in contrast with private water rights to ownership, and the case of transboundary water resources), the relative investments made in supply-side versus demand management, and the prioritisation and various types of mechanisms for water allocation (Horne et al., 2017a. b). Processes for water allocation decision-making that are more adaptive, dynamic, and coupled with robust climate science and analysis (reflecting meteorological and hydrological system variability and uncertainty - Section 7.1) should increase abilities to understand climatological and hydrological changes occurring in the system, forecast any supply shocks, and to make decisions on how much to allocate to different sectors that better incorporate trade-offs and the socio-economic realities of populations.

Access to associated data on the resource, as well as inclusive and equitable data collection (e.g., water measurement mechanisms), manipulation and generation, ownership and sharing, are fundamental considerations. They are factors that can help, from early on, to support the reconciliation of values and build trust and awareness (Section 1.2). For instance, the task of understanding fluxes and changes in resource supply and demand can be in the hands of a select few (e.g., government officials and engineers) with limited sharing of those data with others who must take decisions to use the water for farming, household consumption, and so on. In certain instances these latter actors can be excluded not only from the early stages of data collection and processing, but also from the allocation decisions that follow. This risks limiting the degree of awareness across practitioners from different sectors of factors such as the availability, total demand, infrastructure and other resource constraints.

In a general sense, monitoring is clearly important for water resource management. It is also becoming more feasible nowadays, due to substantial advancements in information technology (Section 9). In relation to valuing water, one specific link to tease out could be the opportunity for valuing water to increase and improve water monitoring for data acquisition and use – in that once a true value is determined, there will be a desire to quantify the resource in a more robust and credible way. Monitoring the stewardship of water budgets (in addition to flows) is another facet of valuing water and holding parties accountable for its most effective use. The lack of knowledge around water users and of disaggregated data, e.g., sex disaggregated indicators for water assessment, monitoring and reporting (Seager, 2015) are constraints to be addressed.

2.2 Environmental Dimensions of the Resource – A Vital Consideration

The environment is necessarily a dual consideration when valuing water, as it is both the resource base and a competing water user. The value of water as an integral component of an ecosystem, and its driving roles in flows of water, sediments, nutrients, energy and biota, and their interconnections in the landscape, are seldom adequately considered. The value of the diverse environmental aspects of water, including biodiversity's value proposition for water, are particularly neglected areas (Arthington et al., 2018; Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES, 2019). Continuing inefficiency in use of the water resources, degradation of aquatic ecosystems, and disruption of critical freshwater services are known to pose critical challenges for securing a resilient common future for society (United Nations Environment, UNEP, 2016; SIWI, 2018).

Policies and practical applications of ecosystem services as a concept have given considerable impetus to continuing efforts to document the value of ecosystems, including as natural infrastructure within water management systems (Emerton and Bos, 2004; The Economics of Ecosystems and Biodiversity, TEEB, 2013; Berghöfer et al., 2016; Gilvear et al., 2017). These values and benefits are being documented in increasingly transparent, sophisticated economic terms (Vörösmarty et al., 2018). Quantified or semi-quantitative estimates remain scant, however, for many services of significant value to society beyond the short-term. The value of water to the conservation (protection, maintenance, or recovery) of ecosystems (incl., habitats, species and genetic populations, and processes) within and outside protected areas, as well as in functionally connecting protected area networks in developed landscapes, can be high (whether for Ramsar wetlands of international importance or local community managed forests) (Pittock et al., 2015).

Despite these myriad values of ecosystems as the natural resource base (UNEP, 2016), precipitous downward trends in the biodiversity, overall condition, and resilience of ecosystems have reached globally critical proportions (WWF EU, 2019; IPBES, 2019). Flow regime alteration and losses in river functional connectivity are widespread, to the extent that only 37 per cent of rivers longer that 1000 km remain fully free-flowing and even fewer reach the ocean uninterrupted (Grill et al., 2019); impacts on migratory fish species alone are enormous. Water quality changes are also now manifest at a global scale, with presently over half the world's population suffering from polluted waters and more than 400 hypoxic ocean dead zones due to eutrophication, just two examples (OECD, 2017).

Given the unprecedented rates of increase in water abstraction, polluting activities, population growth, and the resurgence of major drivers of change, such as large water infrastructure and energy projects, these negative trends are not altogether surprising. For instance, worldwide, over 80% of all wastewater is still returned to the environment without being treated (WWAP, 2017) and most forms of pollution are projected to rise in all world regions (OECD, 2017; UN Environment, 2018; IPBES, 2019). Increases in the numbers of large water infrastructure projects are expected in world regions where some of the most precious natural resources for people are located (e.g., freshwater fisheries) (e.g.,

Opperman et al., 2015). Ecosystem services and social impacts remain insufficiently addressed in major water engineering projects (Hansjürgens et al., 2016), this despite social and environmental safeguards (Skinner and Haas, 2014). Efforts to value the environment and maintenance of ecosystem services have been more readily focused on determining the implications and costs of inaction (e.g., need for a greater level of water treatment) rather than the direct values of maintaining nature. Environmental degradation has climbed as a destabilizing factor to become one of the highest ranked global risks, and rising (WEF, 2019a).

These trends all signal a previous lack of attention disproportionate to the state of health and value for society of water ecosystems, and with grave implications. The degradation of land and marine ecosystems undermines the well-being of 3.2 billion people and costs about 10 percent of the annual global gross product in loss of species and ecosystems services (https://www.unenvironment.org/news-and-stories/press-release/new-un-decade-ecosystem-restoration-offers-unparalleled-opportunity; UN Environment Website: accessed 21 August 2019). Several actions now being proposed to halt the global scale decline in freshwater biodiversity and restore ecosystems are connected to SDG targets for water, e.g., Target 6.6 specifically reflects a commitment to 'protect and restore water-related ecosystems' (Arthington et al., 2018) Vörösmarty et al. (2018) present one positive alternative vision for water security to address this situation. Tonkin et al. (2019) argue the need for better forecasting of river ecosystem response to environmental changes (beyond state-of-the-system monitoring) to enhance system resilience and limit risk.

2.3 Solutions that Support the Environment and Additional Resource Values

Solutions for valuing water for the environment also support many of the values to the water services and productive economic sectors (see below for some examples, and Section 4.4).

Environmental flows

All regions and most countries now have in place national policies and laws, and increasingly, supporting regulations (e.g., Mexico, Kenya, China, and the European Union) embracing the values of water for both basic human needs and the environment. The water that is needed to directly sustain ecosystems in a near-natural, modified, or novel state (Acreman et al., 2014), where the objectives for health/condition are set by society, and to maintain their valued benefits to society is termed an environmental flow. Water abstractions (surface water or groundwater) and different types of water infrastructure, such as dams, pumps, and diversion weirs, alter flow regimes and water levels, impacting negatively on river condition (Poff et al., 2017). Environmental flows describe the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being (Arthington et al., 2018). Aquatic ecosystems can include rivers, streams, springs, riparian, floodplain and other wetlands, lakes, coastal waterbodies, including lagoons and estuaries, and groundwater-dependent ecosystems. The benefits to people are typically represented in terms of various diverse ecosystem services, which range from productive inland and coastal fisheries, and storage of high quality water supplies, through to cultural services, flood attenuation, and carbon storage; they are crucial insurers against environmental perturbations and climate change (e.g., Parker and Oates, 2016).

Environmental flow management is recognised worldwide as a central interdisciplinary and intersectoral approach for effectively considering the multiple values of water in IWRM. In some circles, an environmental flow is viewed as a 'baseline' or 'threshold' component of water value (i.e., a (minimum) amount of water that gives value to the environment). Environmental flow policy and practice have grown exponentially, opening new avenues, approaches and partnerships for the ecological management of water (Poff et al., 2017; Horne et al., 2017a). Interdisciplinary bridges being created between the ecohydrological and social sciences are serving to better integrate sociocultural and ecological values of water (Finn and Jackson, 2011; Jackson, 2017; Arthington et al., 2018; Section 3.2). e.g., an attempt was made to quantifying well-being values of environmental flows for more equitable decision-making in the Hamoun wetlands, Iran (Meijer and Hajiamiri, 2007).

Environmental flows, when implemented, and adaptively managed and monitored, have been shown to yield a diverse range of high-value ecosystem services (Gilvear et al., 2017) and other societal benefits, which in turn support many others. Approaches and mechanisms that explicitly include the environment in water allocation processes have garnered considerable attention in recent years (Horne et al., 2017a; see Section 6). The WWF (2017) provides a stepwise approach for successful environmental flow implementation and details case studies.

While there is not a fully comprehensive global picture of environmental flows, estimates of environmental flow requirements are being explicitly integrated into SDG Target 6.4.3, to generate national datasets for monitoring water stress (FAO, 2019). The provision of environmental flows (as an environmental water allocation in a basin plan, operationalised flow release regime from a dam, or regulated limits on diversion or groundwater withdrawal, etc.) supports the achievement of other water-related goals and targets, such as those addressing food security and nutrition from fisheries and flood recession agriculture, and human health (Arthington et al., 2018; Vörösmarty et al., 2018).

Source water protection and water funds

The protection of high value catchment water towers and water sources is increasingly recognized for conferring benefits to downstream rural and resource urban users (Abell et al., 2017). Source protection translates into measurably improved supplies for downstream users, as well as cost savings associated with higher water quality and thus lower treatment costs. e.g., cities in Colombia, the USA, Ecuador, and Kenya obtain high quality freshwater supplies, representing significant proportions of their urban demand, from nearby protected or near-natural areas, ensuring a sustained reliability of supply and considerably reducing water treatment costs. Investment in watershed conservation could generate a positive return on investment for one in every four cities (McDonald and Shemie, 2014). For example, efforts by New York City to protect its watershed enabled it to avoid building a drinking water filtration plant with estimated construction and operating costs of USD 10 billion and almost USD 1 million per day, respectively. Water funds are innovative tools for promoting these benefits (The Nature Conservancy, TNC, Water Funds Toolbox provides examples: https://waterfundstoolbox.org/). “Source watersheds are a nexus of value and action” and a wide range of interventions supported through water funds have been shown to have benefits for the communities, conservation, and water security (TNC, 2018, p. 5).

Nature based solutions

Considerable progress in the area of solutions (NBS) that are inspired and supported by nature and use, or mimic, natural processes has opened up a portfolio of NBS options that offer a pragmatic way forward for concomitantly addressing environmental, economic and social values (WWAP/UN-Water, 2018). Placing greater value on the environment has been shown to generate greater value for other sectors, yet less than five per cent of capital investment in water supply schemes is in the environment (WWAP/UN-Water, 2018). Payment for ecosystem services (PES) schemes remain a tried and tested solution. Nature based solutions contribute to the improved management of water, as well providing essential ecosystem services and a wide range of secondary co-benefits. e.g., floodplains can reduce flood risk and simultaneously improve water quality, recharge groundwater, support fish and wildlife, and provide spiritual and religious, recreational, and tourism benefits (WWAP/UN-Water, 2018). As such, these solutions have a central role to play in delivering the social, economic and environmental co-benefits required under the SDGs, including: access to water supply and sanitation services, food and energy security, human health and livelihoods, economic growth, job creation, improved human settlements, water-related disaster and climate risk reduction, and last but not least, ecosystem restoration and the protection of biodiversity. The substantial value of these co-benefits can “tip investment decisions in favour of NBS” (UNEP et al., 2014; WWAP/UN-Water, 2018, p. vi). The Green Infrastructure Guide for Water Management (UNEP et al., 2014) describes various ecosystem-based management approaches for water-related infrastructure projects and WWAP/UN-Water (2018) covers these kinds of solutions in depth.

Innovation in NBS is continuing (Vörösmarty et al., 2018), with little sign of a slow-down. Low impact development (LID) design and technologies for cities, focused on a portfolio of outcomes for stormwater management ranging from green roofs, rainwater harvesting, and permeable hard surfaces, to flood prevention and water quality restoration, is one such area. Vörösmarty et al. (2018) also give actual case-based scenarios for different national/urban development contexts of the opportunities for and benefits of strategic blending of grey and green infrastructure for future water security, oriented around the following main ecosystem services: drinking water for cities; water quality and pollution mitigation; and flood risk control. Specific principles and standardized implementation guidelines have been developed for flood risk management (World Bank, 2017; Section 7).

3 SOCIAL PERSPECTIVES ON THE VALUE OF WATER

3.1 Basic Human Needs for Water Services

The crucial importance of water management to the realization of the human rights domains of the rights to life, health, food, and a healthy environment is recognised (UNDP Cap-Net/WaterLex/WGF SIWI/REDICA, 2017). Access to safe water is central to the three pillars of sustainable development: people, planet and prosperity (UN, 2015). Universal, affordable and sustainable access to water, sanitation and hygiene (WASH) is a major focus of SDG 6 and a key public health issue within international development. Currently, however, some 89 and 69 countries are not on track to meet sanitation targets or to achieve basic water coverage for all by 2030, respectively (SIWI, 2018). Despite significant past progress, around 2.1 billion people lack access to safe, readily available, good quality water at home, and 4.5 billion people lack safely managed sanitation (WHO/UNICEF Joint Monitoring Programme for Water Supply, Sanitation and Hygiene; SIWI, 2018). Regulatory functions need strengthening for continuity and quality in service delivery, including for peri-urban and rural areas (SIWI, 2018; WWAP, 2012).

Domestic and household uses of water represent a comparatively small, but exceptionally high value component of water demand and use. This to the extent that in South Africa, Kenya and Tanzania, for instance, water for Basic Human Needs (25 litres per person per day) forms one of only two legislated rights to water, termed a Reserve, with water to sustain the natural environment the other priority legal right. Data at global, national and subnational scales clearly indicate the economic value of water service provision. However, the actual cost of water and sanitation services, at national, sub-national and community levels, as well as access to information about service performance, need improvement in most countries (SIWI, 2018).

Volumetric quantifications can be generated, based on the cost of pre-use treatment, storage and distribution, post-use treatment, and disposal (the notion of full-cost recovery). Human health values of water appear patchier. Co-benefits of access to WASH, including poverty alleviation, savings in health costs, increased workforce productivity and income, and improved access to education, can also be factored-in to assessments of value in a quantifiable way. Perhaps the best known examples are the cost-benefit ratios of 5.5 for sanitation and 2.0 for drinking water (Hutton, 2012). There are also intangible benefits that add value to WASH, such as improved quality of life, but these are remain more difficult (if not impossible) to quantify. Water has an enormous value in terms of productivity not only in terms of economic output, but also for workers and certain segments of the community. Reducing occupational illnesses (such as WASH-related communicable diseases) and reduced health impacts on women fetching water, mainly through access to safe WASH, will increase the number of hours people can dedicate to productive work and education. This is important in agriculture and employer-provided housing, for example. The International Labour Organization (ILO) has adopted 10 conventions, numerous recommendations, and 18 Codes of practice that require or propose measures to ensure this access. Social dialogue is an important means to increase this value, gathering the inputs from workers and enterprises on how to improve access.

Water values differ according to the varied realities, restrictions and opportunities that exist among urban, peri-urban, and rural communities. For instance, inequality in access to water supply and sanitation is multi-dimensional (e.g., globally, eight out of 10 people without improved water live in rural areas; WWAP, 2019). Currently cities already account for 54.0 per cent of population and an anticipated further increase to 66.4 per cent by 2030 (UNICEF, 2017) is liable to increase the vulnerability of these populations (e.g., through increased water scarcity, growth in informal settlements, and climate change). As a result, the values accorded to water in urban settings necessarily have already become an area of major attention.

Assessing the values accorded water by the various groups within each of these settings is a challenge made more complex by the intersectional dimensions of disadvantage (WWAP, 2019). Differences in both perceived and real value occur between high income households and the poor in different settings. The urban poor pay more (up to 30% of their income) for lower quality services, whereas services for the wealthy are highly subsidized and they pay comparatively little. The wealthy do not necessarily perceive the 'true' value (or cost) of water services, which can lead to water wastage. For the rural and peri-urban poor, WASH is also an issue, but so is having access to water for supplemental irrigation for their crops to survive periods of drought.

3.2 Social and Cultural Values Associated with Water - An Expanding Theme

Socio-cultural values are reflected in and shaped by human identity, rights, ethics, world views, cosmologies, and belief systems, cultural heritage, sense of place, art and aesthetics, and quality of life. The many different values and meanings of water can be expressed in spiritual, cultural, and emotional terms and found in the heritage of water language, norms, and artefacts. These reflect the deep perceptions, need for connections, and participation of all of society. This yields a rich array of epistemological, Indigenous, spiritual, recreational and other perspectives on and relationships with water, all of which ultimately reflect or influence the ways in which water is valued (among others, Johnston et al., (2012), Bakker (2012), Jackson (2017), and Groenfeldt (2019). Such values, some of which are intangible or extremely difficult to quantify but still need to be included, have been shown to influence the factors considered, directions taken, and degree of sustainability of outcomes of water development.

The importance of understanding user behaviour patterns is under recognised. Human behaviours, customs, and traditional practices are ingrained in all people and these drives decisions and actions daily on water use practices (for individuals, firms, farmers, governments, etc.). A better understanding of behavioural drivers is needed, including how to change or influence these behaviours towards more sustainable actions. Differences in perceptions as to the value of water also are to be expected. Yet, explicit knowledge of this issue appears limited in many contexts in which valuing water is pertinent.

Society's values and expectations, including terms of the benefits and acceptability of costs and risks associate with water resources development, also change over time. Studies of historical trajectories of basin development provide insights into the changing values that have guided past decision-making and those guiding paths to future development. e.g., the extensive and dynamic history of water management decisions for the Yellow River, China (Wang and Liu, 2019).

More explicit, regular inclusion of community, indigenous, and other traditional ways of knowing and associated sources of knowledge into water science and practice introduces different values and ways of conceptualising, valuing, and assessing the roles of water in development. It is contended, for instance, that greater inclusion of social and cultural issues, and better approaches for their measurement, might result in more balanced water resources decision-making.

Thematic Growth Areas

In this context, below are some areas of current growth within the wider theme of social-cultural aspects of valuing water. There are doubtless others and it is recognised that this entire subject is ripe for more in-depth assessment.

Value for rural, local, and indigenous communities - Water holds enormous value for rural, local, and indigenous communities, because they tend to depend on water resources more than other groups. It is suggested that member states should be encouraged to establish frameworks to enable these communities to manage water resources in an integrated manner, as an inherent part of strategies for a just transition to a green economy. The ILO Convention No. 169 is currently the main international instrument on indigenous peoples in this regard. Further experience pertaining to indigenous peoples and water can be drawn from the issues and recommendations highlighted in UNDP-SIWI Water Governance Facility, WGF (2016) and other resources (http://www.watergovernance.org/resources/indigenous-peoples/) including on: marginalization and multidimensional poverty; access to WASH services; and roles as custodians of knowledge and holistic management practices. More inclusive, intercultural approaches to water governance that help meet the needs and aspirations of indigenous peoples can be expected to have added value in addressing the water SDGs. Solutions on valuing water, best practices, insights, and guidance could be provided, together with the identification of data and knowledge gaps.

Full and equal participation of people of all cultures and ethnicities, and respect for their rights, responsibilities, and systems of governance is growing in attention in the area of environmental water decision-making (Arthington et al., 2018; Section 2.3). For example, Tipa et al. (2016) discusses the cultural values of Maori, which have been used, for example, to establish cultural flow preferences and set cultural water allocations for New Zealand rivers; other cases have been documented (Poff et al., 2017; Jackson, 2017; Anderson et al., 2019). In a growing number of countries, rivers are being accorded the same legal status and rights as persons, opening the door to currently largely unexplored terrain in water management (O'Donnell and Talbot-Jones, 2018).

Water ethics - Another emerging area is that of water ethics (e.g., the ecological ethic that rivers should be kept alive or that deliberate water pollution is unconscionable) including the ethical use of agricultural, domestic, urban, and industrial water, which is advocated for inclusion as a standard component of water governance (see below). For instance, the connections between ethics, values, and environmental flows (Section 2.3) has begun to be explored. Experience can be gained from various practitioner networks engaged in the field of water ethics, such as the Water Ethics Working Group of the Sustainable Water Future Programme (http://water-future.org/working_groups/water-ethics-working-group/) and the Water and Faith network below.

Water and faiths - Inclusiveness and strong partnerships are required to be able to realize the water (and other) SDGs and for all human development. Faith and spirituality are known foundational sources and drivers of behaviour; shaping and inspiring individual and community worldviews, priorities, daily rituals, and community structures – including relationships to and values of water resources (Global Water Partnership, GWP/SWH (Swedish Water House) SIWI/Swedish Institute Alexandria/Church of Sweden, 2016). Moreover, in rural and remote locations, or where governments are unable or otherwise fail to provide essential services, faith-based organizations (FBOs) and networks are often relied upon to fill essential service gaps. Many FBOs support people in humanitarian crises and in need. The Cluster Group on Water and Faith of the SWH (http://www.swedishwaterhouse.se/en/cluster-groups/water-and-faith/), SIWI, and partners serves as a platform to build bridges between the water community and FBOs to raise awareness and strengthen implementation for improved water governance.

Aspects to address under faith based perspectives could include: the role of FBOs in guiding community values, beliefs, and behaviours; the symbolic meaning of water in faith based and traditional perspectives, influence, presence and reach. Various policy statements, insights, and case studies could be drawn upon. Suggestions could be provided, for example, for increased collaborative engagement to support faith leaders in championing sustainable development, creating a conducive policy environment, and increasing political commitment. The impacts of water challenges and added value of these perspectives to the inclusive water governance processes necessary to achieve SDG 6 could be highlighted. Solutions on valuing water, best practices, and supporting guidance could be identified, as well as data and knowledge gaps. Synergies exist with broader human rights issues, including migration, justice, and water conflict and cooperation (Section 7.3).

4 A PERSPECTIVE ON THE VALUE OF WATER FOR OTHER ECONOMIC SECTORS

Industry (including power generation) and household water use account for 19% and 12%, respectively, of annual water withdrawals globally (AQUASTAT, n.d., cited in WWAP, 2019); most industrial and domestic water withdrawals are non-consumptive, returning to the water system. Much of the projected growth in global water demand is anticipated to be attributable to demand increases from the industrial and domestic sectors. According to the WWAP (2019, Figure 2, p. 13) while agriculture's projected share of total water use is liable to fall in comparison with that of other sectors, it will remain the largest user overall over the coming decades in terms of water withdrawal and water consumption; specific projections vary (WWAP, 2019). The need to build resilience in water systems is increasingly understood and undertaken in urban, agricultural, industrial, and energy systems (SIWI, 2018).

The political economy of investing in water is outlined in WWAP (2012). A core benefit of water is national economic growth (e.g., GDP/m^3), and the generation of income at country, regional, and/or local) levels, by catalysing new types of economic activity and providing other measurable co-benefits such as job creation, equality, security against fluctuations in water availability, and long-term climate resilience; there is, however, growing debate as to the utility of GDP as a measure of progress in sustainable development. Water used as 'inputs' to various economic sectors (e.g., agriculture, energy, industry, human health) readily lends itself to volumetric quantification in a similar fashion to the water resource above (i.e., cost of capture, use, treatment and disposal. Costs associated with certain environmental and social impacts, often indirect, remain more challenging for various reasons - but see below. There is additional, readily quantifiable value than can be added as a function of economic indicators, for any economic sector, notably: water use efficiency, i.e., the value added per water volume used (expressed in unit currency/m^3, as per SDG indicator 6.4.1); water productivity associated with various water uses, i.e. the output or yield per cubic meter of water, expressed simply in terms of profit/

m^3, or in the case of agricultural yield or basin productivity as 'crop/drop' or 'value per drop', respectively (Kijne et al., 2003) or value of what can be produced with a unit of water; and water use intensity i.e. the volume of water used to produce a unit of value added (measured as m^3/unit currency). These aspects of value can be integrated to generate accounts for physical water assets (as an element of natural capital accounting - Section 4). e.g., the national capital accounts for water for Rwanda (National Institute of Statistics of Rwanda, NISR, Ministry of Environment, Government of Rwanda, 2019). Physical accounts of the water resource and its use can be combined with economic accounts, forming 'hybrid' flow accounts that facilitate the derivation of indicators of water use efficiency or productivity, as well as combined analysis of the volume of water used with measures of economic activity, such as value of output, value added, and employment (Government of Rwanda, 2019). These assessments enable water decision makers to consider the distinct issues (and inherent values) associated with each water source and the specific needs of different economic sectors, promoting improved management practices for water quantity. What is often missing, however, is a cost per m^3 associated with infrastructure development and maintenance. This is becoming better known through, for example, desalination projects. For large projects, such as dam construction, costs are commonly only estimated as global figures. In South Africa, a Unit Reference Value approach provides a cost per m^3 of water delivered for water resources related projects.

Various methods, such as social return on investment (SROI, e.g., https://socialvalueint.org/) provide options for determining the kinds of extra-financial environmental and social values not typically reflected in conventional accounts. Increasing attention appears to be being given to social accounting (e.g., indigenous approaches and practices for water storage, supply, and consumption, as well as an understanding of who is involved or excluded).

There is also a clear economic case to be made for improved water quality management, targeting the point source and diffuse pollution impacts of various economic activities and their implications for sustainable development (OECD, 2017). Consumptive uses of water by industry, in cities, and agrochemical inputs in agriculture can lead to biologically and chemical contaminated groundwaters and degraded downstream water quality, strongly impacting other resources users. Industries, and at times agriculture, also use water non-consumptively. As a result, wastewater often returns to the environment without proper collection or treatment, polluting receiving water bodies (e.g., pollutants from mining effluents, and thermal pollution from cooling). Point sources of pollution from various economic sectors, such as industry, are deemed to be "largely under control in OECD countries" because they are easier to identify and more cost-effective to quantify, manage and regulate (OECD, 2017, p. 5), but this is not necessarily the case in other parts of the world. Moreover, managing diffuse pollution (e.g., from agricultural runoff, and mixes of pollutants and sources from urban environments) presents a persistent global challenge.

Poor water quality has numerous socioeconomic costs associated with it, including: water treatment and health-related costs; impacts on economic activities such as agriculture, fisheries, industrial manufacturing and tourism; degradation of ecosystem services; reduced property values; and opportunity costs of further development (e.g., UN Environment, 2018). Examples of water quality impacts to economic, social, and environmental values are summarised in OECD (2017). The estimated annual national costs of water pollution from only diffuse sources exceeds billions of dollars each year in just the OECD countries. Algal blooms associated with excessive nutrients in freshwater systems cost Australia 116-155 million USD annually, including through major disruptions of livestock and town water supplies and fish kills. In England, the yearly costs of treating drinking water to deal with cumulative effects of point and diffuse sources is in the range of USD 892-1656 million. The scale of these costs means that "seeking increasingly marginal reductions in point source pollution is no longer the most cost-effective approach to improving water quality in many OECD countries" (OECD, 2017, p. 7).

4.1 Food and Agriculture

The high value of water use for agriculture purposes to meet society's growing demands for food security and nutrition (SDG 2), is reflected in the global figure of 69% of annual water withdrawals for this purpose (WWAP, 2019)- already, approximately 92 per cent of humanity's water footprint is related to agriculture for food production (Hoekstra and Mekonnen, 2012). Willett et al. (2019) state that up to 75–84% of global consumptive water use can be attributed to agriculture, with 84% of cropped land rain fed and the remainder irrigated. In water-scarce regions, irrigated agriculture is responsible for more than 90% of all consumptive water use (Richter et al., 2017), making that water unavailable for other uses in the basin. Moreover, population growth and changes to the food system mean it will likely be necessary to allocate more water – in absolute and relative terms – to future food production (Willett et al., 2019). A fundamental

transformation of food and agricultural systems, coupled with rural revitalization, are necessarily if the SDGs are to be achieved by 2030 (International Food Policy Research Institute, IFPRI, 2019). There is also strong evidence that "food production is among the largest drivers of global environmental change by contributing to climate change, biodiversity loss, freshwater use, interference with the global nitrogen and phosphorus cycles, and land-system change (and chemical pollution, ...)" (Willett et al., 2019, p. 447).

These facts are driving closer scrutiny of the values attributed to water in food systems and specifically in irrigation. They underscore the need to further improve on efforts to do more with less water - to meet rising food and nutritional demands, accommodate shifts in consumption patterns, address the water in food waste, lower consumptive water use below present levels to alleviate scarcity, and at the same time ensure sufficient water remains in agroecosystems to sustain their health, productivity, and resilience with climate change (Food and Agriculture Organization of the United Nations/International Fund for Agricultural Development/United Nation Children's Fund/World Food Programme/World Health Organization, FAO/IFAD/UNICEF/WFP/WHO, 2018; IFPRI, 2019). This need to improve is especially critical given new evidence signalling a rise in world hunger in recent years. The number of undernourished people has increased to an estimated 821 million in 2017 – around one out of every nine people in the world (FAO/IFAD/UNICEF/WFP/WHO, 2018). Along with severe food insecurity, undernourishment is increasing in most parts of Africa and in South America, though stable for much of Asia.

Information sources and management practices

The FAOSTAT database is a rich source of food and agriculture data for over 245 countries and by region, from 1961 to the most recent year available (http://www.fao.org/faostat/). These data reveal major trends in the beneficial uses of water for food security and agriculture products, as well as in the costs incurred, from indicators of food security and values of agricultural production for major food crops, to trade values of fertilizer inputs, and producer and consumer commodity prices. A comprehensive, recent overview of food policy trends, including in key food policy indicators at country and regional levels, is given in IFPRI (2019).

The CA (2007) described a suite of Best Management Practices (BMPs) for maximising vital benefits needed from the full spectrum of agricultural production, while better addressing environmental and social concerns ; many recommendations therein remain current (e.g., agroecological and diversified farming systems and strategies, and sustainable intensification) (e.g., CA, 2007; Boelee, 2011; Fleiner et al., 2013; Willett et al., 2019). Multiple use of water systems (or MUS) in agriculture is one such approach, and with focus on gender relations and smallholder agricultural systems. It often increases the economic productivity of water use in irrigation schemes, in addition to providing more vulnerable water users with low cost services for domestic water; water supplies for homesteads, livestock and rural enterprises; and habitats for fish and other key aquatic resources.

Tools continue to be advanced to explore the benefits being generated through BMPs for sustainable agricultural production and food systems (e.g., Molden et al., 2010; Willett et al., 2019). As an example, the FAO Water Productivity Open Access Portal (WaPOR, https://wapor.apps.fao.org/home/) can be used to interactively map, monitor and report on agricultural water productivity near-real time, using data generated with remote sensing technologies (i.e., annual gross biomass water productivity, as quantity of above ground biomass production in relation to the total volume of water consumed in the year (actual evapotranspiration) at continental, country/river basin, and sub-basin/irrigation scheme scales, for Africa and the Near East. Water productivity gaps can be identified this way, facilitating proposed solutions to reduce them, contributing to a sustainable increase of agricultural production while taking into account valued ecosystems and equitable use of water resources (Molden et al., 2010); eventually these steps should lead to reduced overall water stress. Similar approaches are in development by FAO and partners for assessing water and land productivity, in production per volume of water (kg/m^3) and yield (kg/ha), respectively (e.g., for specific crops under rainfed or irrigated agriculture, and for particular scales, including individual irrigation schemes (http://www.fao.org/in-action/remote-sensing-for-water-productivity/water-and-land-productivity-assessment/wl-productivity-overview/en/). Water productivity plays a central role in performance assessment of irrigation, as the basis of system modernization. Assessment of economic water productivity for multiple uses of water, in terms of economic return per amount of irrigation water, can be used to identify irrigation schemes for modernization to make the water services provided to all water users more reliable, cost effective, adaptive to increased climate variability, environmentally sound, and potentially more diversified (MUS). Water accounting using remote sensing helps assess the extent to which water productivity increases affect different water users, and subsequent water auditing, are key follow-on stages in the valuation process (http://www.fao.org/in-action/remote-sensing-for-water-productivity/water-accounting/water-accounting-overview/en/).

Founded on such approaches, Richter et al. (2017) discuss water-saving strategies to alleviate water scarcity, that (on the basis of case study review) demonstrably reduce water consumption in irrigation systems, and allow reallocation of the water savings to other uses, including environmental restoration, in ways that properly account for return flows.

As the path for agricultural development transitions to sustainable intensification and zero expansion of new agricultural land at the expense of natural ecosystems (Willett et al., 2019), alongside the implementation of additional measures such as reducing water allocations, the evidence base for BMPs and the supporting tools to support them should grow and novel solutions emerge. It remains to be seen how such advances will better incorporate and impact on values. Concerted efforts continue to be made to generate even higher returns on investments, with attention to gains from demand management, such as appropriately reallocated water savings through increased efficiency in irrigation that avoids increased water depletion (so-called rebound effects) (e.g., drip irrigation, and other technological advances of precision agricultural), supplemental irrigation, conjunctive surface water-groundwater resource use, and improved land and water management practices. However, benefits gained in terms of factors such as crop yields, increased nutrition, poverty reduction, and job creation have often had serious cost implications in terms of human and environmental health (e.g., diffuse pollution impacts from increased agrochemical inputs). There have also been serious implications for the long-term sustainability of the resource for agriculture itself, as evident, for instance, in declines in groundwater below accessible levels, loss of previously productive lands and waters to salinization, declining productivity of estuarine and coastal fisheries. A lack of full cost accounting is still commonplace in agricultural water use, with many of the costs associated with such detrimental impacts remaining unaccounted for or only partially quantified. e.g., costs of fuel for pumped groundwater extraction for irrigation have been accounted for, but not the true cost of the water, or its detrimental impacts on groundwater-dependent wetlands and livelihoods (Comprehensive Assessment of Water Management in Agriculture, CA, 2007). The environment, and thus the dependencies on it of smallholder farmers and subsistence resource users, are often treated as externalities. The footprint of smallholder farmers on the global water system is vast, as 90% of the world's farms are smallholder systems. Yet, a significant gap in information and awareness is apparent, where farmers as the main 'consumers' are unaware of how much water they are applying. Few smallholder farmers can measure accurately the quantity of water consumptively used for various crop cycles, as supporting technology and applications are limited. While disruptive technology interventions using satellite data and precision farming are in use on large scale commercial farms (e.g., in Europe), knowledge transfer to small-scale farms using simple agricultural methods (e.g., in Asia or Africa) is limited.

The use of wastewater use in agriculture, including in urban and peri-urban settings, is a well-studied case where multiple values, benefits, and costs (e.g., human health, cash crops, and productive lands) have been well studied, generating various options for potentially substantially increasing wastewater recycling and safe reuse globally. This has the potential to help achieve SDG Target 6.3, which aims to improve water quality through such efforts, in addition to halving the proportion of untreated wastewater and improving water quality. The progressive transformation of wastewater treatment and management in the direction of reuse, rather than disposal, presents various value propositions for resource (water, nutrient and energy) recovery which could support cost savings, cost recovery, and profits (and in a sector customarily reliant on public funding) (Drechsel et al., 2015). Wastewater could become an increasingly valuable economic asset in urbanizing developed and developing countries (Drechsel et al., 2015).

4.2 Energy and Industry

Data from across the different areas of energy and industry convey in detail the economic values of water for production in these sectors (WWAP 2015). Corresponding quantitative or semi-qualitative data on additional benefits and on the costs and risks (pollution impacts on human health, loss of migration-based fisheries, etc.) attributable to under-valuing other needs tend to be limited, but see, for example, OECD (2017) and (WWAP, 2014).

The proliferation in hydropower schemes as infrastructure producing renewable energy is drawing special interest (Zarfl et al., 2015). Historically, social and environmental values have seldom been placed on an equal footing with the direct socioeconomic gains from electricity generation (in USD, Megawatts (MW), or similar measures). However, new planning tools are helping readdress such imbalances (Section 6.1), as well as the well documented, but still underappreciated detrimental impacts and risks to society and ecosystems (e.g., Opperman et al., 2015; Grill et al., 2019). Other renewables, notably biofuels, have significant diverse positive and negative impacts on water. The same is true for mining, including of fossil fuels, and other extractive industries. The impact on water values might differ significantly in each instance, and the

multiple vales of water should be considered in related decision taking; case studies would be a useful way of illustrating these points. Mining in particular, has significant negative impacts on both water quantity and quality, but derives huge value from its use of resources. The long-term impacts of these kinds of activities and their costs to society (e.g., after a mine has closed, but continues to pollute) are important considerations.

4.3 Water Stewardship and Private Sector Roles

The value of water to private or public-private sector industrial and agricultural enterprises typically has been approached in economic (monetary) terms. It is only more recently that the water-related risks to business of not considering other resources users, particularly at basin or system scale, have gained traction (Newborne and Dalton, 2016). This has galvanised a move by businesses, including, among others, corporate agribusiness, energy companies, and food and beverage industries, beyond basic requirements for corporate social responsibility to water stewardship and associated alliance building. There are several formative initiatives highly active in this space, of which a few are highlighted below. The Alliance for Water Stewardship (AWS, http://a4ws.org) is a partnership of environmental organizations, businesses, research institutes, and others that developed a detailed set of guidelines, the AWS International Water Stewardship Standard 2.0 (adoptable for certification) as "a globally-applicable framework for major water users to understand their water use and impacts, and to work collaboratively and transparently for sustainable water management within a catchment context." The AWS Standard aims to drive economic, social, and environmental benefits at catchment scale, by engaging 'water-using sites' in understanding and addressing not only site water risks and opportunities, but also shared catchment water challenges. Resultant progressive shifts towards best practice are expressed in terms of five outcomes, viz.: safe water, sanitation and hygiene for all; sustainable water balance; good water quality status; important water-related areas; and good water governance (AWS 2019). Water-related costs, revenues, and shared value creation are considered as holistically as possible within a site assessment (AWS 2019); creation of shared value is focused on the creation of economic value, social value, or environmental value that benefit stakeholders outside of the site being assessed. Specific standards are being developed for economic sectors and regions. e.g., the European branch of AWS has adapted the standard for use by agricultural businesses in Europe, and AWS is working with partners to support water stewardship among rice and cotton farmers in Central and South Asia (Groenfeldt, 2019).

As UN Global Compact initiative, the CEO Water Mandate mobilizes business leaders on water, sanitation, and the SDGs (https://ceowatermandate.org/). Its endorsers (approx. 145 companies worldwide) commit to continuous progress against six core elements of stewardship (viz., direct operations, supply chain and watershed management, collective action, public policy, community engagement, and transparency) and "in so doing understand and manage their own water risks". Under the Business for Water Stewardship (http://businessforwater.org) in the USA, over 1200 companies have engaged in environmental water stewardship efforts (to balance their water footprints) that have restored 19 billion gallons of water, generating a purported economic value of USD 1.4 trillion. Various non-governmental organisations (NGOs) also promote water stewardship (WWF, 2013) and non-profit partnerships have adopted the term to describe their sustainable water activities.

Some companies are undertaking water valuation exercises. One case is that of International Paper (IP). Although a water-intensive industry, IP returns more than 90% of the water used to waterways (IP, 2019). The company has a 2020 water goal to build on facility water risk assessments by incorporating water stewardship efforts and local stakeholder engagement to address water-related issues (https://www.wbcsd.org/Sector-Projects/Forest-Solutions-Group/Forest-Products-Sector-Guide-and-Case-Studies/International-Paper-Attaching-a-value-to-water); attaching a value to water is recognised as an important next step towards water stewardship. The cost and value of water to the company and to the community and other local users, as well as IP's economic value-added per unit of water, have been determined (IP, 2019). Different results were obtained for the three sites assessed, reflecting local conditions - a global benchmark of USD 1/m^3 was used as a societal value on water. Efforts are being made to integrate water values into IP's operational models, to internalize key 'externalities' related to water intake and discharge. Such comprehensive exercises are comparatively few. Moreover, they are often reactive (e.g., in response to drought, a pollution event, or public relations crisis) rather than proactive. There is a recognised need to create both an internal and an external demand for business to do more. Water stewardship and the assessment of water-related risk are also useful to more comprehensively assess values (e.g., WWF Germany, 2015) and have been incorporated into cross-sectoral analyses of water's value in local economies (e.g., WWF-Zambia, 2016; WWF-Greater Mekong, 2016).

4.4 Approaches for Determining Multiple Values of Water Across Sectors

The Dublin Statement on Water and Sustainable Development of 1992 states that 'water has an economic value in all its competing uses and should be recognised as an economic good' (WWAP, 2012). Water is undervalued among sectors. "Inadequate valuation and ineffective pricing of water for energy generation, industrial and agricultural activities and domestic uses has led to inefficient water use, high discharges of pollutants, and degraded marine and freshwater systems; all leading to high levels of water stress due too little, too much, or too dirty water" (SIWI, 2018, p. 3). Generic methods and tools are rapidly advancing for determining the economic value of water for different uses and economic sectors (incl. water services; Section 3) and for comparative purposes (WWAP, 2012). Some examples are the following (see also Section 2.3).

Water pricing

The economic value of water is a central area. In this regard, the appropriate pricing of water uses and services has a role to play as a well-established mechanism for cost recovery across all economic perspectives, stimulating wise use of the resource, while simultaneously ensuring affordability of water and its benefits and services for all (Kijne et al., 2003; WWAP, 2012; Garrick et al., 2017; HLPW, 2017a, b)It is further argued that a more direct conversation is needed about pricing water appropriately across multiple levels. However, metering water (including via sliding-scale tariffs), a necessary step for pricing to be effective in improving efficiency and sustainability, has been met with resistance in several geographies, due to apprehensions about affordability of water services and equitable access (Garrick et al., 2017). Concerns of water users about measurement usually reflect perceptions of constraints on resource use or the creation of new (higher) tariffs. Various other economic instruments applied for valuing water have not been without controversy in places. Robust institutions are needed to support these kinds of approaches, not only to monitor and control water use, but also to engage vested interests and resolve valuation disputes (Garrick et al., 2017).

From a business perspective, lessons can be learnt from carbon. The growth in internal carbon pricing in recent years has been impressive, driven by consensus on the climate emergency, the Paris Declaration, and policy and market instruments (which water does not have in place yet). The question has been raised as to what would drive business to similarly establish an internal price for water; some companies (e.g., Nestlé) are now undertaking this step.

Water accounting frameworks

Water accounting is another approach for valuing water at national, basin, and other scales. Hydromet data collection infrastructure and remote sensing, land use, hydrological and coupled socioeconomic-hydrological modelling techniques underpin water accounting frameworks.

Water accounting using water footprinting as a tool has proved useful for some time, in highlighting the comparative value of green, blue and grey water in the production of different agricultural, industrial, and other commercial products in a comprehensive, consistent and reproducible way. A water footprint is the volume of freshwater used to produce a product, measured over the full supply chain (or for any single step in the process). It indicates water consumption volumes by source and polluted volumes by type of pollution, with all components of the total water footprint specified in geographic, spatial and temporal scales. For instance, water footprints for a diverse range of food products from crop and animal origin reveal that global animal production requires about 2422 Gm^3 of water per year (87.2% green, 6.2% blue, 6.6% grey water) (https://waterfootprint.org/en/water-footprint/product-water-footprint/). A third of this volume is for beef cattle and 19% for dairy, with most of the value of the total volume of water used (98%) embedded in animal feed; in contrast, animal drinking water, service water, and feed mixing water account for a tiny amount. In addition to directing where the greatest water savings potential exists, such water footprints reveal human health, waste reduction, and environmental protection benefits (Hoekstra et al., 2011). Water footprint accounting has demonstrated utility in assessing diverse supply chains and in scaling up from field to basin, various administrative units, and national levels, as well as in virtual water trade (Hoekstra et al., 2011). Ecological footprints have also emerged as an instructive way to demonstrate how far development has exceeded sustainable limits, thereby reflecting where the greatest attention on values and benefits has been placed (e.g., WWF-EU, 2019; https://www.footprintnetwork.org/).

Natural capital accounting

The use of accounting frameworks to document the value of the natural environment and its resources (including in monetary terms, alongside social and other capital) is now a highly active field that continues to evolve worldwide, informing planning, management and investment decisions in new ways that help maximize opportunities and minimize risks for both public and private benefit (Natural Capital Accounting, 2019: https://ecosystemsknowledge.net/resources/themes/accounting).

As cases from the UK show, natural capital accounts can be generated for countries, large organizations and businesses, cities, protected areas, and smaller-scale areas of land and water (e.g., private estates, and public parks) (https://ecosystemsknowledge.net/resources/themes/accounting). The World Bank-led Wealth Accounting and the Valuation of Ecosystem Services (WAVES) partnership (WAVES, 2019: https://www.wavespartnership.org/en; resources are available online in the WAVES Knowledge Center) encourages the incorporation of the value of the environment in national economic accounts and development planning. e.g., Rwanda and Botswana have produced first national accounts of status and trends in water and energy, respectively. The Rwanda national account include: water resources data, key water measures and indicators of supply and efficiency of use (water abstracted, used, consumed, and water efficiency, productivity, and use intensity), and other water values (Government of Rwanda, 2019). As in this case, physical accounts of the water resource and its use can be combined with economic accounts, forming 'hybrid' flow accounts that facilitate the derivation of indicators of water use efficiency or productivity, as well as combined analysis of the volume of water used with measures of economic activity, such as value of output, value added, and employment.

The UN System of Environmental-Economic Accounting has standardized methods in place to report on the relationship between the environment and the economy. Illustrative case studies are available (e.g., Global Environment Facility (GEF) 6 project, South Africa).

Water quality policy interventions

Within an integrated policy framework for diffuse pollution management (OECD, 2017) a mix of policy interventions reflecting basic principles of water quality management could be optimal – pollution prevention, treatment at source, the polluter pays and the beneficiary pays principles, equity, and policy coherence; a range of policy instruments and innovative case studies are described. Receiving water quality objectives for the environment also have a role to play and supporting guidance can be used to ensure ecological health is maintained (UN Environment, 2018). Environmental taxes and fees can be used to create incentives and produce revenue to address both water quantity and quality (e.g., Government of Rwanda, 2019, p. 49).

Digital water technology

Smart design, use, and control options, such as those empowered by new digital technology are one solution set for maximising the valued benefits of water use in water services, especially in urban centres and industry (International Water Association, IWA, and Xylem Inc., 2019). They are liable to become transformative elements of network monitoring of water quality and water quantity. Options encompass: smart designs for adaptive 'off-grid', distributed systems that provide diversity, and modularity, both characteristics critical for resiliency; smart use through combining concepts of water fit for purpose (different grades for different uses), and resource recovery and reuse (of water, energy, and nutrients from wastewater); and smart (digital) control: Internet of Things (IoT)-supporting, data-driven models that can help integrate and optimise smart pumps, valves, sensors and actuators, and enabling devices to communicate (direct or via smartphones), and send real-time information to be accessed and shared via the cloud. The IWA platform (https://iwa-network.org/projects/digital-water-programme) assists utilities to recognise emerging digital technologies and solutions and to understand how they can be integrated across the utility value chain, to foster adaption and value creation (IWA and Xylem Inc., 2019).

5 VALUES IN WATER GOVERNANCE

5.1 Factors Influencing Values

Failures of governance have affected the quality and availability of surface water and groundwater resources, compromising their capacity to generate social, economic, and environmental benefits. Value judgments are a pervasive aspect of governance, embracing diverse perceptions of and responses to impact, risk and uncertainty, alongside dimensions of ethics, equity, and other elements (Timmerman et al., 2017; WWAP, 2015). Increased recognition of multiple

values can serve to improve the governance of water (Garrick et al., 2017). Further, speaking to the diverse values of water engages the whole of society in a shared effort to achieve the SDGs. Yet our ability to incorporate these values into water governance is inadequate (Garrick et al., 2017). Values need to be part of the necessary adaption of governance structures to all levels, in complementary and mutually reinforcing ways, down to the level of local value sets. Effective, accountable and transparent institutions are needed in water governance and management (SIWI, 2018).

International and national laws and other mechanisms are an essential consideration. The establishment of and/or adherence to existing and new laws and mechanisms (including intergovernmental mechanisms at global and regional level) that encapsulate multiple perspectives and aim to leave no one behind, remain a cornerstone. Also with important roles are rights based mechanisms, standards, and protocols that have values embedded and with which compliance is agreed (e.g., Free, Prior and Informed Consent or FPIC). A growing body of useful guidance exists as well (e.g., online user's guide for the UN Watercourses Convention; https://www.unwatercoursesconvention.org/).

Multi-stakeholder platforms, dialogues, and vision and objective-setting processes tailored to water development all provide key, under-utilised entry points for valuing water. The degree of influence of people's participation in decision-making needs to be enhanced and only some 25 per cent of countries examined report a high level of stakeholder participation in any subsector (SIWI, 2018). It is argued that a primary reason for limited successes in attaining IWRM and in water governance is the omission of a full representation of the values of water. As Groenfeldt (2019, p. 5) states "Water governance is all about values". Polarization of views based on value divides (cf. value differences) can preclude reasonable governance solutions (WWAP, 2012).

Ethics contribute a complementary set of behavioural guidance to that of the laws, policies, and regulations concerning water and there is a need to institutionalize ethics into all water decisions and water behaviours (Groenfeldt, 2019). "Ethics adds to the resilience of water systems through systematizing value principles which can endure even through legal and policy changes" (Groenfeldt, 2019, p. viii). Such principles are a means to navigate the terrain of complex, conflicting and unresolved values about the many functions and uses of water. Importantly, even when ill-formed or vague, values motivate behaviours in water resources management and decision-making that can have real impacts on the ground. Lessons can be learnt from the active area of Indigenous water ethics. New normative water standards are emerging, ranging from the industry initiative around water stewardship (Section 4; WWF, 2013) to water charters, including the ongoing development of a global water ethics charter. Corruption also merits scrutiny, as several well studied cases related to water show (e.g., the Lesotho Highlands Project, southern Africa).

5.2 Politics and Decision-Making

The various values of water need to be factored into political and business decisions (HLPW, 2017a), particularly as "each choice that is made about water has implications for the wider political economy WWC and OECD, 2015, p. vii). The failure to fully value all the benefits of water in its different uses is considered a root cause of the political neglect of water and its mismanagement (WWAP, 2012). It can lead to (WWAP, 2012): insufficient appreciation of the importance of water, a low priority being given to water policy in country development programmes, poverty reduction strategies, and other policies; suboptimal levels of investment in water infrastructure; and even failure in meeting to international socioeconomic goals (WWAP, 2012).

Political will is critical, as the willingness to consider all value sets for water and to then act on that basis. Collective action is needed to address issues around the dynamics of power and entrenched power asymmetries, for example. As true for valuing water as it is for other aspects of sustainable water resources development, change requires the transformation of economic, social and political processes and a redistribution of power and voice (WWAP, 2019). Such change could be aided by, for example, the establishment of a Global Leadership Coalition on valuing water to mobilize champions, as recommended by the HLPW (2017b), as well as more generally by the creation of ownership, building of public awareness, and voter pressure). A potentially useful information source focused on women as change-makers in the governance of shared waters is available (Fauconnier et al., 2018).

6 WATER RESOURCES PLANNING AND MANAGEMENT - BEST PRACTICE SOLUTIONS

The different values of water need to be reconciled, and the trade-offs between them resolved and incorporated into systematic and inclusive planning and decision-making processes (Garrick et al., 2017). Stakeholder consultation and the active involvement of users and beneficiaries are critical to ensure full representation of perspectives and values from the outset, and throughout the development process (WWF, 2016; Horne et al., 2017a). All socioeconomic sectors, from water supply and sanitation, to agriculture, energy, and industry, stand to benefit from an improved integration of the values of water across the full water development or engineering cycle, from planning and pre-feasibility, through to adaptive management and monitoring. Water opportunities and risks cannot be managed by a single institution and require collective action, and at a meaningful scale.

6.1 Integrated Development Planning

Valuing water at the planning stage of national and basin development, and throughout the water engineering cycle, allows greater and more equal consideration of economic and technical, social, and environmental multiple values (through inclusion of stakeholder inputs), thereby increasing the feasibility of finding more balanced solutions.
Early phases of water resources planning and infrastructure design in particular present considerable, but underused opportunities for introducing various aspects of water's value and ensuring their equitable treatment in subsequent stages of water management. "New development can change the balance of benefits between actors and regions" (Geressu and Harou 2019, p. 201). The way in which such developments are financed, however (Section 8), is extremely influential in the planning approach adopted and may impose serious constraints on options.

System-scale planning of water and energy infrastructure (e.g., dams for hydropower,water storage, or multiple purposes; and planned irrigation schemes), particularly strategic siting of new infrastructure, opens up a wider set of possibilities for addressing mutiple values and trade-offs than can be achieved focusing only on individual projects. Examples showing increasing interest include: Strategic Environmental Assessment (e.g., applied in the context of hydropwer in the Mekong Basin); Cumulative Impact Assessment; and the early stage assessment tool of the Hydropower Sustainability Assessment Protocol (International Hydropower Association, IHA, 2011; http://www.hydrosustainability.org/). Solutions and protocols for these early stages of water resources development and planning continue to evolve.

Integration of freshwater values into the planning and management of protected areas is a complementary approach (Pittock et al., 2015; Vörösmarty et al., 2018). Nature based solutions (NBS) which, importantly, can be complementary and potentially financed in a single package (WWAP, 2018) can play a role in such cases, including in protecting valuable water sources for people.

6.2 Optimising Benefits and Accounting for Trade-Offs

Similar opportunities exist in later stages of decision-making to more comprehensively address sharing of costs and benefits from water development. Methods for multicriteria decision-making in evaluating allocation trade-offs and for the optimization of dam operation for downstream flow releases, optimization of water supply and demand management systems, scenario development, and water gaming, are a related area of ongoing innovation, generating solutions that allow more sophisticated, integrative assessments of social, economic, and environmental trade-offs across values to attain more balanced endpoints.

Traditionally driven by minimizing total discounted costs (an area which needs exploration and analysis; Section 8), the scheduling of investments in water supply system infrastructure is increasingly taking account of environmental, social and economic downstream impacts (Geressu and Harou, 2019). Geressu and Harou (2019) propose a many objective approach to explicitly explore trade-offs, where a schedule of new dams is optimised along-side dam selections and operating rules; a focus is on the extent to which changing management rules during infrastructure system expansion increases the ability to identify the best performing plans (explored using the case of the Blue Nile River Basin).
Typically, water allocations reflect the outcomes of dialogue between interested and affected stakeholders who need to build convergence in their 'value perspectives' (WWAP, 2012). The main aspects of a water allocation system (viz., water entitlements (formal or informal), the allocation process, water service delivery (or control), and water use) and the

associated challenges of allocation under conditions of risk and uncertainty are discussed in WWAP (2012). Most water allocation mechanisms nowadays include the allocation of environmental water as a value domain (Section 2.3). They present a diversifying, growing portfolio of solutions, for more active, adaptive and sustainable water management, that strive to place more equal consideration and weight on environmental, economic, and social values. They include (Horne et al., 2017b): water reserves, caps on consumption, sustainable abstraction limits, water markets, licence conditions on infrastructure operators, and flow release rules and regimes for dams. Caps or other firm total limits on consumptive water use can be set by governments for specific basins or at the level of communal water systems, such as irrigation districts, to avoid depleting available water supplies. Such caps on water extraction can be linked to the regulation of use through issued water entitlements. Water trading, banking, and markets (below) are other complementary ways in which water values are made more visible and accounted for during allocation.

6.3 Water Markets

Water markets, when well designed and regulated, facilitate the allocation of water to the most productive uses and are becoming a popular response in water trading. Economic values become established through trading prices (WWAP, 2012). As they disclose the value of water to different users, markets can help drive efficiency of water allocation. However various characteristics (e.g., asymmetric information and imperfect competition) can affect the appropriateness of market prices as metrics for value (WWAP, 2012). While also not a solution to mediate all scarcity situations, they are a powerful regulatory construct to manage commercial and public uses (Richter, 2016).

The growing ability of markets to accommodate environmental water needs when supported by capable institutions (Garrick et al., 2017; Horne et al., 2017a) has created ways to shift water back to the environment (environmental flows) while meeting urban water demands and increasing agricultural productivity. “In many regions, a well-functioning water market can provide the institutional framework for users willing to consume less to be rewarded by those needing more or wanting to return water to the environment” (Richter, 2016, p. 7). Cases from the USA and Australia are among those best known. The high values of water in the water scarce Murray-Darling River Basin, Australia, precipitated the investment in a highly active formal water market within which a significant volume is dedicated to the environment, to be allocated as prescribed through environmental water regimes and when needed (though the Commonwealth Environmental Water Holder agency). Unintended consequences of such trading in water occur, in part driven by the degree to which different values of water are appropriately considered in investment and allocation decisions (e.g., a dominance by some purchasers/leasers of water at the expense of others), leading to user and upstream-downstream disputes (Garrick et al., 2017). There are also potential impacts on groundwater use and of increases in water depletion, with the activation of unused and dormant allocations (i.e., sleeper or dozer rights), as seen in Australia.

7 WATER SCARCITY, CLIMATE CHANGE, AND OTHER MAGNIFIERS OF VALUE

7.1 Water Scarcity and Climate Change

Water scarcity is known to be a magnifier of the value of water, particularly when coupled with similar declines in water quality. As water becomes scarcer and more polluted, it becomes more valuable and thus more subject to competition and conflict among uses and users. Today, more than 50% of the world’s cities and 75% of all irrigated farms are experiencing water shortages on a recurring basis (Richter, 2016). Water scarcity data, especially when disaggregated down to monthly and basin scales, indicate that trends of increases in water scarcity are widespread and continuing (World Bank, 2016a; Richter et al., 2017), including in transboundary settings (Klimes and Yaari, 2019).

The impacts of climate change on society will be directed primarily through changes in the global and local water system, further affecting spatial and temporal patterns in water availability (World Bank, 2016a; ADB, 2018). Water-related climate risks cascade through food, energy, urban, and environmental systems, directly impacting on existing values, benefits and costs of water, altering patterns of supply and demand, affecting development opportunities and heightening risks (e.g., water scarcity and drought, and flood risk) (World Bank, 2017; Ligtvoet et al., 2018) Particularly vulnerable regions will include coastal and mountain regions and small island developing states (SIDS). Climate change will increase water-related shocks on top of already escalating water demand and use (both in terms of surface water and groundwater

resources) and introduce water scarcity into presently unaffected areas (World Bank, 2016a). The severity of the effects will depend upon factors like geographic location, demographic change, conditions of water availability and utilization, legal and regulatory frameworks, water management and allocation systems, governance arrangements and institutions, and the resilience of socioecological systems. Values are an intrinsic feature of these factors but remain all too implicit in knowledge bases, policies, and decision-making.

Progress is being continues made, however, with several projects and modeling efforts illustrate the substantial benefits of improving water management in the context of climate change. For example, the World Bank estimates that improving water resource management could accelerate growth in some regions of the world by six percent (World Bank, 2016b). The Climate Risk Informed Decision Analysis or CRIDA (developed under UNESCO International Hydrological Programme and the International Center for Integrated Water Resources Management, ICIWaRM) provides a multi-step process to enable water managers and policy makers to assess the impact of climate uncertainty and change on their water resources, effectively scale decisions, and design robust adaptation pathways (CRIDA, 2018). As a participatory, bottom-up approach it engages local communities in tailored analysis and use of models and data, aiming to provide locally embedded solutions to water security vulnerabilities (including Indigenous and gender-related options) and water management challenges under climate change and other global changes (CRIDA, 2018). Through the 'decision context' step, CRIDA particularly has potential to introduce, and confer weight to, local values of water.

7.2 Water-Related Disasters

To varying extents, natural hazards and human-made disasters reflect the costs of not valuing water, in terms of resilience in the face of climate change and water resources mismanagement. A large part of disaster risk is directly or indirectly linked to water (e.g., flood, drought, water pollution incidents, etc.) Globally, water-related disasters account for 90 per cent of natural disasters, with floods the most frequent and damaging hazards (World Bank, 2017). Between 1994 and 2013, floods accounted for 43 per cent of all recorded natural events, affecting some 2.5 billion people (World Bank, 2017). Each year, water-related disasters (incl. droughts, flooding, and water pollution) affect some 160 million people, with fatalities estimated at 13 500 (Ligtvoet et al., 2018); flooding affects most of these people (106 million, annually) and causes the greatest economic damage (USD 31 billion, annually). During the extreme cases of 1998 and 2010, total losses due to flooding exceeded USD 40 billion (World Bank, 2017). Droughts as slow-onset events also substantially damage the economy, potentially leading to the collapse of social structures and refugee crises that cause social disruption in adjacent regions (UNISDR and UNECE, 2018). The negative impacts of such disasters exacerbate existing inequalities and are disproportionately borne by poor and vulnerable communities, women and children (Ligtvoet et al., 2018).

Inroads in disaster risk management are being made, including through improved disaster preparedness, early warning and evacuation systems, nature-based measures (ecosystem based approaches) to address risk and confer resilience, and increased disaster management capacity. The incorporation of values into frameworks for managing risks around water tends to be implicit (e.g., typically only built into the cost and discount rate for planning purposes). The values and benefits of healthy, resilient wetland ecosystems have been considered in the context of the Sendai Framework for Disaster Risk Reduction (UNISDR, 2015) (Partnership for Environment and Disaster Risk Reduction, PEDRR, Undated) and in recent guidance for implementation of nature-based flood protection (World Bank, 2017), demonstrating progress.

7.3 Valuing Water as an Asset for Peace

Peace building is a key aspect of valuing water, especially across-boundaries and regions (Global High-Level Panel on Water and Peace, 2017; Valuing water multilateral meeting in Davos, 2019). Water has recognised value as an entry point to cooperation and peace building processes, including through methodological approaches to water diplomacy and facilitated water dialogues (Klimes and Yaari, 2019). The WWDR could include a section on this topic, with experience drawn from various case studies (e.g., https://www.siwi.org/publications/water-diplomacy-facilitating-dialogues/; Water Diplomacy Group, IHE Delft Institute for Water Education). Transboundary water agreements and institutions, as well as various 'soft law' instruments, reflect a recognition of the value of water and of the associated upstream-downstream and other dependencies across state and country borders (UNEP-DHI and UNEP, 2016). These tools represent various opportunities for creating a common vision of the values water supports and for defining paths to more sustainable water resources development. As such, they should be more fully utilized (Global High-Level Panel on Water and Peace, 2017). In many areas of the world "much still remains to be done to expand transboundary and regional water cooperation

to the desired level" in lake, river and aquifer basins, including some traditionally sensitive basins (Global High-Level Panel on Water and Peace, 2017, p. 6). The existing level of international cooperation is deemed far from satisfactory for internationally shared aquifers, where out of some 400, there are solely five where international agreements exist.
It has been recognised for some time that failure to adequately manage water sustainably, strategically and effectively risks transforming this valuable natural resource into an increased source of human conflict (Gleick, 1993). Water conflicts are increasing. Most of the approximately two billion people who lack access to safe drinking water inhabit fragile and conflict-affected areas, and by 2030 an estimated 46% of people living in poverty will be living in such regions (Global High-Level Panel on Water and Peace, 2017; WWAP, 2019). Recent data (January 2019) from the Water Conflict Chronology (https://www.worldwater.org/water-conflict/) show a dramatic escalation in the number of reported water-related conflicts (post mid-1980s), as well as a shift in recent years from multi-state or nation-to-nation conflicts towards subnational (intrastate) events (Gleick, 2019); mapped conflicts total 655, an acknowledged underestimate. In addition to water resources and water systems being weapons or casualties of conflict, water can be a trigger or root cause where issues of economic or physical access to water or water scarcity elicit violence (Gleick, 2019; WEF, 2019b). For instance, there has been an increase in disputes over access to scarce water in Africa, brought about by extensive droughts and rising populations (Gleick, 2019). Civil conflicts around water will continue to be disproportionately felt by certain groups (WWAP, 2019).

Environmental migration, including water-related environmental migration, is multicausal. Only very specific contexts (commonly natural disasters, and potentially also environmental degradation) can 'induce' migration where adaptive capacity is exceeded. Changes in water availability and supply may play a role in the decision to migrate (Ligtvoet et al., 2018; World Bank, 2018; WWAP, 2019).

It remains to be further tested on the ground as to whether or not differences in the way in which water is valued can help build cooperation, promote peace, and address unmanaged or forced migration flows (thereby maintaining migration as a positive force for development, in line with the UN-wide approach and in accordance with the Global Compact of Migration), and thus the extent to which valuing water exhibits potential as a feature of water diplomacy (e.g., through the Blue Peace Initiative, Global High-Level Panel on Water and Peace, 2017).

8 INCREASING FINANCIAL INVESTMENT THROUGH VALUING WATER

The topic of financing is vast and the following section highlights only a few of the range of complex issues likely requiring consideration in the WWDR.

Unlike most other valuable resources, it has proven hard (and controversial) to put a price on water, at least in a comprehensive way (Garrick et al., 2017). The price of water is "a financial or fiscal transaction between the provider and the user, which is often closely controlled by public authorities, and often bears little relation to either its value in specific uses, or its cost of supply"; value, cost, and price of water are distinctly different (WWAP, 2012, p. 282). Moreover, while many now argue for alternative or complementary approaches to pricing, their development has lagged. As a result, the value of this vital resource is simply not reflected in the levels of financial investment in many parts of the world. This leaves hundreds of millions of people without the sustainable water services and other benefits from this precious resource that they need to survive and thrive. Investments in institutions, infrastructure, information, and innovation are required to fully realize the many different benefits derived from water and to reduce risks (HLPW, 2017a, b).

Financing and its efficiency remain a major deficiency in delivering on the SDGs (SIWI, 2018). With the expectation that much of the investment will come from national budgets and decreases in foreign aid, innovative forms of domestic and international finance are required (SIWI, 2018). Achieving universal, safely managed water and sanitation services by 2030, as envisioned by the SDG 6, is projected to require capital expenditures of USD 114 billion per year alone (Hutton and Varughese, 2016). The actual costs are even higher, as this number only includes necessary investments - it does not cover water infrastructure operation and maintenance costs. It remains to be fully assessed as to how much potentially could be saved cost-wise, if operation and maintenance costs were accounted for. Investment on that scale, along with accompanying policy reforms, can be motivated by a growing appreciation of the value of water (Garrick et al., 2017). Innovative sources of finance are needed to invest in water services to help achieve all SDGs that touch water: drinking water and sanitation, biodiversity and ecosystems, agriculture and food, energy, and impacts upon economic and social development for all segments of global society.

8.1 Investments in Water Infrastructure

It has been well recognised that current approaches for financing, and the models employed, do not encourage the required level of attention on flexible, multi-purpose (cf., primarily single purpose) infrastructure that is needed for future water security (WWC and OECD, 2015). There also remains the challenge of estimating the future value of a cubic metre of water in a comparable way for different kinds of solutions, e.g., the cost and value of water from a dam, borehole, desalination plant, or NBS. A discount rate approach is usually applied. However, it can be considered fundamentally flawed in that the 'value of nature' for future generations is discounted too much, leading to short termism (i.e., the 'tragedy of the horizon'). Effectively, costs are transferred to future generations under this 'return on investment' paradigm.

Not only have the values and competing priorities of the many different affected stakeholders not been adequately considered in past infrastructure financing (despite the vast sums invested), some infrastructure components have not even proved financially profitable under market conditions (WWC and OECD, 2015). On the other hand, it is clear that past investment in water infrastructure has helped significantly reduce poverty and increase social welfare and capital, and that future infrastructure will continue to play key roles in water for development. Deepening the levels of engagement with stakeholders, will allow representation of their viewpoints (and thus also, indirectly at least, values) in terms of the proper level of water security required, their readiness to pay for it, and what they consider to be a fair allocation of costs and risks (WWC and OECD, 2015).

Water investment is challenged with becoming more efficient, and at scales beyond the project level to that of the actual sequencing investments in response to development policies, to help properly maintain existing assets and also to "avoid building future liabilities" (WWC and OECD, 2015, p. III). Emphasis is needed on 'beyond infrastructure and engineering' values and information around where, how much, how large, and for what purpose infrastructure is designed and built. Research is emerging that shows that the decision making process for construction of a large number of irrigation systems is mostly engineering driven, without good understanding of hydrological systems or patterns – new values (e.g., new information) need to be incorporated into such infrastructure design for it to be more effective in the future (e.g., recent work by Sinha et al. (2019) in India).

Financing water infrastructure through hybridity and blended finance is a key area (e.g., Roundtable on Financing Water, founded by OECD, WWC, and Government of the Netherlands: http://www.worldwatercouncil.org/sites/default/files/2017-10/Roundtable_on_Financing_Water_Summary.pdf; WWC and OECD, 2015). Traditional development finance alone will not suffice to achieve water security. Blended finance is a tool that uses development finance to attract and engage additional finance, often private, to scale up investments in water. Emphasis is placed on corporations, as they currently account for more than half of all private sector investment in infrastructure.

The notion of blending could be applied not only to finance, but also to projects through the development of a portfolio of infrastructure projects, mixing different return profiles. This portfolio approach would allow projects with low financial return but with high social impact, and projects with high financial return but no notable positive impact to be both investable and attractive for investors, as the overall portfolio return will be considered. Similarly, an aligned typology of water infrastructure projects could be developed to reduce existing asymmetries between projects and finance. By matching suitable projects with their most appropriate funding sources, it could be possible to reduce costs associated with project financing and unlock funding for projects that previously may have been considered unbankable. As investors present different profiles and appetite for risk and returns, a complementary typology of water infrastructure investors could help connect appropriate investors to the right projects, ultimately increasing the number of suitable projects financed.

8.2 Impact Investment and Other Financing Models

Economic, social, and environmental cases are increasingly being made for impact investment. International Non-Governmental Organisations (INGOs), such as The Nature Conservancy (TNC), are actively promoting impact investment initiatives in water, including private investment in water markets. A new conservation and impact investment model (Water Sharing Investment Partnerships, WSIPs), developed by TNC, takes advantage of the motivations and incentives for trading water (already existing in several countries, incl. USA) to leverage water markets through private investment (Richter, 2016). The value of water provides the incentive for water conservation and water savings on which the model

relies; model attributes will vary according to local context and it may not be applicable in certain places. In essence, WSIPs rely on investor capital, along with government grants and philanthropic donations, to acquire a pool of water-use rights within existing markets. A portion of those rights can be used to reallocate water to the environment (also generating funding for ongoing ecological monitoring), the majority provide ongoing water security through lease agreements (or resale to the market) to users in the community (e.g., farmers and cities), and a portion generate financial returns to investors (TNC, 2016; https://www.nature.org/en-us/what-we-do/our-insights/perspectives/investing-our-way-out-of-the-global-water-crisis/). It is estimated that if fully scaled, WSIPs (or other creative financing solutions to water scarcity) could mobilize USD 13.4 billion per year in transaction value to reallocate water, corresponding to an underlying assets value of USD 331 billion (Richter 2016). When enabled by high-functioning water markets, such models can help provide a more water-secure future for cities, agriculture, industries, and ecosystems. Today, at least 37 countries in water-scarce regions have water allocation systems based on the issuance of water rights that make them potential candidates for WSIPs (Richter, 2016). Parallel lessons for freshwater also can be drawn, for instance, from impact investment research by Encourage Capital and TNC (O'Shea et al., 2019) which demonstrates that (with appropriate governance and underpinned by science) (marine) aquaculture can be a nutritious, sustainable food system for that also generates rural community incomes and benefits ecosystems, while providing credible investment opportunities with convincing financial returns.

Global models of indigenous-led (conservation) finance are also emerging (many of which value water using different approaches), such as the Coast Funds' Great Bear Rainforest and Haida Gwaii model. The model evolved through a First Nations-government-industry partnership established with a CAD 120 million fund a decade ago, to support a sustainable coastal economy that now generates multiple benefits in a region where Indigenous values are paramount in natural resources stewardship and decision-making (Coast Funds, 2019).

These kinds of sources of sustainable finance that create additional value are liable to become increasingly important for sectors currently experiencing even more critical funding shortfalls than those of WASH, such as the environment. Within the private sector, there is an increasing role for innovation in water entrepreneurship to generate profit while also securing measurable social and environmental benefits.

Better valuing of water could contribute solutions to the above kinds of challenges, including in the area of good water governance where integrity and transparency will be paramount (e.g., case study of water equity). Increased recognition of the multiple values of water should not only serve to promote increased financial investment, but also inspire private-public partnerships across sectors by highlighting current financing and social opportunities and helping less familiar stakeholders understand the linkages and overall value of investments in water.

9 OTHER POTENTIAL RESPONSES AND GAPS

A diversity of other potential response options and solutions exists from which to draw, reflecting the multitude of perspectives, contexts, and ways in which water is already valued, and will continue to over the longer time horizon for sustainable development. However, a generalisable and transferable framing and compendium of approaches (comprising options to examine different type of values) appears to be lacking or non-operational, to guide more equitable, transparent, and consistent expressions of the values of water and of approaches to valuing it.

Greater effort is required to quantitatively document the state of knowledge on water's values and of the co-benefits, and shared costs and risks of their inadequate consideration in water resources decision-making and management. Learning, as a response mechanism, is recognised as important, to stop and understand where and why policies failed or did not achieve a sustained positive impact. The process of continually checking-in on progress, adapting, and feeding back lessons learnt into new governance and allocation decisions represents a loop that does not really exist in today's water management governance systems - it needs to be implemented to help enable better decisions to be made. The HLPW (2017a, b) also strongly advocates for greater promotion of the value of water through education, communication, and public awareness.

9.1 Approaches for Addressing Inter-Sectoral Trade-Offs for SDGs

Each of the SDGs includes numerous specific targets and indicators of the degree of progress achieved across the economic, social and environmental dimensions of sustainable development. Sustainable Development Goal 16 (good governance) and SDG 17 (means of implementation) are central to realising the potential for synergies across goals (Griggs et al., 2017). As Griggs et al. (2017, p. 7) observe "For many if not all goals, having in place effective governance systems, institutions, partnerships, and intellectual and financial resources is key to an effective, efficient and coherent approach to implementation." Valuing water is a part of all these elements for successful attainment of all SDGs. An assessment framework, based on a 7-scale scoring approach, enables systematic analysis of the interactions and relationships among different sets of SDGs: from increasingly positive interactions ('enabling', 'reinforcing', to 'indivisible'), through neutral interactions, to interactions characterised by trade-offs (scored negatively as 'constraining', 'counteracting', or 'cancelling') (Griggs et al., 2017).

The framework is intended to help policymakers, investors and other actors to identify and manage the benefits and risks of achieving the various goals and targets, by providing a more nuanced view of interactions "to move the discourse beyond the simple notion of trade-offs and synergies" (Griggs et al., 2017, p. 22). It can be applied at international, national, and sub-national scales through a geographic or thematic entry, with analysis based on existing literature and expert judgment. It may hold potential for a science-informed thematic analysis focused on the range of achievable outcomes through valuing water differently across SDG domains. At the least, it could stimulate greater science-policy dialogue on the importance of values and their interrelationships (including inter-sectorally and across disciplines), helping policy-makers and other stakeholders shape their priorities and implementation strategies, and engaging the policy community in further knowledge developments in this area (a general objective of the scoring approach; Griggs et al., 2017). Griggs et al. (2017) illustrate the approach's practical potential to examine synergies and trade-offs between the SDG2 to end hunger, achieve food security and improved nutrition, and promote sustainable agriculture, and other development goals, for Amazon region, Senegal, and California cases. Various approaches are available for also unpacking the water-energy-environment-food nexus at system scale (Sood et al., 2019).

Solutions need to be developed in response to what people state they need (WWAP, 2019). The Sustainable Water Future Programme's Water Solution Labs (http://water-future.org/) present one potential approach for reaching a portfolio of possible solutions from which to select the most appropriate option for piloting (Vörösmarty et al., 2018).

9.2 Closing Critical Gaps

Data and monitoring are clear gaps, among others still to be identified. More data are needed and in formats that are readily accessible and amenable to disaggregation (e.g., gender; SIWI, 2018). There are widespread water resource data deficits and an uneven coverage of hydrological monitoring networks and, more critically, the hydrological gauging network is in global decline (Ruhi et al., 2018). This suggests persistent neglect of sources of information that are essential in our efforts to value water. National monitoring systems and capacities need strengthening, to track progress towards achieving SDG 6, and to help increase transparency and accountability in decision-making, build awareness, and encourage civil society engagement (UN, 2018).

The information and communications technology revolution has begun to close some gaps, improving our knowledge of the water resource, including through remote sensing, low-cost monitoring devices, online surveys, machine learning techniques, high-resolution modeling, and artificial intelligence (AI). e.g., the upcoming US National Aeronautics and Space Administration (NASA)'s Surface Water and Ocean Topography project (SWOT) to generate the first global survey of earth's surface water, providing comprehensive coverage and invaluable new data on freshwater ecosystems. Innovation is also ongoing in the field of valuing water in areas such as sustainable agricultural intensification, and in energy and industry best practice (e.g., data visualization platforms, such as those of FAO). Novel opportunities are appearing in the arena of digital water that are already creating value (International Water Association, IWA, and Xylem Inc., 2019). e.g., digitalization (e.g., use of smartphone applications and blockchain technology) and 'smart use' and 'smart control' systems are purported to be transforming and optimizing real-time and remote information sharing and water services management by water and wastewater utilities (IWA, 2019; https://iwa-network.org/projects/digital-water-programme). Ethics remains a knowledge frontier for water (Groenfeldt, 2019) with the potential to influence the consideration of values across all dimensions. Similar potential to influence the field of valuing water exists in the growing area of Indigenous water management.

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ANNEX 3 - WWDR 2021 STORYLINE

Storyline – Final Draft for Discussion, August 2019

Context – the value of water to society for sustainable development

The intrinsic value of water to society, and its essential role and relevance in all aspects of life, are undisputed. Moreover, unlike other natural resources, water has no substitute. Water is a fundamental condition of human survival and dignity, and the basis for the resilience of societies and the natural environment (Global High-Level Panel on Water and Peace, 2017[1]). The right to safe and clean drinking water and sanitation is recognised by the United Nations as a fundamental human right. As individuals, we also intuitively recognise that water is more than a substance and carries multiple meanings, attributes, and values (United Nations/World Bank High Level Panel on Water, HLPW, 2017). It can at the same time be a public good, a private good, an environmental resource, and of spiritual significance. Our cultural heritage, world views, ethics, gender, faith, and established norms frame our relationships with water, influencing how we think about and value this unique natural resource. Different cultures, societies, and communities around the world, including Indigenous peoples, thus understand and define the value of water in quite different ways. Divergent values are accorded to the resource and its uses that may be perceptional, difficult, or even inappropriate to attempt to reconcile.

The way water is valued is of particular relevance to the policy agenda for water for sustainable development. The transformative change required for humanity to deliver on the 2030 Agenda and its 17 Sustainable Development Goals (SDGs), while remaining within sustainability boundaries for water and other resources, is predicated on capturing the values of water as fully and appropriately as possible. The HLPW's (2017) Valuing Water Initiative to chart the principles and pathways for valuing water presents an opportunity to rethink the value of water. The Bellagio Principles[2] which support the initiative provide a useful basis for considering water's values in the context of the SDGs.

While appreciation of the value of water is growing, our ability to fully address its multiple and diverse values to society and to incorporate these values into water governance and management remain inadequate. Learning how best to undertake these steps is important to improve the decisions made in integrated water resource management (IWRM). Efforts to value water have advanced over the past 30 years, generating a wide range of experiences and approaches for doing so. However, many still consider valuing water to be complex and contentious, owing to water's biophysical, political, sociocultural (e.g., gender), and economic characteristics.

Failure to fully value all the benefits of water in its different uses is considered a root cause of the political neglect of this precious resource and its mismanagement. Underestimation of the values of water has led to measurable undervaluing of benefits, and at increased costs and risks to society, across economic, social, and environmental dimensions. The implications for human well-being, security, resilience, and the sustainability of future water development have been serious, with the greatest burden often borne by poor and marginalised groups, and the environment. This has not only led to inequalities in terms of people's access to and benefits from water resources and water-related services, but also unsustainable use and degradation of the quantity and quality of water supplies, with negative impacts on the environment and all facets of socioeconomic development, including financial investment. Until recently remaining largely under-recognised and unaccounted for, these cascading direct and indirect impacts of water scarcity, water pollution, reduced ability to deliver vital ecosystem services, and ecosystem degradation underscore the need to change the way we value water. The fundamental purpose of recognizing the true value of water and more comprehensively accounting for it in development lies in reversing such negative impacts and feedbacks, helping ensure the sustainability of water resources. This in turn leads to cooperation, joined management, and peace building. Values potentially can and should be attributed to all the main perspectives and dimensions of water – economic, socio-cultural, and environmental.

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1 Global High-Level Panel on Water and Peace. 2017. *A Matter of Survival. Report of the Global High-Level Panel on Water and Peace*. Geneva Water Hub, Geneva. 112 pp.

2 The Bellagio Principles on valuing water are: Principle 1 Consider the multiple values to different stakeholders in all decisions affecting water; Principle 2 Conduct all processes to reconcile values in ways that are equitable, transparent, and inclusive of multiple values; Principle 3 Value and protect all sources of water, including watersheds, rivers, aquifers and associated ecosystems for current and future generations; Principle 4 Promote education and public awareness about the essential role of water and its intrinsic value; and Principle 5 Increase investment in institutions, infrastructure, information and innovation to realize the full potential and values of water. HLPW. 2017. Bellagio Principles on Valuing Water. Unpublished draft product of the HLPW on water to be used for consultation. Bellagio, May 2017. 3 pp.

An approach based on 'perspectives'

In the WWDR 2021, it is proposed to begin with the above contextual framing of precisely why water, as a unique resource which simultaneously embodies multiple attributes, is difficult to value and thus to manage, and thus why IWRM has been so elusive. The proposal is to focus on opportunities and challenges to determining the multiple values of water as viewed through the lenses of a number of broad perspectives, examining each of them integratively across social, economic, and environmental domains. These perspectives, and potential solutions to valuing water for them, include: (1) the water resource, including ecosystems; (2) fulfilling basic human needs for water services (drinking water, sanitation, hygiene, and health); (3) other socio-cultural values of the resource, and contributions to sustainable development (e.g., equality and peace); and (4) water as an input into economic production (focused on food and agriculture, and energy and industry); each of these perspectives is covered in the literature overview accompanying this storyline. The report could incorporate practical case studies of both successful and unsucessful approaches and of best practices of valuing water, for each of the perspectives. Going forward, the report could also highlight the connections among these perspectives. For instance, clean and sufficient water is vital for human capital development, which is important for both basic human needs as well as economic production within a society.

It is suggested to identify and explore the highest potential, more successfully adopted and scalable solutions for valuing water, given the main challenges and opportunities outlined, including current and emerging best practices in water management, governance, and finance. Insights, and possibly also guidance, could be generated for formulating potential valuation approaches (direct values, e.g., monetary value; indirect measures, e.g., positive or negative impacts and co-benefits; and more qualitative and intangible values) for particular groups of actors. The report could also serve to outline how a more comprehensive, balanced, and nuanced inclusion of water's values could unlock additional benefits and help mediate trade-offs under SDG 6 and other water-related Goals.

Finally, critical gaps are expected to highlighted for which solutions need to be sought, as well as areas with clear scope for innovation.

The current landscape and challenges of valuing water

Water scarcity and pollution - both recurrent, widespread issues that continue to escalate - magnify the value of water, rendering it more valuable and subject to increased competition and conflict among domestic, health, agricultural, urban, industrial, and energy uses and users. Differences are expected among locations and development contexts.

Water has recognised value in creating benefits through the hydrologic cycle and its interconnections with socio-ecological systems. Water resources are traditionally valued and assessed in terms of sources of supply. Volumetric quantification based on the costs associated with the capture, storage, abstraction, and transportation of the raw surface or groundwater resource, as well as its ultimate return flows to the environment, can be expressed in various terms, such as cost per m3 or measures of efficiency, productivity, and intensity of use. The additional cost of negative impacts to the source, society (e.g., displacement and migration, changes to livelihoods) and the environment (e.g., altered flow regimes and polluted return flows) potentially could be factored-in, as could positive co-benefits, such as enhanced climate resilience. Values of the water resource are also reflected through factors such as access to the resource, including through ownership, the relative investments made in supply-side versus demand management, and the various mechanisms for water allocation.

The environment is necessarily a dual consideration when valuing water, as both the resource base and a competing water user. The value of water as an integral component of an ecosystem, and its driving roles in flows of water, sediments, nutrients, energy and biota, and their interconnections in the landscape, are seldom adequately considered. The value of the diverse environmental aspects of water, including biodiversity's value proposition for water, are particularly neglected areas. Efforts have been more readily focused on determining the implications and costs of inaction than the direct values of maintaining environmental values of water - a rich growth area. Benefits to people are typically represented in terms of ecosystem services, ranging from the food and nutritional benefits of inland and coastal fisheries, and water storage, to flood attenuation and carbon storage; economically exceptionally valuable, they are also insurers against environmental shocks and climate change. Despite these values, downward trends in the biodiversity, condition, and resilience of ecosystems have reached globally critical proportions. In addition to major drivers such as population growth and climate change, stressors include unprecedented water abstraction, detrimental impacts of water and energy infrastructure, and polluting activities. Solutions to arrest declines in biodiversity and restore ecosystems also support values for water services and productive economic sectors, as well as SDG targets.

Services to fulfil basic human needs for water are a human right. Universal, affordable and sustainable access to WASH is a focus of SDG 6 - many countries are not on track to meet sanitation targets or achieve basic water coverage for all by 2030. Domestic uses of water represent a comparatively small, but exceptionally high value component of water demand. Data at global, national, and finer scales indicate the economic values of water service provision - volumetric quantifications can be generated, based on the cost of pre-use treatment, storage, and distribution, post-use treatment, and disposal (full-cost recovery). Human health values of water appear patchier. Co-benefits of access to WASH can also be factored-in to assessments of value. These include, among others: poverty alleviation; health cost savings; increased workforce productivity, additional and new jobs and sources of income; empowerment of women, girls, and youth; and improved access to education. Water values differ according to the realities, restrictions and opportunities facing urban, peri-urban, and rural communities, and between high income households and the poor.The wider, emerging perspective of the socio-cultural values of water, beyond and in addition to WASH (as defined by SDGs 6.1 and 6.2) and human health, is also important to address in the WWDR, particularly as awareness grows of the importance of human-rights based approaches to IWRM. Socio-cultural values are reflected in and shaped by human identity, belief systems, ethics, cultural heritage, sense of place, quality of life, and spiritual (including faith-based), aesthetic, Indigenous, and other factors. This yields a rich array of other perspectives on and relationships with water, all of which influence the ways in which water is valued and hence, the sustainability of water resources development. Values which are intangible or challenging to quantify also need inclusion. The topic of socio and cultural values appears ripe for a more in-depth examination of key issues. A core benefit of water is national economic growth (GDP per m3), and the generation of income at country to local levels, by catalysing new types of economic activity and providing other measurable co-benefits such as job creation, equality, security against fluctuations in water availability, and climate resilience. Water used as 'inputs' to various economic sectors readily lends itself to volumetric quantification (cost of capture, use, treatment and disposal). Costs associated with certain environmental and social impacts, often indirect, remain more challenging for various reasons. Various methods, such as social return on investment (SROI), provide ways to measure and include extra-financial environmental and social values that are not conventional financial accounts) relative to resources invested.

Additional value can be added as a function of economic indicators for any sector, such as: water use efficiency, or the value added per water volume used; water productivity, the yield per cubic meter of water or value of what can be produced with a unit of water; and water use intensity, the volume of water used to produce a unit of value added. There is also a clear economic case to be made for improved water quality management, targeting the point source and diffuse pollution impacts of various economic activities and their implications for sustainable development. Poor water quality has numerous socioeconomic costs associated with it, including water treatment and health-related costs, impacts on economic activities such as fisheries, industrial manufacturing and tourism, degradation of ecosystem services, reduced property values, and opportunity costs of further development. The estimated annual national costs of water pollution from diffuse sources exceeds billions of dollars each year in solely the OECD countries.

Agriculture's roles in meet growing demands for food security and nutritional health (SDG 2), as well as in rural revitalization, are paramount. Its share of total water use is already 69 per cent of the global total and it is projected to remain the largest user overall over the coming decades. . Population growth and changes to the food system are expected to drive the allocation of more water – in absolute and relative terms – to food production in the future. The use of over 90 per cent of all consumptive water for irrigation in water-scarce regions is forcing closer scrutiny of the values attributed to water in food systems, as well as efforts to do more with less water. Ever higher returns on investments through sustainable agricultural intensification are occurring, but benefits gained in terms of factors such as crop yields, better nutrition, poverty reduction, and job creation have serious cost implications in terms of human and environmental health (e.g., diffuse pollution effects from agrochemicals). A lack of full cost accounting is still commonplace (as it is for water infrastructure development more generally), and there have also been implications for the long-term sustainability of the resource for agriculture itself.

Data from across the different areas of energy and industry convey the economic values of water for production in these sectors. Corresponding quantified benefits, costs (e.g., pollution impacts, reduced sediment delivery to estuaries), and risks from undervaluing other needs are limited. Hydropower as part of renewable energy portfolios is drawing interest. Other renewables, notably biofuels, have significant diverse positive and negative impacts on water. The same is true for mining, including of fossil fuels. The impact on water values might differ significantly in each instance and the multiple vales of water should be considered in related decision-taking. The value of water to private or public-private sector industrial and agricultural enterprises typically has been approached in monetary terms. It is only recently that the water-related risks to business of not considering other resources users, particularly at basin or system scale, have gained

traction. This has galvanised a move by businesses, including agribusinesses, energy companies, and food and beverage industries, beyond basic requirements for corporate social responsibility to comprehensive water stewardship. Failures of governance compromise the capacity of surface water and groundwater resources to generate social, economic, and environmental benefits. International and national legislation, intergovernmental mechanisms at global and regional level, and other standards or protocols that take values into account are an important element, but insufficient in isolation of other approaches. The active involvement of users and beneficiaries is critical to ensure appropriate representation of diverse perspectives and values from the outset. Full and equal participation of people of all cultures and ethnicities, and respect for their rights, responsibilities, and systems of governance is a growing area of attention. Increased recognition of multiple values can serve to improve the governance of water, but the ability to incorporate these values is inadequate. Values need to be part of the necessary adaption of governance structures to all levels, in complementary and mutually reinforcing ways, down to the level of local values. As with other aspects of managing water, valuing water requires robust, capable institutions. Ethics adds to the resilience of water systems through systematizing value principles which persist beyond legal and policy changes, helping to navigate the terrain of complex, conflicting, and unresolved values of water. Values motivate behaviours in water use and management that can be poorly understood, but yet can have real and lasting impacts, including the setting of priorities for basin planning and water allocation. Proactive valuing of water at the planning stage of national and basin development, and throughout the water engineering cycle, allows greater and more equal consideration of economic, social, and environmental values, increasing the feasibility of finding more balanced solutions. Opportunities also exist within subsequent adaptive management steps to comprehensively address risks, and share costs and benefits. Scenario-building and trade-off analyses can result in water allocation outcomes reflecting convergences in stakeholder values.

Finance challenges remain significant, but recognition of the multiple values of water could promote increased financial investment, and inspire private-public partnerships across sectors by highlighting current financing and social opportunities and helping less familiar stakeholders understand the linkages and overall benefit of investments in water. It has proven difficult and controversial to put a price on water in a comprehensive way and the development of alternative approaches has lagged. While comparatively greater attention has been focused on water services than other dimensions of water, this area alone requires considerable further investment to ensure vital benefits reach hundreds of millions of people. Past water infrastructure investments have markedly reduced poverty and increased social welfare and capital, but current approaches for financing, and the models employed, do not encourage the level of attention needed on flexible, multi-purpose infrastructure for future water security. Nature-based and other environmental solutions for water management remain grossly underfunded. There is also the challenge of estimating the future value of a cubic metre of water in a comparable way for different kinds of solutions. The argument is being made that better valuing of water contributes to greater and more efficient financial investment, at the level of the sequencing of investments in response to development policies and through proper asset maintenance. Financing water infrastructure through hybridity and blended finance is commanding increased attention, as is the development of portfolios of infrastructure projects, mixing different return profiles. Impact investment is also a growing focus.

Unvalued water leads to an uncertain, less resilient future. Water scarcity, climate change, water-related disasters (e.g., flood, drought, pollution events), unmanaged or forced migration flows, and conflict all potentially intersect with diversesocial, economic, and environmental drivers directly linked to water. As such, they potentially magnify the risks of non or inadequately valuation of water, which can casade through food, energy, urban, and environmental systems. However, the links to benefits of climate change adaptation, disaster risk reduction, and peacebuilding (including in a transboundary context) are complex and not, as yet, clearly articulated through the lens of valuing water. Incorporation of values into risk management frameworks and guidance tends to be implicit. The WWDR could provide further opportunities to explore these paths.

Potential responses and best practice solutions

It is argued that a primary reason for limited successes in attaining IWRM and in water governance is the omission of a full representation of the values of water. Progress has been made in approaches for valuing water, however, and a range of approaches and best practice solutions are available that could be considered in the WWDR. Among them are the following:

- **Enhanced water governance.** *Stakeholder engagement and empowerment* by means of multi-stakeholder platforms, dialogues, and vision and objective-setting processes tailored to water development, all provide entry points for ensuring full consideration of the multiple values of water. *Institutionalizing ethics* into all water decisions and

water behaviours could contribute a complementary set of behavioural guidance to that of the laws, policies, and regulations concerning water. Political will is critical as the willingness to consider all value sets for water and to then act on that basis, necessitating the t*ransformation of political processes* and a redistribution of power and voice (aided by, e.g., leadership coalitions to mobilize champions, and the building of public awareness andpressure for change).

- **International and national laws and other mechanisms.** The establishment of and / or adherence to existing and new laws and mechanisms (including intergovernmental mechanisms at global and regional level), that aim to encapsulate multiple perspectives and leave no one behind, remain a cornerstone. Also having important roles are *rights-based mechanisms, standards, and protocols* that have values embedded in them and with which compliance is agreed (e.g., Free, Prior and Informed Consent, FPIC).

- **Integrated development planning.** The early (decision context) stages of water resources planning present underused opportunities for economic sectors, notably energy and agriculture, to introduce and accommodate values in a more balanced way, including through stakeholder input, and to share costs and benefits in subsequent stages of water management. Existing frameworks and protocols for planning and risk informed decision analysis, and system-scale integrated development and conservation planning methods, especially for siting and design of new multiple purpose infrastructure, show potential.

- **Water allocation processes, methods and mechanisms** present a diverse, growing set of solutions for dynamic, adaptive and sustainable water management that strive to more equally consider and weigh environmental, economic, and social values. More inclusive and equitable collection, manipulation and generation, ownership and sharing of data on the water resource is a necessary element of any approach taken, helping to reconcile values, and build trust and awareness of resource considerations among actors from early on. More *adaptive and dynamic water allocation processes* need to be designed and coupled with robust climate science and analysis (e.g., systems of allocation that do not have an automatic set allocation each year or each cropping season). The *suite of allocation mechanisms for piloting and adoption* continues to expand, and includes: water reserves, caps on consumption, sustainable abstract limits, licence conditions on infrastructure operators and reservoir operating rules, and water trading systems, including water markets. Well designed and regulated water markets facilitate efficient allocation of water to the most productive uses but are not appropriate in all contexts and can have unintended impacts.

- **Solutions for optimizing benefits and accounting for trade-offs**. Various methods for multicriteria decision-making in evaluating allocation trade-offs, optimization of water supply and demand management systems and infrastructure, and scenario development are undergoing considerable innovation. They are enabling sophisticated, integrative assessments of the values needed to attain more balanced water-food-energy and environment endpoints, including in the context of trade-off analysis across SDGs, and in relation to climate change.

- **Agricultural Best Management Practices (BMPs)** continue to generate benefits in terms of sustainable production while using less water. Alongside additional measures such as reducing water allocations or limiting irrigation expansion, these practices include: multiple use of water systems (MUS) that increase economic productivity of water use in irrigation schemes, in addition to providing vulnerable water users with low cost services and other benefits; appropriately reallocated water savings through increases in irrigation efficiency that avoid rebound effects (e.g., technological advances); and others aspects of performance measurement. Notable among the latter are the near-real time assessments of *agricultural water productivity*, generating information on economic return per amount of irrigation water used for multiple purposes. *Water accounting* (e.g., using remote sensing) helps assess the extent to which water productivity increases affect different water users. It is a well-used means (with water auditing) for valuing water at national, basin, and other scales. The use of *water footprints* as a tool highlights the comparative value of green, blue and grey water in the production of different agricultural, industrial, and other products. Broader *ecological footprints* demonstrate how far development has exceeded sustainable limits.

- **Valuing different types of water and the resources they contain.** Transformation of wastewater treatment and management in agriculture, urban environments, and industry, in the direction of reuse rather than disposal, presents various value propositions for resource (water, nutrient, and energy) recovery which could support cost savings, cost recovery, and profits. Similar opportunities exist to value the resources and other benefits (such as community development) contained in other types of water (e.g., saline water, water in deep geological settings, and fog water), well beyond the predominant focus on freshwater and good-quality water as a resource.

- **Water quality policy interventions.** A mix of interventions reflecting basic principles of water quality management could help more optimally and equitably address values, costs, benefits, and risks, including: pollution prevention, treatment at source, receiving water quality objectives for the environment, the polluter pays and beneficiary pays principles, environmental taxes and fees to create incentives and produce revenue, and policy coherence.

- **Smart design, use, and control options using digital technology** comprise an emerging innovative solution set for maximizing water service benefits, especially in urban centres and industry. They possess potential as transformative elements of network monitoring of water quality and water quantity.

- **Environmental flows**[3]. Environmental water management provides an inclusive, interdisciplinary and comprehensive approach for effectively considering the multiple intersectoral values of water in water resources policy, planning, and adaptive management, and one where objectives for future condition are determined by stakeholders. Exponential growth in national environmental flow policy and practice have created new avenues and partnerships for ecologically managing water that can deliver a wealth of ecosystem services and other societal benefits, in turn reducing costs and risks to the economy. As a water allocation in a basin plan, operationalized regime of flow releases from infrastructure, or regulated limit on surface water diversion or groundwater withdrawal, environmental flows can support the achievement of water-related SDGs in addition to conservation targets.

- **Nature Based Solutions** (NBS). Investments in source *water protection and supporting mechanisms*, such as water funds and Payment for Ecosystem Services (PES) address multiple values and generate diverse benefits and high investment returns for a wide range of water uses. Returns include measurably improved landscapes and water supplies for local communities, and cost savings for downstream users due to higher water quality and thus lower treatment costs (e.g., watershed conservation could generate a positive return on investment for one in every four cities). *Blended grey and green infrastructure portfolios* can build resilience in different rural and urban development contexts, as can *low impact development (LID) design and technologies* for urban water management.

- **Natural capital accounting** incorporates the value of the environment and its resources in national economic accounts and development planning. An actively evolving field, it informs planning, management and investment decisions in ways that maximize opportunities and minimize risks for public and private benefit. Natural capital accounts can be generated for countries, large organizations and businesses, cities, protected areas, and smaller-scale land and water areas. Standardized methods are in place through the UN System of Environmental-Economic Accounting.

- **Water stewardship** is advancing as a stepwise approach for economic sector actors, including private companies, to determine their business-related water risks at site and supply chain levels. It assists water users in achieving best practice, from safe water services to good water quality status and governance. Water-related costs, revenues, and the creation of economic, social and environmental values that benefit stakeholders beyond the point of assessment are considered. Alliances are being built to mobilize business leaders and support standards development, e.g., the CEO Water Mandate.

- **Increasing financial investment through valuing water and appropriate investments in infrastructure**. *Appropriate pricing of water uses and services* has a role to play as a mechanism for cost recovery, stimulating wise use of the resource while simultaneously ensuring the affordability of water and its benefits. Robust support institutions are needed to monitor and control water use, engage vested interests, and resolve valuation disputes. Financing of multi-purpose infrastructure needs to consider the different values and competing priorities of the many affected stakeholders, and ensure infrastructure components remain fit for purpose, financially viable, and sustainable long-term and under market conditions. Financing water Infrastructure through hybridity and blended finance, and more aligned typologies of water infrastructure projects and investors are additional solutions being advanced. New impact investment and conservation models (e.g., Water Sharing Investment Partnerships) are being used to leverage water markets through private investment. If fully scaled, these kinds of solutions could mobilize USD billions per year to reallocate scarce water, providing a more water-secure future for cities, agriculture, industries, and ecosystems.

[3] Environmental flows describe the quantity, timing, and quality of freshwater flows and levels necessary to sustain aquatic ecosystems which, in turn, support human cultures, economies, sustainable livelihoods, and well-being (Arthington et al., 2018). Aquatic ecosystems include rivers, streams, springs, riparian, floodplain and other wetlands, lakes, coastal waterbodies, including lagoons and estuaries, and groundwater-dependent ecosystems.

Clear gaps remain, including in the data and monitoring required to comprehensively assess the resource (including surface waters, groundwater, and water quality) and the diverse range of associated values. Innovation is occurring, from novel approaches for monitoring and assessing the water resource, to the digital transformation of the water services industry[4].

Overall, a generalisable and transferable framing and compendium of approaches for addressing different type of values is arguably limited to non-operational, to guide more equitable, transparent, a

[4] An element of the emerging field of digital water. IWA (International Water Association) and Xylem Inc. 2019. *Digital Water. Industry Leaders Chart the Transformation Journey*. IWA. 43 pp.

ANNEX 4 - WWDR 2021 MAIN MESSAGES

Water is a unique and non-substitutable resource which, as the foundation of life, societies, and economies, carries multiple values and meanings that need explicit recognition. Water is more than a substance. It simultaneously embodies different, often complex attributes - as a private good, a public good, an environmental resource, and one of social and cultural significance - all of which makes it exceedingly difficult to value and manage. Water and its sources are precious and must be respected - if neglected, water has the power to harm, divide, or even destroy societies. Making all the values of water explicit gives recognition and a voice to dimensions that are otherwise easily overlooked, poorly understood or ill-defined - which can lead to inequitable sharing of benefits, inadequate reconciliation of negative impacts, costs, unsustainable solutions, unintended consequences, risks, and weakly performing policies and institutions.

Valuing water is a prerequisite to ensuring human rights of access to water and sanitation and to life, health, food, and a healthy environment, and for delivering on water-related and other Sustainable Development Goals. Valuing water is integral to human rights and the SDGs.

A transparent, pragmatic, and robust framing needs to be in place and operational for more fully and appropriately valuing water for society and explicitly incorporating its multiple and diverse values into governance and management, to engage all of society and improve both the quality and usefulness of decisions affecting water. The recent Bellagio Principles on Valuing Water (UN/World Bank High Level Panel on Water) provide a clear point of departure. Any framing of perspectives and solutions for valuing water should address essential water services, and economic, socio-cultural, and environmental dimensions. This should be done in a transparent, balanced, and appropriate way that redresses negative impacts and feedbacks and leads to balanced decisions. Special attention needs to be paid to engaging marginalized groups and ensuring negative feedbacks affecting them are mitigated.

While significant gaps and uncertainties remain, there has been progress in developing tools and methodologies, and in applying solutions for addressing all values of water. Efforts have commonly focused on select, data-rich demonstration sites, helping ensure that economic, socio-cultural, and environmental values, and associated benefits, costs, and risks are accounted for as part of best practice in governance, management, decision-making, and finance. Greater attention needs to be directed at further developing and adapting such approaches and solutions for better adoption, replication, and scaling up in new and less well studied water development contexts. Opportunities for innovation abound.

Monitoring of water resources and related services is a fundamental, and feasible, yet neglected early step underpinning valuation. The lack of knowledge on the state of water resources, and incomplete, approximate, and conflicting estimates, limit the ability to value and sustainably develop water resources. Data on the resource in terms of the volume, flux, and quality of water (including surface and sub-surface sources, be they natural, constructed, or a combination of both), its technical, social, economic and cultural importance, uses, and access, as well as on ecosystem state, inform all subsequent steps of valuation, decision-making, and governance. Monitoring the stewardship of water budgets is another facet of valuing the resource, as is holding parties accountable for its equitable, efficient, and most effective use. Lack of knowledge on water users and of disaggregated data are constraints. Monitoring is becoming increasingly feasible, however, due to major advances in information technology.

Environmental flows are a central element of water resources policy and management which, when effectively allocated during implementation, prove an inclusive, equitable, and comprehensive means of addressing multiple values of water. The allocation of water to the environment, in terms of the quantity, quality, and timing of flows and water levels to maintain healthy ecosystems and prevent biodiversity loss, also ensures a wealth of essential ecosystem services and additional benefits are maintained and/or reaches society (and the converse), helping tackle poverty and securing long-term resource resilience - all fundaments of sustainable development.

Every socioeconomic sector, from water supply and sanitation to agriculture, energy, health, and industry, potentially stands to benefit longer-term from an improved integration of the values of water across the full development cycle, from planning through to adaptive management and monitoring - but there will be trade-offs and a need for adaptation for certain sectors in particular instances. Early phases of water resources planning and infrastructure design present considerable, but underused opportunities for introducing various aspects of water's value,

as identified though stakeholder processes of engagement and empowerment, and ensuring their equitable treatment in subsequent stages of water management. Similar opportunities exist in later stages of decision-making to fully address trade-offs. In the short-term especially there may not be benefits, not all sectors will benefit every time, and some sectors, if not all, will need to adapt to reflect the true cost of water.

Valuing all the different types of water and the resources they contain is an important step beyond valuing fresh and good quality water, with the potential to help transform water and wastewater management. While freshwater/ good-quality water is the predominant consideration when assessing the water-value proposition, due consideration should be given to other types of water. Transformation of wastewater treatment and management in agriculture, urban environments, and industry, in the direction of reuse rather than disposal presents various value propositions for resource (water, salts, nutrients, minerals, and energy) recovery which could support cost savings, cost recovery, and profits. Similar opportunities exist to value the resources and other benefits to society (e.g., community development) contained in other types of water (saline water, water in deep geological settings, fog water, etc.).

Water has tremendous value in terms of productivity, which extends far beyond economic output to include benefits to workers and other groups within society. Water is well established as having value in terms of economic productivity and outputs. It also holds various kinds of benefits for the workforce and other groups, from reducing occupational illnesses and health impacts on women fetching water, to increasing time available for productive work and education. Social dialogue is an important means to increase this value, gathering the inputs from workers, enterprises, and others on how to improve access.

The demand for valuing water needs to be created. Water is universally underpriced and undervalued. Few, if any, governments, business, or citizens are demanding that water is valued. Moreover, sometimes the opposite holds true - where citizens perceive water as a 'free' good (in the context of water as a human right) and demand a free water supply. There is a particular need to establish internal and external demands for business to do more.

Water has an economic value that needs to be appropriately established across multiple levels, and as part of a wider national water policy and strategy. That water may need to be valued with an associated cost or fee needs to be further and more directly addressed. Water needs to be priced appropriately across multiple levels. Pricing is not synonymous with value. However, it is one way of covering costs, reflecting part of the value of different uses, and ensuring adequate resources and finance for related infrastructure services. Water valuation should be part of a larger water policy and strategy for a country, and not necessarily monetized from outside the country.

New approaches to considering return on investment are needed for financial investments in infrastructure intended to deliver water to society. A change is needed in the way in which water related investments are made and the time horizons over which they are considered. New approaches to considering return on investment are needed for investments into infrastructure to deliver water (be it green or grey infrastructure or a blend), which consider the full value of water (not only economic) and for future societies too. The current discount rate approach essentially favours short term returns on investment. Much of the valuation is linked to capital investments too, with insufficient consideration of other factors, such as infrastructure operation and maintenance.

Unvalued water leads to an uncertain and less resilient future, which is especially pertinent in the context of growing water scarcity and climate change. Water scarcity, climate change, natural and human-induced disasters, and conflict, all intersect with numerous social, economic, and environmental drivers directly linked to water. As such, they potentially magnify the risks of non or inadequate valuation of water, which can cascade through food, energy, urban, and environmental systems. Valuing water is considered to offer positive contributions in these contexts. However, the links to benefits for, among other aspects, climate change adaptation, disaster risk reduction, reduced unmanaged or forced migration, and peacebuilding (including in a transboundary context) are not yet clearly articulated through the lens of valuing water.

Socio-cultural values continue to emerge as an area ripe for expansion, with a more in-depth examination of the wide diversity of issues timely and necessary. Values are integral to human rights-based approaches, the perspectives and needs of rural, local, and indigenous peoples, and faith based perspectives, among others. Water holds tremendous value for rural, local and indigenous communities, because they depend on water resources more than other groups. Member states should be encouraged to establish frameworks to enable these communities to manage water resources in an integrated manner, as an inherent part of strategies for a just transition to a green economy.

ANNEX 5 - WWDR GENERIC STRUCTURE (AS DECIDED IN 2012)

Executive Summary (3 to 5 pages)

Part 1: Baseline and Context (10–15 pages)

- Presentation of the theme – links to water and development
- Notable recent developments related to water and the theme (e.g. major global crises, trends and events; evolution of key drivers/externalities)
- Theme-related highlights from previous WWDRs, other UN-Water and UN agency publications, and flagship reports by UN-Water Member and Partner Organizations and from the international scientific community.
- Data availability issues (knowns and unknowns)

Part 2: Thematic Focus (30–50 pages)

- Three to five chapters covering the theme from the different perspectives of the most relevant challenge areas, including hotspots and externalities (i.e. drivers)

Part 3: Regional Aspects (10–15 pages)

- One comprehensive chapter (or regional chapters, depending on relevance of the theme to regional coverage). Highly focused cases, hotspots, externalities, examples, stories and/or unique perspectives from the five regions: what aspect of the theme makes it uniquely relevant to the region (and vice versa)?

Part 4: Response Options (15–20 pages)

- From 'in' and 'out' of the water box – these should be directly linked/applicable to the 'challenges' identified in Parts 2 and 3
- Policy implications

ANNEX 6. SKELETON TABLE OF CONTENTS

WWDR 2021 - Valuing Water
Annotated Table of Contents
(Draft)

October, 2019

Note: The order of the chapters is not necessarily indicative of the final report. The final sequence will be determined once content development has matured..

Executive Summary
Words: **2,000**
Lead Agency: **WWAP**

PART 1 – STATE OF KNOWLEDGE AND THEME PRESENTATION

Prologue : The State of Water Resources
Words: **4,000**
Lead Agency volunteer: **WWAP**
Contributing Agencies: **...**

Overview of the state of the world's water resources, and coverage of water supply and sanitation services in the context of valuing water. Highly populated with metrics (incl. figures, maps, graphs and tables), the Prologue essentially provides an update on the 'state of knowledge' that the other chapters can refer back to and build on.

Chapter 1 – Valuing Water: Challenges and Opportunities
Words: **4,000**
Lead Agency volunteer: **WWAP**
Contributing Agencies: **...**

Introductory chapter summarizing what the report is about: scope, objectives, and potential value added in terms of addressing global water issues and broader sustainable development aspirations. The four 'perspectives' for valuing water are introduced. Previous attempts at 'valuing water' are introduced and the basic terminology is described.

Chapter 2 – A Nexus Approach to Valuing Water
Words: **3,000**
Lead Agency volunteer: **UNU (FLORES & INWEH)**
Contributing Agencies: **UNESCO Cat II Centre hosted by SIWI, RAMSAR, WWF, FAO (Environmental flows), UNU-INWEH (cost of pollution), the WB...**

Brief chapter exploring how the concepts of valuing water can be perceived differently and how 'relationships' between different stakeholders to water (and amongst themselves) can influence how water can be valued through the different 'perspectives' and ultimately allocated.

PART 2 – THEMATIC FOCUS

Chapter 3 – Water Resources and the Environment (i.e., Valuing the 'Source')
Words: **4,000**
Lead Agency volunteer: **t.b.d.**
Contributing Agencies: **AquaFed, WSSCC, Water.org, WaterLex, [IWA is proposed as a possible contributor]**

Examines challenges and opportunities for valuing water resources and the ecosystem services upon which they rely. Consideration is given to the water's type/origin, its quality and its intended use(s). Environmental dimensions include environmental flows, source water protection and nature-based solutions.

Chapter 4 – Water Supply and Sanitation (WASH) Services in Human Settlements
Words: **3,000**
Lead Agency volunteer: **UN-Habitat (t.b.c.)**
Contributing Agencies: **AquaFed, WSSCC, Water.org, WaterLex, IWA…**

Examines the costs and benefits (direct and indirect) of WASH services across the full value chain (including wastewater treatment), with a comparison of opportunities for service provision in rural and urban settlements (including high-cost vs. low-cost solutions and centralized vs. small scale systems).

Chapter 5 – Food and Agriculture
Words: **4,000**
Lead Agency volunteer: **FAO (t.b.c.)**
Contributing Agencies: **…**

Examines challenges and opportunities for valuing water along food production chains, with a focus on both rural and urban (including peri-urban) agriculture. The issues of land management, water tenure and community ownership are also to be addressed, as are the positive and negative outcomes of subsidies and tariffs structures.

Chapter 6 – Energy and Industry
Words: **4,000**
Lead Agency volunteer: **UNIDO (t.b.c.)**
Contributing Agencies: **…**

Valuing different sources of water (at different levels of treatment) for different uses across entire value chains. Valuing water as a way to address risks to businesses.

Chapter 7 – Socio(?)-Cultural Values
Words: **4,000**
Lead Agency volunteer: **t.b.d.**
Contributing Agencies: **UNESCO World Heritage Centre (t.b.c.), UNU-IAS (t.b.c.)…**

Examines Factors shaping socio-cultural values: human identity, rights, ethics, world views, cosmologies, and belief systems, cultural heritage, sense of place, art and aesthetics, and quality of life etc. How can the more 'intangible' aspects of water be addressed? Opportunities for valuing water for peace building'.

PART 3 – REGIONAL PERSPECTIVES

The objective is to provide insights into the theme 'valuing water' from different regional perspectives. Structure, approach and practical details to be explored with the Regional Economic Commissions.

PART 4 – RESPONSE OPTIONS

Chapter 8 – Creating an Enabling Environment for Change
NOTE: These three major sections will either be combined into one chapter or will appear as three separate chapters. The decision will be taken in conjunction with the Lead Agencies after the first full drafts have been submitted.
In terms of the production process, it is proposed to address these sections as separate chapter, with a specific Lead Agency (and list of potential contributors) for each one.

- **Governance and Management Systems**
  Words: **3,000**
  Lead Agency volunteer: **t.b.d.**
  Contributing Agencies: **FAO, GWP, Water,org, WaterLex, UNDP WGF, UNCDD, UNU-FLORES, WSSCC, …**

  Examines how valuing water can influence governance and management systems, and inversely the role that governance and management systems in moving the concept of valuing water forward. Links to human rights and SGD frameworks.

- **Financing**
  Words: **3,000**
  Lead Agency volunteer: **t.b.d.**
  Contributing Agencies: **World Bank, Water.org, AquaFed, WSSCC, IIASA, FAO, …**

  What are the advantages and disadvantage to valuing water in terms of financing water resources management and WASH services provision?

- **Knowledge, Research and Capacity Building**
  Words: **3,000**
  Lead Agency volunteer: **IHE co-leading with WWAP or UN-Water member**
  Contributing Agencies: **U: IHE co-leading with WWAP or UN-Water member**
- **Contributing Agencies: UNDP (indigenous perspectives), FAO (water accounting), IWRA, UNIDO, GEMI group, ILO (t.b.c.), …**

  Describes what is needed in terms of advancing knowledge about valuing water for stakeholder empowerment, policy and decision-making, and the improved management of water resources and WASH services provision.

Chapter 9 – Moving Forward
Words: **2,000**
Lead Agency volunteer: **WWAP**
Contributing Agencies: **…**

Highlights the main messages of the report, summarizes the 'value added' of valuing water, and issues a call for action from different stakeholder groups.

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