Achieving Sustainable Development Goals from a Water Perspective

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Efforts to meet human water needs at local scales may cause negative environmental externalities and stress on the water system at regional and global scales. Hence, assessing Sustainable Development Goals (SDGs) targets requires a broad and in-depth knowledge of the global to local dynamics of water availability and use. Furthermore, interactions and trade-offs between different SDG targets may lead to sub-optimal or even adverse outcomes if the set of actions are not properly pre-designed to consider such inter-linkages. Thus, scientific research and evidence have an important role to play in facilitating the implementation of SDGs through assessments and policy engagement from global to local scales. This paper addresses some of these challenges related to implementation and monitoring of the targets of the SDGs from a water perspective, based on the key findings of a conference organized in 2015 focused on three essential aspects of SDGs: indicators, inter-linkages, and implementation. The paper argues that indicators should not be too simple and should ultimately deliver sustainability measures. The paper highlights that remote sensing and earth observation technologies can play a key role in supporting the monitoring of water targets. It also recognizes that implementing SDGs is a societal process of development, and there is a need to link how SDGs relate to public benefits and to communicate this to the broader public.

Keywords: SDG6, global water, nexus, environment, indicators

INTRODUCTION

Human activities play a dominant role compared to many other natural processes in changing the biosphere and affecting the functioning of the Earth system (Vörösmarty et al., 2010, 2015a,b; Green et al., 2015). Stresses on the earth system and exhaustion of its resources are causing interrelated, complex, and frequently unwanted outcomes that include impacts on the water system and unprecedented changes to global water circulation (Vörösmarty et al., 2004, 2015a). Actions at the local scale to meet human water needs may trigger increased environmental stress at regional and global scales, and thus create a trade-off between human water needs and environmental sustainability. As stated in the first sentence of the World Water Development Report 2015, "water is at the core of sustainable development" (UNESCO-WWAP, 2015); and the latter isstrongly connected to the availability and access to sufficient quantity and quality of water for the preservation of healthy ecosystems and is critical for socio-economic and human development. Yet increased pressure on the water system is observed through increased global demand and mismanagement of our water resources and water-related infrastructure. The following illustrate some of the serious threats to water-related sustainable development:

- Approximately 1.4 billion people live in river basins where water use exceeds recharge rates (UNDP, 2006).
- In developing countries, almost 90% of sewage is discharged without any treatment (UNESCO-WWAP, 2012).
- Increased use of fertilizer for food production, combined with increased wastewater effiuent results in 10–20% increase in nitrogen flow in global rivers (UNEP, 2007).
- Globally, some 750 million people (mostly in rural areas) lack access to an improved source of drinking water
- 170 million people rely on untreated surface water (Clarke et al., 2002)

- 1.8 billion people have used a source of drinking water with fecal contamination (UNICEF WHO, 2015).

Thus, while the manifestations of human water access at the expense of freshwater ecosystem health may be at both local and regional scales, the widespread occurrence of both makes them a global issue (Haddeland et al., 2014, Wheater and Gober, 2015). The governance systems in both industrialized and developing countries lack the capacity to handle these challenges and uncertainties (Pahl-Wostl et al., 2013; Pahl-Wostl, 2015). Superimposing the different elements of global change, the question thus arises of how sustainable human development can be ensured while safeguarding earth's vital life-support system on which the welfare of current and future generation depends?
In September 2015, the UN General Assembly responded by adopting a set of seventeen Sustainable Development Goals (SDGs). It emphasized the importance of water as an integral part of human development, and ecosystem needs (Harlin and Kjellén, 2015; UN-Water, 2015). However, assessing whether the SDG targets related to water are "SMART," i.e., Specific, Measurable, Attainable, Realistic, and Timely, requires a broad and in-depth knowledge of the global to local dynamics of water availability and its use (BWS, 2013). Furthermore, interactions and trade-offs between different SDG targets may lead to sub- optimal or even adverse outcomes if the set of actions are not properly pre-designed considering such inter-linkages (ICSU, 2016). Scientific research and evidence can play a strong role in facilitating the implementation of SDGs through assessments and policy engagement from global to local scales (Lu et al., 2015; Bunn, 2016). This paper addresses the challenges related to integrated implementation and monitoring of the targets of the SDGs from a water perspective[1].

1 The paper, however, do not cover topics like conflict resolution, south-south cooperation, and efficiency of development assistance in the context of SDG as significant details of such issues are beyond the scope of this paper.targets of the 17 SDGs on local, national and global scales, particularly when data in many parts of the world are either non-existent or not readily accessible. Thus, indicator-based assessments will have to rely on intensified monitoring and sustained follow-up. Beyond measuring success (or the lack of it) on 169 accounts, the indicators have to capture the strong interlinkages and interdependencies among various goals and targets (Griggs et al., 2013; Nilsson et al., 2016). Ultimately, these changes should also be monitored to ensure successful and sustainable implementation of the SDGs

Table 1 summarizes the challenges related to implementation and monitoring of the targets of SDG-6 and lists some critical comments, key recommendations formulated by the science community, and other stakeholders during the conference. The targets are classified into "how to do" and "what to achieve" targets. The recommendations and research gaps in the table have been updated given more recent developments related to the definition and adoption of the official indicators which will be used for monitoring and reporting purposes (UN-Water, 2016).
More or less the same comment as for target 6-1 holds here as well. Hand washing has been introduced here as an additional hygiene component. Consequently, at least two indicators will be needed as the two (safely managed sanitation and hand washing with soap) are not mutually inclusive.
There are many missing links between agriculture and water, sanitation and health particularly considering the effects on irrigation agriculture on human health. For instance, groundwater contamination due to irrigated agriculture has been responsible for a major proportion all waterborne diseases in developed and developing countries (Cronin et al., 2006). There is a need for a more comprehensive understanding of such kind of missing links and their cumulative effects.

TABLE 1 | Continued

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Indicators	Comments on the indicators	Research gaps and recommendations for future research
Target 6-4 By 2030, substantially increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of freshwater to address water scarcity and substantially reduce the number of people suffering from water scarcity ("HOW" target)		
Level of water stress: freshwater withdrawal in percentage of available freshwater resources Change in water uses efficiency over time	Water stress has several definitions. Without adopting a definition, this indicator could lead to cacophony rather than to sound measures.	How can we use the "saved" water equitably, sustainably and efficiently which is key to understanding the benefits of water use efficiency. Develop assessment Indicators on economic water scarcity that can give insights about the lack of investment in water or insufficient human capacity to satisfy the demand.
Target 6-5 By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate ("HOW" target)		
Degree of integrated water resources management (IWRM) implementation (0–100%) Proportion of transboundary basin area with an operational arrangement for water cooperation	IWRM has many definitions and is openly disputed as an implementable paradigm (Biswas, 2004) as it is more of a process than a target. It is very much questionable that a practical indicator capturing the real situation could easily be developed. The indicator requires comparable water governance databases collected nationally and in a transboundary context. The indicator without any related reference to the intensity of conflict and water scarcity may not capture the progress toward transboundary water cooperation where it is needed most.	Measure the role of IWRM to achieve other targets, for instance, 6-4 and 6-6. Develop an indicator that focuses on the implementation of solutions and contributes to effective flood and drought prevention, and integrated land and water management. Develop a transboundary assessment exercise that focuses on benefits sharing principle in water sharing.
Target 6-6 By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes ("WHAT"/"HOW" target)		
Change in the extent of water-related ecosystems over time.	It is very unlikely that an easy-to-use, sound quantitative criterion would be available soon. It would need surrogate measures. It is likely that we need a multitude of biological/ecosystem parameters to rely on, for instance, to reflect on the loss of aquatic species. To make the concept of water flows better understandable for politicians and stakeholders, an indicator that describes seasonal or monthly river discharge as a percentage of annual flow would be beneficial.	Determine the main drivers of change in the high-mountain cryosphere and to assess the risks implied by these changes.
Target 6-a By 2030, expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies ("HOW" target)		
Indicators	Comments on the indicators	Research gaps and recommendations for future research
Amount of water and sanitation related Official Development Assistance that is part of a government coordinated spending plan	The proposed indicator does not account for national or private funding efforts. Further, the indicator captures only water supply and sanitation while recycling and reuse are not relevant in this context. Political will is needed to ensure local level solutions emerge and achieve the twin goals of environmental conservation and economic development over a broader domain and over a time span of generations simultaneously.	Engage policy, business, science and civil society at large in developir innovation in water institutions and new instruments of governance. Free data sharing and transparent public reporting against quality and objectives in place.
Target 6-b Support and strengthen the participation of local communities in improving water and sanitation management ("HOW" target)		
Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management	The existence of policies and procedures alone does not imply automatically implementation and the quality thereof. It is acknowledged that there is no easy way to capture these features.	Local co

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In order to understand the relationships between water quality and human well-being and environment, there is a need for an effective tracking of point and non-point source pollution. Science can play a role in providing an in-depth understanding of the links between water, phosphorus, nitrogen and carbon cycles and other pollutants, assessing the magnitude and the impact of these pollutants on water quality and in determining how these impacts could be reduced and controlled (Refer to **Table 1**). Such assessments at different scales can help to identify the root causes of the problem and help to fill up the knowledge gap to formulate the right policies in implementing SDGS.

Many global measures or indicators do not reflect the household or community level action toward or away from sustainability. The sustainability conditions that may appear at the macro level may not hold at the household (micro) level. There is a strong need also to include household and community level water quality and sanitation assessments to account for the multiple scale nature of the respective target achievement. For instance, in order to gain more information on wastewater treatment which is a crucial part of sanitation, the Yale Environmental Performance Index (EPI) has been developed as a national wastewater treatment indicator (Malik et al., 2015). An interactive map of the percentage of wastewater treated per country performance can be established using crowdsource data to overcome data scarcity in this field (Hsu et al., 2014).

Even more "on the ground" approaches have been taken up for example by the Swachh Bharat Mission (SBM) in India. Their sanitation campaign aims at promoting the use and construction of latrines in rural areas. The previous monitoring system was based on expenditure for sanitation, thus not directly observing de facto toilet construction leading to significant over-reporting: 80% of the toilets being recorded could not be verified as existing by the Census 2011. In order to improve the monitoring system, the SBM is setting up a smartphone based observation system. Using geo-tagged pictures of latrines is a simple and efficient method to report household specific toilet construction and existence. Both cases could be used as baseline examples for SDG monitoring. However, neither of the procedures bridges the gap between local and global scale monitoring. Further, the issue still remains about the role of an indicator. An ideal SDG indicator may reflect on the sustainability of (i.e., lasting and delivering intended benefit) water management measures and not the one that requires counting of installed latrines per capita or other simply quantifiable achievements.

ROLE OF EARTH OBSERVATION

As mentioned in **Table 1**, national statistics often fail to assess water stress and fail to capture the full dimensionality of water problems. The alternative geospatial analysis could give better insights on populations, and environment at risk. Remote sensing and earth observation technologies can play a key role in supporting the monitoring of water targets, particularly where temporal data are unavailable, for instance on freshwater biodiversity. It can also identify emerging risks of underachievement, and help to understand responses when economic changes take place. These technologies could lead to a cost-effective, high-quality, monitoring program for water, by providing global data to complement *in situ* data at national level (Lawford et al., 2013).

UNDERSTANDING THE SDG INTERLINKAGES

While the SDGs are formulated as individual goals, they are hardly independent. Water runs as a common link through several of them, and the targets and indicators relating to freshwater systems are to be found not only in the dedicated water goal (goal 6) but also in other goals and indicators.

Groundwater systems serve as a useful example to illustrate some of the interconnections. Local, regional and continental aquifers are strategically significant, constituting the planet's major storage reserve of freshwater and representing a critical buffer for socioeconomic adaptation to climate and environmental change. Threats to their sustainability, associatedwith both excessive exploitation and quality degradation over the past 30–50 years (Foster et al., 2013), represent a potential impediment to achieving the SDGs—and this applies not only to the SDG-6 for water but also to SDG-2 on food security, SDG-3 on human health, SDG-11 on resilient cities and SDG-15 on protecting ecosystems and conserving biodiversity. In many ways, the proposed SDGs tend to "skate around" the critical consideration of absolute physical constraints on natural resources such as groundwater, and how these have been significantly reduced as a result of historically inadequate custodianship. The SDGs relating to food production, resilient cities, and aquatic ecosystems can only be achieved in the long term if underlying groundwater systems are conserved in "good status" and not subject to continued depletion and quality degradation.

SUPPORTING THE SDG IMPLEMENTATION PROCESS

The implementation of the ambitious SDGs poses considerable challenges to water governance. Many water related problems arise from inadequate and dysfunctional governance, irrespectively whether physical scarcity is prevalent or not. A lack of institutional capacity is the central factor to explain the poor performance of water governance in many countries (Schuster-Wallace et al., 2015). The SDG implementation process must thus support the building of institutional capacity to achieve its goals. Water governance should be participatory, accountable, transparent, responsive, consensus orientated, effective and efficient, equitable and inclusive, and should respect the rule of law. This is also connected to Goal 16 which says "promote peaceful and inclusive societies for sustainable development" and target 16.3—"Promote the rule of law at the national and international levels, and ensure equal access to justice for all." It can also be considered as a call for a better transboundary and global level water governance; and it implies that access to justice, law are crucial elements in water governance (Orme et al., 2015).

It also raises the question: How can political will, institutional capacity and good governance be fostered so that SDG process could become a global process driving transformative change toward sustainability? It requires engaging policy, business, science and civil society at large, and formulating incentives that foster harmonized interlinked regulations and policies. It is key to recognize that implementing SDGs is a societal process of development. We need to link how SDGs relate to public benefits and communicate this to the broader public. For instance, the question can be framed as "how do we make water drinkable," rather than an abstract question of water quality without considering the direct or indirect human dimension. With the adoption of the SDGs, the world obliged itself to abandon the clearly unsustainable business-as-usual trajectory and to engage in finding the sustainable path toward the achievement of its societal and environmental goals. The set of 17 goals and 169 targets are conceived as benchmarks to be achieved by 2030 (some of them by 2020 or preferably earlier). In many cases, surrogate indicators will have to be used to measure progress (or the lack of it). Thus, implementation of the SDGs implies continuous monitoring and periodic evaluation to check whether the direction and pace of development are right. It implies collection, archiving, and processing of massive amount of data to be evaluated at different scales. Monitoring and evaluation have their capacity needs both regarding professional and financial resources. Substantial capacity deficits, especially in developing countries, must be addressed. Professional capacity,educational, and media capacity are needed since multi- stakeholder implementation needs informed citizens, public and private engagement and a mentality change. It is clear that, as SDG implementation commences, neither monitoring capability nor assessment capacity is at an ideal level. Thus, implementing the SDGs also requires simultaneously developing the very basis of its targeted success. The "*ladder approach*" epitomizing the process of gradual improvement of monitoring can also be applied to many other facets of the SDG implementation process (UN-Water, 2015).

CONCLUDING DISCUSSION

The decision to incorporate a dedicated water goal (SDG- 6) among the 17 SDGs is a clear recognition that water is not only part of many other SDGs but in many aspects their precondition. Within this goal are fundamental targets for drinking water provision and sanitation but also for environmental sustainability. The water goal is expected to address the global water crisis as it unfolds, as evidenced by increased water scarcity, inadequate sanitation, widespread pollution, accelerated declines in freshwater biodiversity and the loss of vital ecosystem goods and services (GWSP, 2015). The paper addresses some of the challenges related to implementation and monitoring the targets of the SDGs from a water perspective, based on the key findings of a conference organized in 2015 with the focus on three essential aspects of SDGs- indicators, interlinkages, and implementation.

The paper suggests that indicators should be simple and SMART and able to inform policy makers on progress made toward sustainability and at the same time capture the complexity needed to assess the sustainability of its use. The expected set of official indicators for use in the intergovernmental progress reporting will not be able to adequately capture the progress of the SDGs and the cross-cutting role of water for their achievement. Hence, the scientific challenge to develop actionable and scientifically sound (secondary) indicators still exists. At the global level, science, for instance, can help in developing risk metrics that are required to assess whether humans are in a safe and sustainable operating space of the global water system and still can meet their essential needs. Further, water risk assessment can be conducted at the local and regionallevel to guide social, private, and public decisions on investment and also in developing appropriate institutions and coordinating implementation plans. There is a need for the development of scientifically sound assessment and regulatory guidelines that can help to address the gaps in process understanding focusing on the interaction between stressors and their impacts on the ecosystem health of freshwater bodies. It is not perceivable that conclusive answers will be found to all of them before the implementation of SDGs starts and inherent monitoring and indicator related decisions have to be made. This implies that the scientific community must remain involved in the years to come and assist the implementation process. In many aspects it will be a “learning by doing” adaptive process.

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