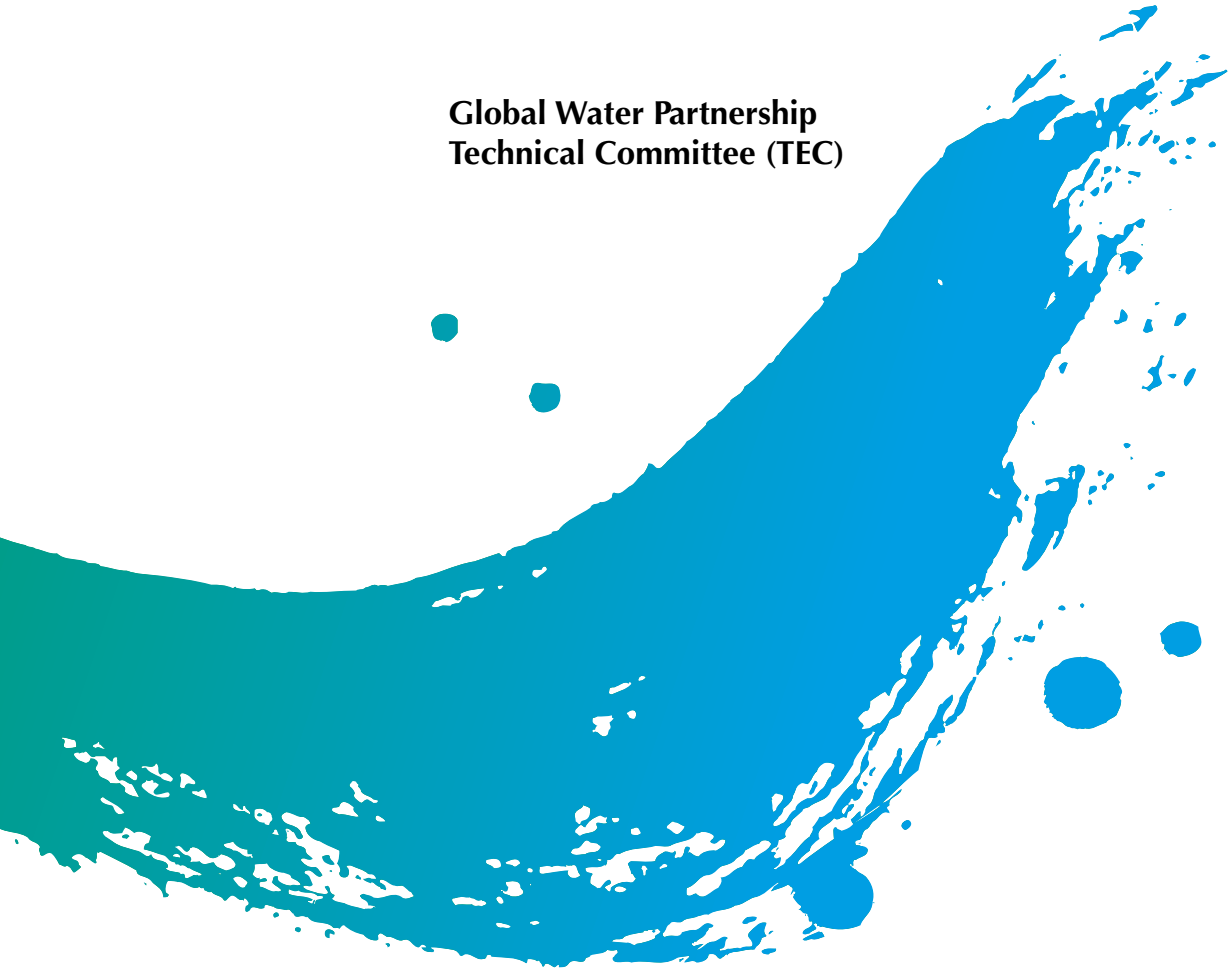
TEC BACKGROUND PAPERS NO. 23

Measuring transboundary water cooperation: options for Sustainable Development Goal Target 6.5

By Melissa McCracken

Global Water Partnership
Technical Committee (TEC)



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Measuring transboundary water cooperation: options for Sustainable Development Goal Target 6.5

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FOREWORD

It is often said that if we do not define, measure, or quantify our policy goals we will not achieve them. The Sustainable Development Goals (SDGs) present ambitious and daunting targets for the world to do so. To help us find our way to measuring targets for SDG 6, and thus to achieving aspirations for water resources policy, this GWP Technical Committee Background Paper offers options to measure progress in achieving one difficult area of SDG 6: cooperation on transboundary water management.

This Background Paper comes to us as monitoring and implementation plans for SDGs are being developed worldwide. As such, it should help with both SDG 6.5 and also those working on methods to monitor implementation of other parts of SDG 6. Many thanks are due to Melissa McCracken, a PhD student of Geography at Oregon State University (supervised by Professor Aaron T. Wolf), who – in cooperation with Professor A. Dan Tarlock of the GWP Technical Committee – opens windows into exploring the challenges of monitoring SDG progress.

Dr Jerome Delli Priscoli
Chair, GWP Technical Committee

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EXECUTIVE SUMMARY

In 2015, the United Nations (UN) adopted 17 Sustainable Development Goals (SDGs), including SDG 6.5, which calls for the implementation of integrated water management through cooperation among transboundary states. In 2016, the UN began the task of identifying the metrics to monitor the implementation of SDG 6.5. Almost 50 percent of the world's land surface (excluding Antarctica) is within a transboundary river basin (TFDD, 2016). Major population centres are dependent on shared waters for domestic, agricultural, and industrial uses. Water is central to sustainable development, making transboundary cooperation on water a core aspect of the SDGs. Under Target 6.5, SDG Indicator 6.5.2 is the "Proportion of transboundary basin area within an operational arrangement for water cooperation". This indicator presents challenges in how to monitor and use the results. How *transboundary area, operational* and *arrangement* are defined can lead to significant variability in the measurement of transboundary cooperation, the reporting of results and, ultimately, the influence this indicator could play in supporting sustainable development. This GWP TEC Background Paper aims to provide guidance on SDG Indicator 6.5.2 as monitoring and implementation plans are being developed. To do this, we examine how operational arrangements can be defined by evaluating three methods for calculating the indicator through both a procedural and a substantive perspective, and identifying the limitations and advantages. The three methods are based on three alternative ways of defining an operational arrangement.

The first method, Method 1, is the UN-Water proposed methodology for SDG Indicator 6.5.2. In Method 1, operational is defined by four criteria: existence of a joint body, regular communication, a joint management plan, and regular data and information exchange (UN-Water, 2016b). Method 2 defines operational using the same set of criteria, but also defines levels of operational cooperation. For an arrangement to be operational, only one of the criteria needs to be satisfied; the more criteria fulfilled the higher the level of operational cooperation occurring in the transboundary area (Sindico, 2016). The final method, Method 3, establishes a typology of cooperation adapted from the GWP TEC Background Paper: Promoting Effective Water Management Cooperation among Riparians by D. Tarlock (GWP, 2015), where operationality

is determined by substantive outcomes of cooperation. The three methods are demonstrated through three case studies: Bangladesh, Honduras, and Uganda.

The three methods have their own unique strengths and weaknesses. The criteria for defining operational in Method 1 and Method 2 are based on provisions in international water law; however, they are procedural and normative. The binary nature of Method 1 – either operational or not – masks cooperation that is occurring, but does not meet all four criteria. Method 3's alternative perspective allows for flexibility in acknowledging cooperative efforts that fit within place-based scenarios and meet socio-political needs; however, the categorical results do not meet the format for the data needed for global monitoring of the SDGs.

Through the demonstration and comparison of these three methods we present several recommendations and guidance in the hope of aiding better monitoring, understanding, and use of the SDG Indicator 6.5.2. In summary, the proposed methodology presented in Method 1 is the most appropriate for calculating the indicator when conducting global-scale monitoring, particularly if clarification in definitions for arrangement, operational, and transboundary areas are included. For local-scale monitoring, we recommend supplementing Method 1 with Method 3 to better reflect context-specific and alternative cooperative efforts that are occurring within a basin or aquifer.

1 THE SUSTAINABLE DEVELOPMENT GOALS AND TRANSBOUNDARY WATERS

Sustainable Development Goals

During consultations to develop the SDGs, there was a global push to ensure the inclusion of a specific goal related to water in the 2030 Agenda. In 2015, the UN Secretary General Advisory Board on Water and Sanitation noted that the importance of water to development means that better water resources management is needed within and between countries, as well as across sectors (Alexovich, 2015). The outcome of global support and recognition of the importance of water to development resulted in the incorporation of a specific SDG water goal with eight targets (Box 1).

Box 1. Sustainable Development Goal 6 (UN, 2015)

Goal 6: Ensure availability and sustainable management of water and sanitation for all

6.1: By 2030, achieve universal and equitable access to safe and affordable drinking water for all

6.2: By 2030, achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations

6.3: By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally

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 security

6.5: By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate

6.6: By 2020, protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers and lakes

6.a: By 2030, expand international cooperation and capacity building support to developing countries in water- and sanitation-related activities and programmes, including water harvesting, desalination, water efficiency, wastewater treatment, recycling and reuse technologies

6.b: Support and strengthen the participation of local communities in improving water and sanitation management

Global sentiment, along with various position papers on proposed targets for the SDG on water, put more emphasis on water resources management compared with the MDGs (Saruchera and Lautze, 2015). Of the position

papers submitted prior to the agreement on the 2030 Agenda, only two discussed the importance of including transboundary cooperation as a target for water resources management – Swiss Water Partnership and UN-Water (Schweizerische Eidgenossenschaft, 2013; UN-Water, 2014). The resultant target (Target 6.5) for Goal 6, "By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate", is of particular importance to GWP and, along with its related indicators, is the focus of this paper (UN, 2015).

Target 6.5 builds on the outcomes agreed upon in the 2002 Johannesburg Plan that countries should develop integrated water resource management (IWRM) plans, establish institutions, and integrate management plans at the basin scale (UN-Water, 2016c). The intention is that an IWRM framework will assist in balancing the other water targets and help to enhance the linkages with the other SDGs. To reach Target 6.5, two indicators have been developed to assist in monitoring and assessing its implementation.

- Indicator 6.5.1: Degree of integrated water resources management implementation

Indicator 6.5.1 will assess four components of IWRM implementation – policies, institutions, management tools, and financing – through a survey instrument in the manner of the 2012 Status Report on IWRM (UNEP and UNDP, 2012). The rationale behind this indicator is that it will assist countries in identifying barriers to IWRM implementation, support the attainment of the other water-related targets, and encourage capacity building at the national level (UN-Water, 2016c).

- Indicator 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation

Indicator 6.5.2 directly monitors the part of Target 6.5, "including through transboundary cooperation as appropriate". Monitoring will yield a percentage, for each country, of the in-country transboundary surface- and groundwater basin area that has a form of transboundary cooperation that includes regular meetings and information exchange between riparians (UN Statistics, 2016a; UN-Water, 2016c). The details will be discussed in more detail later in this paper. The rationale for the indicator is to encourage countries to develop operational frameworks for transboundary basins, as the indicator will show the areas that lack international arrangements over the shared waters.

Monitoring and reporting for Goal 6 will primarily be owned by the individual state. However, the national monitoring efforts will be supported and coordinated by international organisations under the UN-Water umbrella. For Target 6.5 – and the other new targets (6.3, 6.4, and 6.6) – the recently created Global Environmental Management Initiative (GEMI), which is an inter-agency Integrated Monitoring Initiative, will coordinate efforts and support countries in collecting data (UN-Water, 2016c). For Indicator 6.5.1, the UN Environmental Programme (UNEP) through GEMI, under UN-Water, will monitor IWRM status, building upon previous surveys on IWRM implementation. The UN Economic Commission for Europe (UNECE), as the Secretariat for the UNECE Water Convention[1], the UN Educational, Scientific and Cultural Organization (UNESCO), and UNEP will, through GEMI and also under the auspices of UN-Water, coordinate national monitoring and aggregation of data for SDG Indicator 6.5.2 (UN Statistics, 2016a). The inclusion of transboundary cooperation as part of Target 6.5 and monitoring through Indicator 6.5.2 is important as sustainable development will not be achieved without international cooperation over shared waters. This paper presents an evaluation of the proposed monitoring methods for SDG Indicator 6.5.2.[2]

Transboundary waters

Transboundary water is surface water and groundwater that crosses international political boundaries. Wolf et al. define transboundary river basins as areas that contribute both surface water and groundwater to a stream that drains to an ocean, sea, or terminal lake – where perennial water intersects a political boundary (Wolf et al., forthcoming, Wolf et al., 1999). There are 310 international transboundary river basins globally that cross the boundaries of two or more nations. These transboundary river basins encompass 47.1 percent of the world's land surface (Wolf et al., forthcoming). Most of the world's largest, and often most heavily depended-on rivers, cross international borders – Ganges-Brahmaputra-Meghna, Amazon, Indus, Nile, and the Colorado. With about 45 percent of the world's population residing in these basins, equitable sharing and sustainable use is vital for maintaining and increasing the water security of the majority of the world's population (TFDD, 2016).

[1] UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes (Water Convention) was amended in February 2013 to become a global framework. As of 1 March 2016, countries outside of the ECE regions can accede to the convention (UNECE, 2016b).
[2] The UN-Water proposed methodology in Step-by-Step Monitoring Methodology for Indicator 6.5.2 is the proposed method for calculating SDG 6.5.2 presented by the responsible parties. It is a draft version dated 24 April 2016 and is current as of the time of writing.

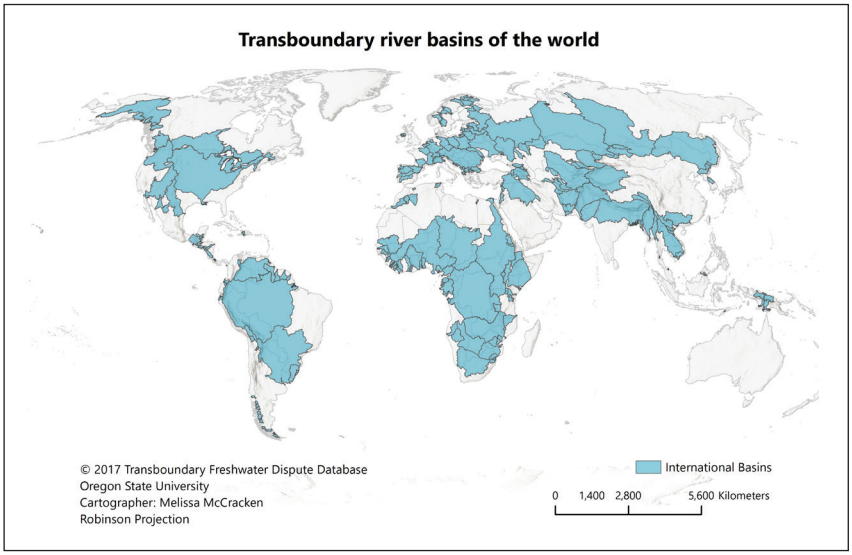


Figure 1: International transboundary river basins (TFDD, 2017)

Transboundary waters also include shared groundwater. Defining transboundary groundwater is more complex then defining transboundary surface water, given the difficulty in determining the extent of groundwater bodies. Unlike surface water, the extent of groundwater bodies cannot be determined by physical observation. As mentioned above, the definition of transboundary river basins includes hydrologically connected groundwater. Groundwater bodies are of two general types. Some are shallow unconfined geologic units that are hydrologically connected to the surface water system and are contained within the river basin boundaries. Others are geologic units that are not hydrologically connected to surface water, such as confined and fossil aquifers; these can also be transboundary groundwaters. The extent of these confined and fossil groundwater bodies is not related to river basin boundaries.

Similarly, the definition of transboundary groundwaters is not consistent in legal texts and the literature. For the purposes of this paper, we will use the definition of an aquifer consistent with the 2004 Berlin Rules on Water Resource Law, which defines an aquifer as a geologic formation that contains water, but excludes the water contained within from the definition; however, the term 'groundwater body' may also be used interchangeably with aquifer[3]. Transboundary groundwaters or transboundary aquifers can then be defined as aquifers that are intersected by state boundaries (UNECE, 2014).

[3] For more concise writing, the author may at points use 'basin' in a general sense to refer to both river basins and groundwater basins; a modifier is used when referring to either surface or groundwater.

According to the latest transboundary aquifer inventory completed by UNESCO IGRAC, there are 592 transboundary aquifers (IGRAC and UNESCO-IHP, 2015). With the difficulty in delineating aquifers, the boundaries are often poorly known – many are unknown – and there may be further difficulty in determining hydrologic connectivity between aquifers. Therefore, countries may be unaware that groundwater resources are even shared. With the future role that groundwater is likely to play in mitigating and buffering impacts from climate change and rapid human development and population growth, it is important to have an accurate inventory of international aquifers and aquifer systems. Without this data, information on transboundary cooperation and management of aquifer systems is limited. As of 2016, only six transboundary aquifers were covered by a formal agreement and two aquifers by an informal agreement. The lack of governance and institutional frameworks for shared groundwater could become a significant impediment to sustainable development (UNESCO-IHP and UNEP, 2016).

Rivers and groundwaters traverse landscapes irrespective of political borders. These borders add political complexity to water management with already diverse interests and values. More than half of the world's land surface contains transboundary waters and major population centres depend on shared waters for domestic, agricultural, and industrial uses. The centrality of water to sustainable development, and the extent of and dependence on shared waters, underscores the importance of appropriate transboundary cooperation and the inclusion of SDG Indicator 6.5.2. To achieve SDG 6, all the targets, including Target 6.5, must be achieved together. Target 6.5 provides a framework – IWRM – for addressing interdependencies between the water targets while balancing competing demands between the targets, water sectors, and water users (UN-Water, 2016d). Including transboundary cooperation in this framework allows for the consideration of water management at all levels and geographic scales. IWRM is primarily a domestic level water management approach; without the inclusion of transboundary cooperation, basin-scale water management is limited, as national management is not able to cope effectively with challenges originating in neighbouring basin states (Sindico, 2016).

For countries to gain the most from monitoring transboundary water cooperation, this paper takes a critical look at three methods for calculating the proportion of transboundary area with an operational arrangement. Using three countries as case studies, this paper demonstrates the three methods for calculating progress on SDG Indicator 6.5.2. The methods differ in how operational arrangements are defined – procedural or substantive.

This paper aims to provide guidance and encourage place-based awareness in transboundary cooperation. Chapter 2 provides a brief overview of transboundary water cooperation from an international legal perspective, then reviews previous studies that have developed alternative methods to measure transboundary cooperation or governance.

2 TRANSBOUNDARY WATER COOPERATION

International agreement on the need for cooperative development of water resources is apparent with the inclusion of Target 6.5 and Indicator 6.5.2 in the SDGs. Cooperation between states is essential. Given the importance of cooperation, a common understanding of what cooperation is, its origins, and what frameworks exist to guide and influence future cooperation are important if we are to achieve transboundary water cooperation.

What is cooperation?

Cooperation is coordination between two states at a level where they collaborate to achieve a common interest that results in mutual benefits for both states (Zartman et al., 2008 in Leb, 2015). This common interest could not be achieved unilaterally. States with shared interests and that see the potential for mutually derived benefits are inclined to cooperate, rather than dispute, particularly given the limited gains to be made through a dispute.

Origins of cooperation in international law

With reciprocity and good-faith, cooperative behaviour between states has led to interstate cooperation becoming an element of customary international law (Leb, 2015). With the establishment of the UN, customary interstate cooperation was formalised as a duty in the UN Charter. The Charter defines the purpose of the UN "to achieve international cooperation in solving international problems of an economic, social, cultural, or humanitarian character, and in promoting and encouraging respect for human rights and for fundamental freedoms for all without distinction as to race, sex, language, or religion," with specific articles outlining cooperation duties[4] (UN, 1945, chap.1, Article 1(3)). The duty to cooperate is not a hard rule and has limited means to be enforced or encouraged. However, international law has incorporated the duty to cooperate into the norms, principles, and rules established to govern state-to-state relations (GWP, 2013). The UN General Assembly adopted a resolution that specifically addresses the duty to cooperate as it relates to transboundary water during the 2013 International Year of Water Cooperation[5] (UN, 2010).

[4] Articles 2, 55, and 56 (Leb, 2015; UN, 1945)

[5] "Encourages all Member States, the United Nations system and all other actors to take advantage of the Year to promote actions at all levels, including through international cooperation, as appropriate." (UN, 2010)

International law, while not the only mechanism to encourage transboundary water cooperation, does provide a framework to address water sharing and water disputes. Ultimately, the rule of law facilitates cooperation: through a framework for governing interstate relations; through a means to integrate across scales, sectors, and disciplines; and through the provision of substantive and procedural rules or legal norms for implementation (GWP, 2013). Substantive rules include those that establish the rights and obligations of states sharing waters, i.e. substance. Procedural rules provide the means to implement the substantive rules, i.e. procedure. Several global instruments are in place that establish international water law through the duty to cooperate and provide a set of procedural and substantive norms to assist states in governing their interactions over shared waters.

Frameworks for international water cooperation

Arguably the most important instrument is the 1997 UN Convention on the Law of the Non-Navigational uses of International Waters (hereafter UN Watercourses Convention) (UN, 1997). Adopted in 1997 by the UN General Assembly, the UN Watercourses Convention is considered to be the first legal instrument at the international level to set a duty to cooperate[6] within international water law (Leb, 2013). The 35th state (Vietnam) ascended to the convention, bringing it into force in 2014 (UN, 2016a). The UN Watercourses Convention has several general principles of both substantive and procedural nature, including two substantive cornerstone principles. Through Article 5, states are expected to use shared international waters in a manner that is equitable and reasonable, as well as to participate in their use, development, and protection. The second cornerstone is Article 7, where states shall take measures to prevent significant harm to other riparians when utilising shared waters (UN, 1997). The UN Watercourses Convention spells out several other principles: the obligation to regularly exchange data and information (Article 8); the rule that no use has inherent priority over another use in the absence of an agreement (Article 10); the requirement for prior, timely notification of a planned measure (Part III); and the peaceful settlement of a dispute by an agreement or the provision in the convention (Article 33) (UN, 1997).

[6] Article 8 (UN, 1997)

In February 2003, the *1992 UNECE Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (hereafter UNECE Water Convention) was amended to allow non-UNECE member countries to ascend to the convention[7]. With the opening for ascension by non-UNECE countries in March 2016, the UNECE Water Convention became the second international convention to deal with transboundary freshwater (UNECE, 2016b). The UNECE Water Convention has both similarities and differences with the UN Watercourses Convention; its "primary purpose is to strengthen local, national, and regional measures to protect and ensure the ecologically sustainable use of transboundary surface waters and groundwaters" (UNECE, 2004, p.6). The UNECE Water Convention has a three-pronged structure that is based on the obligations: to prevent, control, and reduce transboundary impact; the requirement for equitable and reasonable use; and the duty to cooperate with co-riparians (UNECE, 2016a). These obligations are expressed in rules that apply to all parties to the convention (Part I) and in requirements that apply to co-riparians sharing the same international waters (Part II) (UNECE, 2013).

The two conventions are not mutually exclusive and have elements that complement each other. Generally, the UNECE Water Convention is more detailed and includes more procedural rules than the UN Watercourses Convention, which gives more detail on substantive principles e.g. 'equitable and reasonable use' and 'no significant harm' (Tanzi, 2000; UN Watercourses Convention, no date). With respect to the duty to cooperate, both conventions set out procedural rules as means for cooperation, e.g. data exchange, notification, and joint monitoring. The UNECE Water Convention, however, focuses on institutionalised cooperation, as it mandates states to enter into bilateral/multilateral agreements and to establish joint management bodies (Article 9) (UNECE, 2013); within the UN Watercourses Convention these are not compulsory (Tanzi, 2000). Both conventions address groundwater in their definitions of transboundary waters. However, whether an aquifer that is not hydrologically connected to surface waters is included under the purview of the UN Watercourses Convention is questionable and generally considered outside its scope (Tanzi, 2000).

[7] Amendments to Articles 25 and 26 entered into force on 6 February 2003. As of writing, no non-UNECE member states had ratified the UNECE Water Convention (UN, 2016b).

In 2008[8], the UN General Assembly adopted the *Draft Articles on the Law of Transboundary Aquifers*. On 4 November 2016 the Draft Articles were again placed on the provisional agenda of a future session for consideration as to whether they should be adopted or whether consideration should be given to transform the Draft Articles into a convention or comparable action[9] (UN, 2016c). The UN Watercourses Convention was the basis for the Draft Articles, and there are similar provisions between the two instruments. For example, the Draft Articles also include the general principles of equitable and reasonable use, obligation to not cause significant harm, and the duty to cooperate. However, contrary to the UN Watercourses Convention, the Draft Articles include a general principle (Article 3) of state sovereignty over the portion of a transboundary aquifer within its land (Yamada, 2011; Behrmann and Stephan, 2010).

In addition to the Draft Articles, the UNECE has issued *Model Provisions on Transboundary Groundwaters*, which provides guidance on the application of the UNECE Water Convention to transboundary groundwaters. The Model Provisions were adopted during the sixth Meeting of the Parties and are recommended for both member and non-member states to use when developing or amending agreements on transboundary groundwaters (UNECE, 2014).

In practice, most transboundary water cooperation is governed by treaties or bilateral/multilateral agreements between co-riparians, although a few agreements have been signed for transboundary groundwaters. States have historically adopted treaties over shared waters[10]; the precedent of cooperation and the establishment of treaties have created the duty to cooperate as embodied in customary international law (Leb, 2013). In the framework of the conventions, international water law helps encourage cooperation by providing common rules that govern state-to-state relationships. Along with developing cooperation through trust and reciprocity, treaties create stability and predictability in state-to-state relationships (Leb, 2015). Through the substantive principles and procedural duties, international water law encourages cooperation; however, there is not enough stress on cooperation, and unilateral action is often more appealing to states than mutual benefits gained through cooperation

[8] UN General Assembly Resolution A/RES/63/124
[9] UN General Assembly Draft Resolution A/C.6/71/L.22
[10] First treaty known for cooperation over shared water was in 3100 BC between Lagash and Umma, which ended a dispute over irrigation water (Dinar et al., 2007).

(GWP, 2015). The degree of cooperation that occurs between states is ultimately determined by the will of the national government. Collaboration over shared waters can exist without a treaty, but it is generally less stable or resilient (Leb, 2015; Wolf, 1998). Universal frameworks encourage the establishment of an agreement or arrangement to share transboundary water; the UNECE Water Convention goes so far as to make institutionalised cooperation through an agreement or joint body compulsory. However, there is no international mechanism to hold states accountable to begin or to continue to cooperate according to existing agreements.

Customary international law and the universal frameworks within international water law help to conceptualise more formal and institutional transboundary water cooperation, emphasising procedures. Transboundary water cooperation – procedural and substantive – is reflected in agreements over shared surface and groundwaters; agreements which are indicators of hydropolitical resilience and the potential for future cooperation. But, transboundary cooperation can exist beyond treaties and agreements between basin states; political will and non-state actors can contribute to transboundary water cooperation. In fact, many treaties allow the participation of non-state actors (Conca et al., 2006). Therefore, measuring transboundary cooperation is complex, given the types – procedural or substantive – of cooperation and the levels of formality – governmental or non-state. To evaluate the methodologies for SDG Indicator 6.5.2 that this paper presents, the next chapter discusses existing indicators and measures of transboundary cooperation and/or governance.

3 MEASURES OF TRANSBOUNDARY WATER COOPERATION

The inclusion of transboundary cooperation on water in the SDGs, while focusing on measuring cooperation, is not the first attempt to monitor transboundary water cooperation and map global efforts towards collaborative transboundary water governance. As the methods for calculating the SDG Indicator 6.5.2 are being developed, it is important to consider alternative and past experiences, and to draw on existing studies on measuring transboundary water cooperation. For example, the *Draft 3rd State of the Nile Report Indicators* is developing a method for measuring transboundary cooperation that is not based on area. This proposed method calculates the extent of transboundary cooperation by determining the percentage of the number of countries the country of concern is riparian to that it has a cooperative agreement with, out of the total number of countries the country of concern is riparian with (AbuZeid, 2016). Such studies could provide a baseline, validation, or triangulation of the SDG Indicator methodology, depending on the goal and scope of the research. This section briefly reviews three projects which have measured transboundary cooperation in some form, even if not explicitly. While there are many studies and research projects that have measured transboundary water cooperation, governance, or management, this section will only briefly discuss a selection of those that are global in scale and aim to capture the current (at the time of research) state of transboundary cooperation, as a complete review is beyond the scope of this paper[11].

Mapping the resilience of international river basins to future climate change-induced water variability

In 2010, the World Bank commissioned a report on the interactions between transboundary river basin management and climate change to better aid future design of cooperative measures that can adapt to climate variability and uncertainty: *Mapping the Resilience of International River Basins to Future Climate Change-Induced Water Variability*. The study's goal was to compare the global distribution of resilience mechanisms, such as treaties and river basin organisations (RBOs), with current and predicted hydrologic regime changes (De Stefano et al., 2010). To do this, the authors measured institutional capacity in comparison to climate risk. In locations where there is a treaty and/or a RBO the potential to increase cooperation is greater than in locations without any agreements or organisations. But the mere presence of a treaty or RBO is not

[11] For more information, please refer to the associated documents in each section.

the only important factor; the mechanisms and design of the instruments and institutions are important, and international water law can play a valuable role in reducing tension and adding resilience. The assessment of institutional vulnerability in this research essentially measured the level of transboundary cooperation per country within a river basin. The criteria used to evaluate the institutional resilience of an area of a basin in a particular country included the presence of a treaty, a water allocation mechanism, a mechanism for flow variability management, a conflict resolution mechanism, and the presence of a RBO. Each criterion was given an equal weight; the less criteria met, the more vulnerable the basin country area (De Stefano et al., 2010).

The methodology used in the World Bank study differs from the intention behind the proposed methodology for the SDG Indicator 6.5.2 in several ways. First, the scale. The World Bank study focused at the basin level in a particular country whereas the scale of interest for the SDGs is at the country level. If needed, the World Bank study basin-level results could be aggregated to determine a score for institutional vulnerability at a country level. Second, the study looked at institutional vulnerability, rather than transboundary cooperation. In a sense, institutional vulnerability could be considered to imply a lack of transboundary cooperation and, therefore, the assumption could be put forward that a lower vulnerability score indicates a greater degree of cooperation. However, the substantive mechanisms identified as criteria were selected based on the intent of the study – their ability to reinforce institutional resiliency to climate change. Lastly, the focus was on international river basins and, therefore, excluded transboundary aquifers, which are important water resources for the SDGs. The study, however, presents a view of institutional capacity that contributes to transboundary cooperation; it incorporates both substantive and procedural aspects, individual mechanisms, cooperative instruments, and institutions.

Water cooperation quotient

The second project discussed here is the Water Cooperation Quotient developed by the Strategic Foresight Group[12] in 2013 as part of a study on water security in the Middle East (Strategic Foresight Group, 2013). The authors have since refined the methodology and, in 2015, issued a report titled *Water Cooperation Quotient* (Strategic Foresight Group, 2015). The aim of this report was to present a way to measure the "intensity and operational strength" of transboundary water cooperation. The authors argue that simply having a signed treaty that discusses allocation – one of the principal focuses of treaties

[12] Much of the data used as a part of this research is from the Transboundary Freshwater Dispute Database: http://www.transboundarywaters.orst.edu/.

on international waters (Hamner and Wolf, 1997) – is not cooperation, but rather that for cooperation to be operational it needs to be active water cooperation. They define active water cooperation as "the commitment of countries to jointly manage their shared water resources" (Strategic Foresight Group, 2015, p.11). The Water Cooperation Quotient aims to measure active water cooperation by analysing the water cooperation efforts of riparians focusing on RBOs and formal agreements. The Quotient is composed of ten indicators that are given a score of 1 to 10 to indicate the level of commitment to cooperation; the highest possible score, 55, indicates the highest level of active water cooperation. The ten indicators used to calculate the Water Cooperation Quotient (Strategic Foresight Group, 2015) in low to high order of rank score are:

1. Existence of a formal agreement
2. Existence of a river basin commission or organisation
3. Engagement of ministerial level in cooperative meetings
4. Collaboration in joint technical projects
5. Joint environmental protection and quality control
6. Joint monitoring of water flows
7. Active collaboration in planned development, such as notification and consultation
8. Commitment to cooperation at the highest political level
9. Integration into regional economic cooperation
10. Evidence that cooperation mechanisms are functioning with active participation from the riparians.

The authors put forward that the minimum four indicators needed for a cooperative arrangement to be considered active water cooperation are:

1. Existence of a formal agreement
2. Existence of a river basin commission or organisation
3. Engagement of ministerial level in cooperative meetings
4. Collaboration in joint technical projects.

When considering SDG Indicator 6.5.2, we could then conclude that these four minimum components could correlate to the criteria for considering an arrangement to be operational. Similar to the SDG Indicator proposed method, this study calculates the Quotient at a basin level then averages the scores of the different basins within a country to yield a country-wide score. This score can be disaggregated to examine the level of cooperation between a specific set of riparians. The score covers a broad range of indicators and includes technical and economic factors, which are often not included in

other methods to assess cooperation. The focus of the analysis, however, is strictly on formal agreements and RBOs within a basin and does not include other forms of cooperation, such as through third party or civil society actors. The study does present an overview of transboundary cooperation globally at a specific point in time (2015) that could provide a baseline for SDG Indicator 6.5.2.

Transboundary Waters Assessment Programme

The final assessment of global transboundary cooperation discussed in this paper is part of the UNEP and Global Environment Facility (GEF) *Transboundary Waters Assessment Programme* (TWAP). TWAP is creating a baseline assessment of all the world's transboundary waters, including surface water and groundwater. The project's overarching aim is to establish a 'sustainable institutional framework' that can be used to develop a baseline assessment and in future assessments to measure changes in transboundary waters (UNEP-DHI, 2016). Of relevance to this paper and SDG Indicator 6.5.2 is the Transboundary River Basins Assessment[13]. Like the overarching project, the River Basin Assessment is also creating a comparative baseline assessment of the world's transboundary river basins by developing a methodology based on a range of issues, such as water stress, ecosystem threats, and the socio-economic and governance capacity to cope with these issues. Governance capacity within the basins is considered at both a national and international level while aiming to identify the risk of interstate tension because of development or because of a lack of adequate institutional capacity. The governance thematic section of the TWAP-River Basins (TWAP-RB) assessment includes three indicators: legal framework, hydropolitical tension, and enabling environment. The combination of these three indicators provides a framework and baseline for measuring not only transboundary cooperation (as in SDG 6.5.2), but also the link between international cooperation and national policy.

Transboundary cooperation is captured by the indicators for the legal framework and hydropolitical tension. The legal framework indicator arises from the concept that legal agreements provide a framework for managing transboundary waters; therefore, this indicator maps the spatial distribution of several key international principles in water treaties (UNEP-DHI, 2016). The key principles are: equitable and reasonable use; not to cause significant harm; environmental protection; cooperation and information exchange;

[13] Transboundary River Basins: Status and Trends (2016) and more information is available at: http://twap-rivers.org/. Data is available through the interactive data portal: http://twap-rivers.org/indicators/.

notification, consultation, or negotiation; consultation and peaceful settlement of disputes; and whether a country has ratified either the UN Watercourses Convention or the UNECE Water Convention (UNEP-DHI, 2016). The hydropolitical tension indicator considers the institutional resilience to development in the basin (De Stefano et al., forthcoming). The measurement of institutional resilience follows the calculation of institutional resilience in the aforementioned World Bank study quantifying a score based on whether the basin country area has a treaty, allocation mechanism, flow variability mechanism, conflict resolution mechanism, and/or a river basin organisation. The level of institutional resilience is then compared to the planned, proposed, and under construction development of dams, reservoirs, and other major infrastructure projects (UNEP-DHI, 2016; De Stefano et al., forthcoming). The legal framework and the institutional resilience component of the hydropolitical tension indicator complement each other to effectively measure transboundary cooperation from a formal perspective that takes both substantive and procedural rules of customary international law into account, as well as formal legal mechanisms specific to enhancing institutional capacity.

The third component of the governance thematic section of the TWAP-RB assessment measures the enabling environment; this indicator is similar to the proposed methodology for SDG Indicator 6.5.1[14]. This indicator is based on questionnaire data on policy, strategic planning, and legal frameworks; governance and institutional frameworks; and management instruments drawn from the 2012 IWRM Status Report (UNEP-DHI, 2016; UNEP and UNDP, 2012). The management of basins at the national scale has the potential to impact transboundary cooperation and vice versa. Therefore, the enabling environment indicator links the transboundary (or basin) level with the national level; this is important as countries struggling with implementing integrated water resources management at the national level may not have the capacity to address issues and challenges at the transboundary level (UNEP-DHI, 2016).

From the framework and baseline in the TWAP-RB assessment, we can identify valuable aspects to consider in proposals for methods to calculate SDG Indicator 6.5.2 as the methods discussed have already been tested and proven to work at a global scale. The TWAP-RB assessment, like the other

[14] "Degree of integrated water resources management implementation", which is proposed to be measured through a survey with questions surrounding four components: enabling environment, institutions, management instruments, and financing (UN-Water, 2016a; UN-Water, 2016c).

two studies discussed here, focuses only on transboundary cooperation within river basins. The TWAP project included a separate methodology for assessing the governance of transboundary aquifers; however, this methodology differs from the methods used to assess river basins (UNESCO-IHP, 2011). Data was also collected for the basin country area and aggregated to the basin level; however, the base data could also be aggregated to illustrate indicator values at the country level.

Beyond these three studies, Saruchera and Lautze (2015) surveyed previous work measuring water cooperation and governance to develop a list of indicators with the goal of advising on how transboundary water cooperation could be measured in the SDGs. Their study identified six indicators for measuring cooperation: existence of a transboundary agreement; reference to transboundary waters in national legislation; an inclusive basin plan; regular data exchange; standardised units and methods of measurement for water data; and financing available for transboundary institutions and projects (Saruchera and Lautze, 2015). Three of these indicators are 'on paper'; the other three are based 'on practice' and, therefore, are much harder to verify on a global scale as they attempt to reflect the actual cooperation occurring.

Previous studies that have established methods for measuring transboundary water cooperation and governance provide a wealth of experience for developing a methodology for measuring SDG Indicator 6.5.2. The benefit of existing methods is that the data and frameworks already exist and have been tested; indicators and data can be adapted to meet the needs of the SDG target and indicators. In addition, they can be used to triangulate and validate the results of the SDG indicator methodology through comparison and by asking what each method is truly measuring. Furthermore, many of these methods, such as the three presented here, have established global baselines, which can be used to help track changes in transboundary cooperation prior to the implementation of the 2030 Agenda.

Now that we have some conceptualisation of the means and types of methods to measure transboundary water cooperation, this paper will shift to its main focus, which is evaluating several methods for calculating SDG Indicator 6.5.2 from two perspectives. First, the paper presents foundational definitions for understanding and discussing the indicator, then introduces the case study countries in their transboundary context before evaluating the three methods for SDG Indicator 6.5.2 calculations.

4 BUILDING FOUNDATIONS FOR MEASURING SDG INDICATOR 6.5.2

Common terminology

Before presenting the three methodologies, a foundational understanding of commonly used terms and concepts is needed. Given the intent of the SDGs – to monitor progress towards sustainable development globally – and the variation in monitoring capacity between states, consistency in what is being monitored is important to allow spatial and temporal comparison. For example, the UN Statistics Division proposes that SDG Indicator 6.5.2 be the "proportion of surface area of transboundary basins that have an operational arrangement for transboundary water cooperation. Regular meetings of the riparian countries to discuss IWRM and exchange of information are required for an arrangement to be defined as operational." (UN Statistics, 2016a). Without a specific, clear understanding of what is meant by a 'transboundary basin' and an 'arrangement', and what 'regular' means, there is potential for misunderstanding and misleading results. How 'operational, arrangement' and 'transboundary basin' are defined presents specific challenges for the application of the indicator and its utility. The following commonly used concepts and terms are defined and are consistent between all three methodologies.

Transboundary river basin: A river basin is the area of land that drains to a common terminus that is an ocean, sea, or terminal inland water body; it is also known as a watershed or catchment and includes the groundwater bodies that are hydrologically connected to the surface water system. A river basin is transboundary if it contains a perennial tributary that crosses a political boundary between two or more states. (UN CNERT DESA, 1978; Wolf et al., 1999; Wolf et al., forthcoming).

Transboundary aquifer: An aquifer is a geological formation that contains water; this includes confined and unconfined aquifers (International Law Association, 2004). In this paper, 'groundwater body' maybe used interchangeably with 'aquifer'. Groundwater will be reserved for the water contained within an aquifer. A transboundary aquifer (or groundwater body) is intersected by a political boundary and is not hydrologically connected to a surface water system (UNECE, 2014). Differentiating transboundary aquifers is more complex than differentiating river basins, as groundwater bodies can

overlap vertically. For those that are vertically overlapping and hydrologically connected, we will consider them as one transboundary aquifer. If they are vertically overlapping and not hydrologically connected, e.g. an unconfined aquifer over a confined aquifer, the groundwater bodies will be considered as separate transboundary aquifers, unless they are managed conjunctively (UN-Water, 2016b).

Groundwater: The water contained within a water-bearing geological formation (International Law Association, 2004).

Basin country unit (BCU): The area of a transboundary river basin that lies within a particular nation. A transboundary river basin has at least two BCUs. For example, if an international river basin has three riparians, then there will be three BCUs – one for each basin and country combination (TFDD, 2016).

Aquifer country unit (ACU): The area of a transboundary aquifer that is within a particular nation. Given the nature of aquifers, the area referred to – and used in calculations – is the plan-view surface area of an aquifer and does not consider the aquifer thickness nor the potential volume of water.

Transboundary area: The total transboundary area within a nation is the sum of the surface areas of the BCUs and ACUs in that nation. This sum may yield a value that is greater than the surface area of the country; however, as shown in the methods below, this value will be used in a calculation that negates the potential impact of a value for the transboundary area that is larger than the area of a country.

Agreement: A bilateral or multilateral formal legal instrument, such as a treaty, amendment or protocol, between riparian countries regarding transboundary waters.

The final two terms in need of defining are operational and arrangement, which are used in the text of the SDG Indicator 6.5.2. The proposed definitions are loose and may lead to inconsistency in monitoring and representing the extent of transboundary cooperation. How operational and arrangement are defined has the potential to be politicised. A specific definition may favour one method of transboundary cooperation over another; however, vague definitions do not remediate contention, but rather impact the usefulness, accuracy, and effectiveness of the measured value of the proportion of transboundary area covered by transboundary cooperative efforts.

Arrangement for water cooperation is defined in the UN-Water proposed methodology, or Method 1 in this report, as "a bilateral or multilateral treaty, convention, agreement, or other formal arrangement, such as a MOU; between riparian countries that provides a framework for cooperation on transboundary water management. Agreements or other kinds of formal arrangements may be interstate, intergovernmental, interministerial, inter-agency, or between regional authorities." (UN-Water, 2016b, p.3). This definition paints a broad and inclusive definition of *arrangement*, but it is centred around the existence of an agreement. The inclusivity is perhaps a means to build flexibility into the definition to allow for context-specific methods of transboundary cooperation. However, this may lead to confusion when identifying what is or is not an arrangement. For example, does a country with a ratified treaty over shared waters have an arrangement for water cooperation or does a country that is party to one of the two international conventions with no agreement between riparians have an arrangement for water cooperation? The answer is that both have an arrangement for water cooperation, which leads to a subsequent question: should these both be given equal consideration when evaluating the indicator? For this paper, we will use the draft methodology's definition of arrangement, defined at the beginning of this paragraph, for consistency in assessing the methods presented in the following sections. Some deviation will occur in Method 3, which will be noted.

The final term to define, which arguably could be the most controversial, is *operational*. Each of the three methods for calculating SDG Indicator 6.5.2 has a different definition of *operational*. The assessment of the three methods illustrates the variability in defining *operational* and how that can significantly alter the calculation and resulting value of the indicator. In finalising and approving the methodology for measuring SDG Indicator 6.5.2, it will be important to clearly define *operational* in a way that captures the intent of SDG 6.5. Since *operational* is the variable in the methods examined in this paper, the definitions of *operational* relating to each method will be defined separately in the sections discussing the different methods.

Foundations in space and place: case study locations

The purpose of this paper is to provide guidance on measuring and utilising the results of SDG Indicator 6.5.2. In order to do this, we will compare and evaluate three different methods for calculating SDG Indicator 6.5.2: "Proportion of transboundary basin area with an operational arrangement for water cooperation" (UN-Water, 2016c). The three methods are:

- Method 1: UN-Water proposed methodology in *Step-by-Step Monitoring Methodology for Indicator 6.5.2* (UN-Water, 2016b)[15]. This method defines an arrangement as operational if it meets four criteria: joint management body, joint management plan, information exchange, and regular meetings.
- Method 2: adapts Method 1 based on the recommendation in Sindico's (2016) *Transboundary Cooperation and the Sustainable Development Goals,* where an arrangement is considered to be operational if it meets any one of the criteria in Method 1. This creates levels of operational cooperation, depending on how many criteria are fulfilled.
- Method 3: takes an alternative approach to defining operational and is adapted from GWP's TEC Background Paper: *Promoting Effective Water Management Cooperation among Riparians* by D. Tarlock (GWP, 2015). This places arrangements within a typology of cooperation, where their operationality is determined by the substance and outcomes of cooperation.

In the following sections, each of these methods for calculating SDG Indicator 6.5.2 is detailed. The methods vary in the way that they define *operational*. By examining the definition of operational in each method, we hope to identify the advantages and drawbacks of each method in capturing and representing transboundary cooperation over shared waters. This allows us to compare the methods, to present recommendations for the proposed methodology, and to provide guidance on monitoring and using the results of the indicator.

To do this, we examine three country case studies to demonstrate the calculations for the SDG Indicator 6.5.2 based on the three methods and compare the results. The three countries are Bangladesh, Honduras, and Uganda. These countries were selected as they represent several regions and because the number and extent of transboundary river basins and aquifers in each varies. Furthermore, the three countries participate in the GWP SDG and Water Preparedness Facility, which supports countries in rapid implementation of SDG 6 and other water-related SDGs (GWP, 2016b). Uganda and Bangladesh are also pilot countries for the GEMI SDG monitoring methodologies pilot project for SDG 6.3–6.6 (UNESCO-IHP, 2016). The next section provides a brief introduction to the hydrological resources of each country and an overview of its transboundary water cooperation as a background to aid understanding of the discussion of the

[15] This is the proposed method for calculating SDG 6.5.2 presented by the responsible parties. It is a draft version dated 24 April 2016, and it is current as of the time of writing.

results for each method. The section that follows describes in detail the SDG Indicator 6.5.2 methodologies and the calculations for each method in the three countries.

Overview of water resources

Bangladesh: With 57 transboundary rivers, Bangladesh is highly dependent on transboundary water resources. Most of these 57 rivers are either tributaries or distributaries of the Ganges, Brahmaputra, or Meghna rivers and are part of the large transboundary Ganges-Brahmaputra-Meghna River Basin[16]. In addition to the rivers that are part of this large system, Bangladesh also shares several other transboundary river basins with both India and Myanmar: the Fenney, Karnaphuli, Muhuri, and Naaf river basins (TFDD, 2016). Given Bangladesh's geography, it is the most downstream riparian for these surface water systems; about 90 percent of the flow originates outside Bangladesh (Ahmed and Roy, 2007; Bhuiyan and Hossain, 2006; FAO, 2014) Despite having some of the largest annual discharges, the temporal variability of monsoonal precipitation within the catchment areas means that the discharge is unevenly distributed throughout a year; about 85 percent of the total flow enters Bangladesh between June and October (FAO, 2014). This means there is a significant deficit between the available water resources and demand during low-flow months and a high potential for flooding and inundation during peak flows. In addition to transboundary surface water, Bangladesh is underlain by a large transboundary aquifer system – the East Ganges River Plain Aquifer (IGRAC and UNESCO-IHP, 2015). As much of the country is composed of sedimentary and alluvial deposits from the Ganges-Brahmaputra-Meghna River Basin, the aquifer underlying the country is mostly unconfined and shallow (Ahmed and Roy, 2007). Groundwater is available in reasonable quantities and is actively recharged from the surface waters, heavy precipitation, and flood events. In both rural and urban areas, groundwater is the main source of water, despite issues with quality, as about 50 percent of the country is underlain by groundwater bodies that are not suitable to supply drinking water due to arsenic contamination (Ahmed and Roy, 2007).

[16] This paper follows the naming convention of the Transboundary Freshwater Dispute Database for the Ganges-Brahmaputra-Meghna River Basin. This is based on the definition used for an international river basin, a basin which is determined by a common terminus.

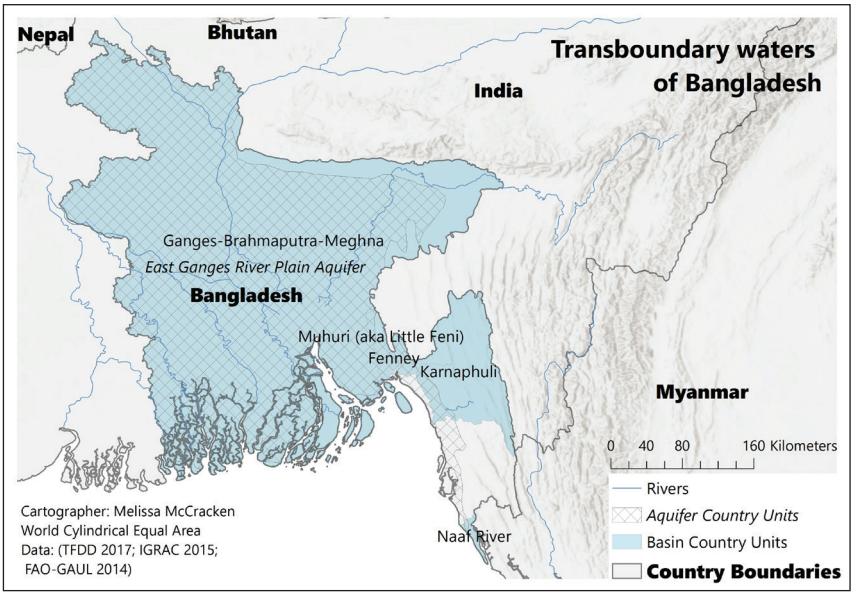


Figure 2: Transboundary basin and aquifer country units in Bangladesh

Box 2: Bangladesh: overview of transboundary cooperation
By: Emilinah Namaganda and Melissa McCracken

As a country with such a significant proportion and dependence on transboundary waters, Bangladesh has a relatively longstanding history of cooperation and disagreement over sharing and managing these waters. This Box provides a brief overview of some of the transboundary cooperative arrangements that are in place, or were previously in place, over Bangladesh's shared waters.

The recent origin of conflict and cooperation over the Ganges River began with the construction of the Farakka Barrage (Rahaman, 2006). Through negotiations in the 1960s and 1970s, the Indo-Bangladesh Joint Rivers Commission (JRC) was established to monitor successive India-Bangladesh agreements on sharing the Ganges (Hossain, 1998). In November 1972, a statute was signed by India and Bangladesh formalising the commission and establishing its function; the JRC liaises between the two countries to ensure joint utilisation and management of the shared river systems, with a particular focus on joint formulation of flood control works and technical assessments (Statute of the Indo-Bangladesh Join Rivers Commission, 1972). This commission is the only formal institution for dealing with transboundary water issues, but is limited in scope.

Following several MOUs and interim agreements, the two countries signed the first Ganges Water Agreement in 1977, which allocated shared water at Farakka and worked towards augmenting flows (Hossain, 1998; Rahaman, 2006; Sood and Mathukumalli, 2011). This agreement expired after five years; several additional MOUs were signed, in 1983, 1984, and 1986, for sharing the dry season flows. In 1996, a long term – thirty year – agreement was signed for sharing the Ganges, known as the Ganges Water Sharing

Treaty (Sood and Mathukumalli, 2011). This document is very similar to the 1977 agreement with regard to the allocation of flows at Farraka between 1 January and 31 May, but removes the discussion of flow augmentation that was included in the 1977 agreement (Nishat and Faisal, 2000). For augmentation to occur, the two countries would need to cooperate with other riparians, particularly Nepal, but no mechanism for addressing other riparians to find a sustainable solution to integrated management of the basin is specified in the treaty. The 1996 agreement includes several of the general principles of international law including those of equity and no significant harm, while also addressing mechanisms for dispute resolution (Hossain, 1998; Rahaman, 2006).

Of the many transboundary tributaries in the Ganges-Brahmaputra-Meghna River Basin, only one has significant cooperative efforts. The Teesta River that begins in the northeast of India is the fourth largest transboundary river in Bangladesh. Negotiations for a water-sharing agreement had been ongoing and a draft interim agreement was developed in 2011, which would have divided the dry season flow between India and Bangladesh (Mirchandani, 2016; Suryanarayanan, 2010). However, political factors intervened and the agreement was not signed. Despite renewed hope following elections in 2014, the agreement remains unsigned and unimplemented (Mirchandani, 2016). In addition to the Teesta River, the 1985 MOU, and the 1986 Summary Record of Discussion of the First Meeting of the Joint Committee of Experts between India and Bangladesh, there has been proposed cooperation to study and share all transboundary waters to mutual benefit; whether this study was completed and sharing of other waters was/is occurring is not apparent.

The National Water Policy of Bangladesh of 1999 emphasises collaboration with riparians on relevant aspects of the management of transboundary water resources, including groundwater (Zahid and Ahmed, 2006). Currently, there is no concrete cooperation between Bangladesh and other riparians on shared aquifers.

Honduras: Honduras's water resources differ greatly from those of Bangladesh and Uganda. The topography of Honduras creates several small transboundary watersheds; only 20 percent of the country's land area contributes water run off to shared surface water systems (TFDD, 2016). There are six transboundary river basins (Figure 3): Choluteca, Coco/Segovia, Goascorán, Lempa, Motagua, and Negro (TFDD, 2016). Catchments in Honduras can be divided into two regions; those draining to the Atlantic Ocean and those draining to the Pacific Ocean. More land drains to the Atlantic than to the Pacific. The watersheds draining to the Atlantic contribute a greater proportion of the total surface water flow of Honduras than watersheds draining to the Pacific (FAO, 2015a). Groundwater aquifers in Honduras are have not been extensively mapped; most delineations are based on geological formations (GWP Central America, 2015). There are

five identified transboundary aquifers: Esquipulas-Ocotepeque-Citalá, Estero Real-Río Negro, Chiquimula-Copán Ruinas, Ostua-Metapán, and Delta del Río Motagua (IGRAC and UNESCO-IHP, 2015). Aquifers in the Atlantic coastal areas tend to have higher yields; in the highland areas, where groundwater is an important resource for irrigated agriculture, groundwater levels are declining (FAO, 2015a).

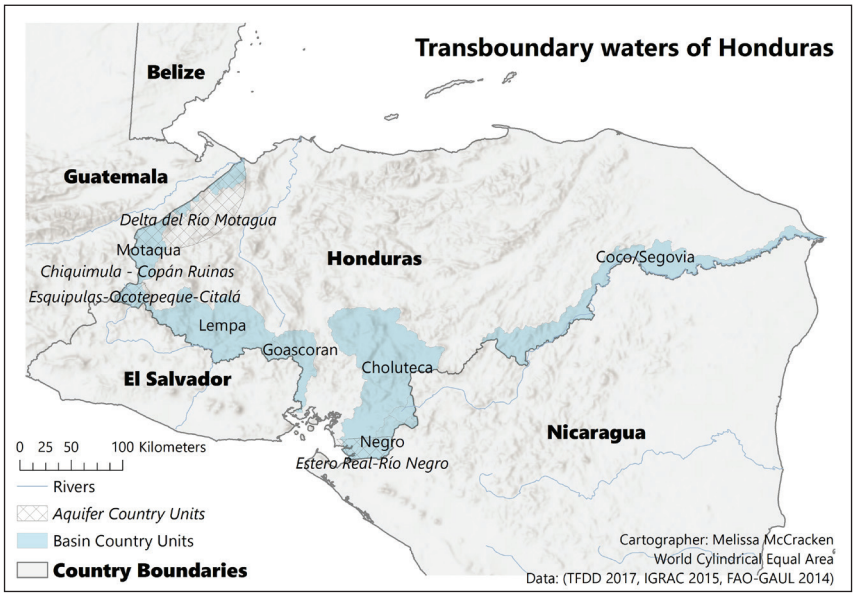


Figure 3: Transboundary basin and aquifer country units in Honduras

Box 3: Honduras: overview of transboundary cooperation

The extent of transboundary water in Honduras differs from the extent in Bangladesh and Uganda: there are a greater number of transboundary aquifers and basins but they account for a smaller proportion of the country's land area. The geographic context may be a factor contributing to the limited history of transboundary cooperation over shared waters between Honduras and its neighbouring riparians. This Box provides a brief overview of the cooperative arrangements that are in place.

Of the Central American countries, only three have national water laws; Honduras has recently updated its national water law. The 2009 National Water Law establishes a framework of principles and objectives for the management of water resources, and includes IWRM principles (GWP, 2016a; GWP Central America, 2015). However, this law does not address the need to cooperate on transboundary surface waters or groundwaters, such as recommending the development of agreements; it does mandate that a representative of the national government should be included in basin councils and transboundary management organisations (GWP Central America, 2015; Republica de Honduras, 2009).

The only transboundary area with a formal institutional framework is the Upper Lempa River Basin, which is managed through the Trifinio Plan (UNEP, 2007). The Trifinio Plan developed out of efforts for conservation in the 1970s. In 1987, Guatemala, El Salvador, and Honduras developed an updated phase of the Trifinio Plan that included the management and sustainable development of the Motagua, Ulua, and Lempa rivers; however, all but the Lempa River were dropped from the plan (López, 2004). In 1997, the three countries signed a treaty for the execution of the Trifinio Plan, which established the Tri-National Commission whose role is to administer the plan (López, 2004; UNEP, 2007). The plan's main focus is on rural development in general and it does not contain provisions for the direct management of the Lempa River (GWP, 2016a). The scope of the plan has not prevented civil society organisations and local authorities from establishing plans and activities that address transboundary and integrated water resources management (GWP, 2016a). For example, the Mancomunidad Trinacional Fronteriza Río Lempa is a local entity that was developed to fill gaps in the Trifinio Plan and the Tri-National Commission's strategy. It has established its own shared waters policy for transboundary cooperation (Mancomunidad Trinacional Fronteriza Río Lempa, 2016).

The other river basins do not have any formal cooperation. In 2006, the Binational Management Group for the Goascorán Basin was established; the group drafted a Binational Management Plan for the basin (GWP, 2016a; MacQuarrie et al., 2013). The group only included local governments and civil society. The Binational Management Group was resurrected in 2011 through support from the International Union for the Conservation of Nature (IUCN) Bridge Project (MacQuarrie et al., 2013; Medina, 2014). In the Coco/Segovia Basin, UNEP and the UN Office for Project Services (UNOPS) partnered with local organisations and municipalities in both Honduras and Nicaragua to build watershed management capacity. The project, beginning in 2009, established water management plans for the sub and micro basins in the middle and upper Coco/Segovia Basin (UNOPS, 2012; Baca et al., 2012a; Baca et al., 2012b). Neither basin has a specific agreement for cooperative management; this lack of involvement of state actors could be an obstacle for continued success of the cooperative efforts and could create a reliance on international donors (Medina, 2014).

Transboundary cooperation is not occurring in shared aquifers. The Trifinio Plan does not mention groundwaters; however, donor projects on aquifers have been completed and recommend that groundwater be included in basin management plans that exist at the local and regional levels (Buch and Guevara, 2010).

Uganda: Like Bangladesh, Uganda is dependent on transboundary waters, given that all the country's land area is within a transboundary river basin. The tributaries and lakes within the Nile River Basin comprise most of the transboundary surface waters; the catchment area that drains to the Lotagipi Swamp and Lake Turkana are the two other transboundary surface waters

(TFDD, 2016). Uganda is a landlocked country that is both upstream (to South Sudan, Sudan, and Egypt) and downstream (to Burundi, Democratic Republic of the Congo (DRC), Kenya, Tanzania, and Rwanda). In terms of groundwater, studies are still ongoing to map groundwater resources, but most of the productive aquifers are found in weathered bedrock or in volcanic formations in mountainous areas (FAO. 2015b). Three transboundary aquifers have been mapped: Mount Elgon Aquifer, Kagera Aquifer, and the Aquifere du Rift (IGRAC and UNESCO-IHP, 2015). Uganda generally is well endowed in terms of water resources when compared to its needs, with withdrawals in 2008 only reaching a little over one percent of the total annual renewable water resources (FAO, 2015b; Nsubuga et al., 2014). However, the country is heavily dependent on rainfall; therefore, the variability in spatial and temporal distribution of precipitation has significant impacts on water availability and stress (Nsubuga et al., 2014; Kilimani, 2013). Groundwater is a primary source of water supply in rural and arid areas, and generally extraction rates are less than recharge rates (Kilimani, 2013). However, water levels – both surface- and groundwater – have been declining in the sub-catchments of the Ruizi River, Lake Wamala, and Lake Victoria (DWRM, 2011).

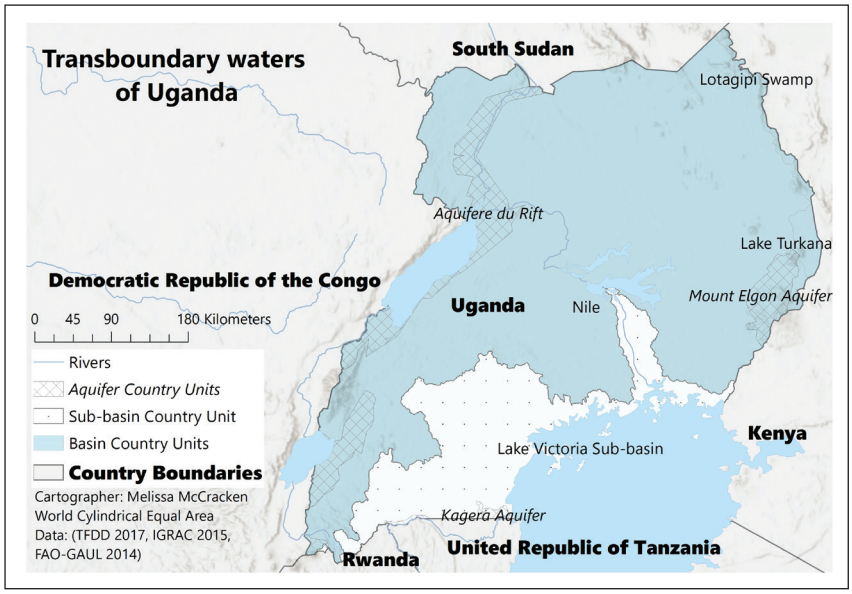


Figure 4: Transboundary basin and aquifer country units of Uganda

Box 4: Uganda: overview of transboundary cooperation

By: Emilinah Namaganda and Melissa McCracken

Uganda, where almost all water resources are transboundary, occupies a unique position as both an upstream and downstream riparian in the Nile River system; the equatorial lakes are a key component of the Upper Nile, which are all located in or shared with Uganda (UN-Water, 2006; MWE, 2013). This Box provides an overview of some of the transboundary cooperative arrangements on waters shared with Uganda.

There have been numerous arrangements signed for sharing Nile waters, both pre- and post-independence. In 1929, Egypt and the British Government, on behalf of Sudan and East African riparians including Uganda, signed the Nile Waters Agreement with the purpose of protecting the interests of Egypt based on 'natural and historic' rights (Kasimbazi, 2015; Paisley and Henshaw, 2013). This agreement gave Egypt overwhelming rights compared to Sudan and the other East African countries. Further, without a specific timeframe, the countries are bound by the agreement; post-independence they could not renegotiate their positions (Kasimbazi, 2015). Uganda, as well as Kenya and Tanzania, in accordance with the Nyerere doctrine on state succession, does not consider itself bound to the 1929 Agreement because it was made prior to independence (Kasimbazi, 2015).

The British Government also signed the 1950 Agreement for the Cooperation between the United Kingdom and Egypt. This agreement established cooperation in meteorological and hydrological surveys (Kasimbazi, 2015; Kasimbazi, 2010). These two agreements, as well as several others signed by Great Britain on behalf of Uganda, do not acknowledge Uganda's right to use the shared waters (Kasimbazi, 2015). The 1959 agreement for full utilisation of the Nile waters was signed between the independent states of Egypt and Sudan. This agreement differs from the 1929 agreement, in that it presumes 'full' use for the two countries. It excludes the other riparians, while reinforcing the dominant positions of Egypt and Sudan over the other riparians should they claim a share of the Nile waters (Kasimbazi, 2010). Therefore, Uganda and other upper riparians are in contention with the pre-independence agreements, highlighting the need for a new cooperative arrangement among all the Nile riparians that recognises the upper riparians' rights, as well as their evolving socio-economic situations.

Post-independence, Uganda signed the Agreement for the Hydrometeorological Survey of Lakes Victoria, Kyoga, and Albert in 1967, which was to evaluate the water balance of the lakes with respect to the flow regime in the Nile (Kasimbazi, 2015). This project failed due to political disinterest and expired in 1992, but was replaced by the Technical Cooperation Committee for the Promotion of Development and Environmental Protection of the Nile Basin (TECCONILE) Agreement. This was intended as a transitional arrangement that aimed to contribute to the development of the Nile Basin in an integrated manner (Paisley and Henshaw, 2013). It was replaced in March 1999 with the Nile Basin Initiative (NBI), which was also established as a transitional arrangement for sustainable management of the Nile Basin with the objective of establishing a cooperative framework that would include all riparians (Salman, 2013; Wolf and Newton, 2007). The NBI is important as it represents the first time all Nile Basin countries cooperated for development

and management of the Nile. Principle 15 of the NBI even declares all existing agreements inconsistent with the NBI framework null and void, a doctrine Egypt and Sudan do not agree with (Kasimbazi, 2015). While the NBI remains the institutional body on the Nile, the Cooperative Framework Arrangement (CFA) was signed in 2010 by Uganda, Tanzania, Rwanda, Kenya, Burundi, and Ethiopia; Egypt, the DRC, South Sudan, and Sudan are yet to sign the agreement. Egypt and Sudan want a provision included in the agreement that states that the water security and current uses and rights of any other Nile Basin riparian would not be adversely affected (Salman, 2013). As expected, the upper riparian states reject this proposal in that it is inconsistent with the goals and vision of the NBI. It is unclear how this will be resolved, given that Egypt and Sudan are party to the NBI, but not signatories to the CFA.

Transboundary cooperation in the Nile Basin also occurs at the sub-basin level. In 1999, the Treaty for the Establishment of the East African Community was signed between Uganda, Kenya, and Tanzania (Rwanda and Burundi acceded later); the treaty aims to promote sustainable growth and equitable development while protecting the environment (EAC, 2000). According to Kasimbazi (2015), the East African Community (EAC) is possibly the most comprehensive regionally-binding basis for developing joint strategies for the integrated management of water resources of Lake Victoria. Under the EAC, Uganda, Kenya, and Tanzania signed the Protocol for Sustainable Development of Lake Victoria Basin of 2003 (Kasimbazi, 2015). This protocol promotes cooperation among the lake's riparians, while preventing significant harm to the other Nile Basin states; it forms the basis for the Lake Victoria Basin Commission, which is responsible for sustainable use and management of the sub-basin.

The two other international basins not connected to the Nile River system – the Lake Turkana Basin and the Lotagipi Swamp – do not have cooperative arrangements with respect to Uganda. In the Lake Turkana Basin, UNEP, Kenya, and Ethiopia have been calling for joint management of the basin and the formulation of a bilateral agreement (Nanni, 2016); however, Uganda contributes very minimally to the basin and is unlikely to be involved.

Transboundary groundwaters are only tangentially addressed in aquifers underlying the Nile River; this is through the CFA and some projects funded through the NBI and donor agencies. It is unclear if any formal cooperation or joint management is occurring on these aquifers and those not hydrologically connected to the Nile River.

Conceptualising the indicator

SDG Indicator 6.5.2 shows the percentage of a transboundary basin area that has an operational arrangement that meets specific criteria. While this percentage may seem straightforward, in using this indicator, it may be helpful to understand what exactly the indicator's value represents and how

minor variations in the methodology can drastically alter the perceived level of cooperation between different countries. Superficially, it is understood that the higher the percentage the greater the proportion of the transboundary area covered by water cooperation. Measuring the proportion of the transboundary area covered by water cooperation is valuable for comparison as it normalises the differences in area between states. In addition, this value provides states with a simple value that summarises progress towards further cooperation, as monitoring tracks changes through to 2030. However, to be more useful at the national level, it is important to consider the percentage in the country-specific context; the extent of the country land area that is part of a transboundary basin or aquifer may alter the relative importance of changes in the proportion of transboundary area that has cooperation. For example, increases in the indicator over time may be more important to a country that has a larger percentage of its country area within a transboundary basin or aquifer, than to a country with very little country area that is transboundary. Similarly, increases in transboundary cooperation within a basin or aquifer in which a significant amount of a country's population resides may be considered a greater gain than cooperative increases in a remote basin or aquifer within which few people live. Table 1 presents the total area of each country and the percentage of each country that is within a transboundary river basin and/or aquifer. In addition, the table shows the population that is dependent on transboundary waters as a percentage of the total population. Bangladesh and Uganda are significantly more dependent on transboundary rivers than Honduras, both in terms of area and population. However, given its hydrogeology, Bangladesh has a larger area and population depending on a transboundary aquifer. The data and the discussion illustrate that small improvements in the extent of transboundary cooperation over the course of the 2030 Agenda, for example on Bangladesh's transboundary aquifers, maybe more beneficial and impactful than large changes in the extent of cooperation on Honduras's transboundary aquifers.

Country	Total country area (km^2)	Total area in TB river basins[17] (%)	Total area in TB aquifers[18] (%)	Total population[19]	Population residing in TB river basins (%)	Population residing above TB aquifers (%)
Bangladesh	138,820	94	78	160,554,305	96	89
Honduras	112,743	20	5	8,228,544	31	6
Uganda	241,495	100	9	34,574,951	100	7

Table 1: Transboundary area and population for Bangladesh, Honduras, and Uganda

[17] Transboundary river basin area calculated from TFDD (TFDD, 2016; Wolf et al., forthcoming).
[18] Transboundary aquifer area calculated from IGRAC (IGRAC and UNESCO-IHP, 2015).
[19] Population calculated from Landscan 2012 data.

SDG Indicator 6.5.2 is the percentage of the transboundary area with an operational arrangement; the most basic interpretation of operational arrangement is whether an agreement exists or not for the transboundary basin and/or aquifer. This interpretation stems from research, as discussed in the earlier sections, that illustrates that adequate institutional capacity is needed to adapt and respond to changes (Wolf et al., 2003b). Treaties, as a form of institutional capacity, increase the potential for future water cooperation (Brochmann, 2012). Therefore, to demonstrate the calculation of the indicator and to compare the three methods presented in the following sections, Table 2 details the basic interpretation of SDG Indicator 6.5.2. In this basic interpretation, operational arrangements are strictly whether an agreement – a bilateral or multilateral formal legal instrument, such as a treaty, amendment or protocol, between riparian countries regarding transboundary waters – exists for the transboundary river basin or aquifer area.

To calculate the SDG Indicator 6.5.2 using this basic understanding of operational arrangement, we have identified the transboundary river basin areas that have a current agreement and the transboundary aquifers that have a current agreement. For this calculation, we do not count an area as having an agreement if, for example, the agreement is no longer valid or applicable. For consistency in comparing the methods, global datasets are used to delineate transboundary river basins – the Transboundary Freshwater Dispute Database – and transboundary aquifers – International Groundwater Resources Assessment Centre[20]. As may be apparent from the introduction of the case studies and the maps of their transboundary areas, there is potential for areas of transboundary river basins and aquifers to overlap. The results of the indicator are intended to be a single value where the river basin and aquifer's proportional area has been aggregated. To aggregate, the total transboundary area is the sum of the areas of both the basin country units and aquifer country units. Because of this summation, the transboundary area has the potential to exceed the area of the country; however, as the indicator is a proportion, the highest possible value is 100 percent (UN-Water, 2016b). The aggregated value may be useful for global comparison, but individual countries may find that separate values for river basins and aquifers are more reflective of the state of transboundary cooperation and give more indication of where efforts to improve cooperation should be applied.

Table 2 presents the proportion of transboundary areas within Bangladesh, Honduras, and Uganda for which a formal agreement exists, using the basic interpretation. The last column reflects the aggregated data; as can be seen,

[20] These datasets were used for calculating areas in World Cylindrical Equal Area Projection.

there are significant differences in values between the countries. Uganda has the greatest extent of transboundary area with an agreement. The Agreement on the Nile River Basin Cooperative Framework (CFA) (2010) covers the Nile Basin in Uganda and includes hydrologically connected groundwaters in its definition of what is included in the Nile River system. This single agreement accounts for the high percentage coverage, since the Nile River Basin and connected transboundary aquifers are all part of the Nile River system and subject to the CFA. Comparatively, in Bangladesh, the 1996 Ganges Waters Treaty also covers most of the transboundary basin area within Bangladesh. Because of this agreement[21], Bangladesh's result for the percentage transboundary basin area with an agreement (Column 2, Table 2) is very similar in magnitude to the result for Uganda, as like the Nile Basin in Uganda, the Ganges Basin constitutes the majority of the nation state's area. This similarity is masked if only the aggregated value – based on the total transboundary area – is considered. By considering the disaggregated data, we can identify the very similar values for the two countries and analyse whether these values reflect equivalent forms of transboundary cooperation.

Country	TB basin area with an existing agreement (%)	TB aquifer area with an existing agreement[22] (%)	Total TB area with an existing agreement(%)
Bangladesh	90	0	49
Honduras	32	0	26
Uganda	98	83	97

Table 2: Proportion of transboundary area with an existing agreement for Bangladesh, Honduras, and Uganda (%)

Having an agreement exist for shared waters may help to indicate the predilection for future cooperation; however, as shown by comparing the results, the quality and degree of transboundary cooperation is not exposed by this simplistic interpretation. Furthermore, this simplified interpretation of the indicator lacks the ability to capture whether the agreement is functioning and effective, which could lead to the inclusion of 'paper tigers' – or agreements that have been signed but not implemented. This interpretation also fails to capture cooperation that exists without a formal agreement. For example, the Goascorán Basin in Honduras has a functioning river basin organisation, but no treaty exists between Honduras and its co-riparians. Therefore, we see through this initial example the need for including operational arrangement in SDG Indicator 6.5.2.

[21] For both Uganda and Bangladesh, there are additional agreements that exist in the transboundary area.

[22] This also includes aquifers that are included in agreements on overlying river basins, i.e. those attempting to manage surface water and hydrologically connected groundwater conjunctively. This is recommended by the UNECE Model Provisions on Transboundary Groundwaters (UNECE, 2014).

By defining ***operational***, we can attempt to capture a more qualified picture of the extent of transboundary cooperation. The following chapter presents the three alternatives ways in which ***operational*** can be defined, beginning with the proposed methodology for SDG Indicator 6.5.2.

5 CALCULATING SDG INDICATOR 6.5.2: DEFINING OPERATIONAL

Method 1: Draft methodology for SDG Indicator 6.5.2

The first method presented in this paper is the proposed method for SDG Indicator 6.5.2 that has been submitted to the Inter-Agency and Expert Group on Sustainable Development Goal Indicators for review. Currently, UN Statistics has ranked SDG 6.5.2 as a Tier III indicator, meaning that the established methodology and standards are being developed and tested (IAEG-SDG, 2016). Under the UN-Water Global Environmental Management Initiative (GEMI), this methodology is being developed by the Working Group on Integrated Water Resources Management, which has members from several UN agencies and other organisations and is being coordinated by UNECE and UNESCO-IHP (UN Statistics, 2016b). To identify the "proportion of the transboundary basin area with an operational arrangement for water cooperation" UN-Water has released a draft *Step-by-Step Monitoring Methodology for Indicator 6.5.2*. This is the methodology described as Method 1 in this paper[23]. The three methods will be described briefly here[24].

As discussed in the common terminology section, how operational is defined varies between Methods 1, 2, and 3. If a cooperative arrangement is found to exist for a basin or aquifer, it must meet the following criteria in order to be deemed operational (UN-Water, 2016b, p.3):

- There is a joint body, joint mechanism or commission (e.g. a river basin commission) for transboundary cooperation.
- There are regular formal communications between riparian countries in [the] form of meetings.
- There is a joint or coordinated water management plan(s), or joint objectives have been set.
- There is regular exchange of data and information."

These criteria for an arrangement to be considered operational are based on the principles of international law that are codified in the UN Watercourse

[23] Method 1 in this paper deviates from the proposed method for SDG Indicator 6.5.2 that has been developed, in that it uses global datasets for the delineations of transboundary rivers and aquifers. This is to allow comparison between the results of the three methods discussed in this paper.
[24] For more detail, the methodology document can be found here: http://www.unwater.org/publications/publications-detail/en/c/428764/.

Convention, UNECE Water Convention, and the draft Law of Transboundary Aquifers (UN Statistics, 2016b). All the above criteria must be met for the surface area to count towards the indicator calculation; these do not have to be specified in the arrangement or agreement, but they must be occurring (UN-Water, 2016b).

To determine if an arrangement meets these criteria, data have been proposed to be collected from countries through the reporting mechanism under the UNECE Water Convention. The reporting questionnaire for the implementation of the UNECE Water Convention also will collect data to track the progress towards transboundary cooperation in the SDGs when it is sent to responsible national authorities (Working Group on Integrated Water Resources Management, 2016; UN Statistics, 2016b). This questionnaire[25] was sent to appropriate contacts within the GWP Network in each of the three countries. Given the scope of the study, the questionnaire was only sent to in-country representatives; therefore, the responses were not calibrated with the responses from co-riparians to the shared waters. Data from this survey[26], in addition to available literature and global datasets, including the International Freshwater Treaties and River Basin Organization Databases at Oregon State University[27], were used to determine the operationality of the identified cooperative arrangements[28].

The steps taken to calculate the indicator, in both aggregated and disaggregated form, were as follows:

1. Identify transboundary river basins and transboundary aquifers, and determine the associated basin country units (BCUs) and aquifer country units (ACUs).
2. Identify the basins and aquifers that have a cooperative arrangement.
3. Determine if the arrangements meet all the criteria to be considered operational.
4. Sum the BCUs with operational arrangements and divide by the total transboundary BCU area to obtain the disaggregated proportion of transboundary river basins that have transboundary cooperation.

[25] The template for the questionnaire was presented at the 11th Meeting of the Working Group on Integrated Water Resources Management 18–19 October 2016 in Geneva. It can be found here: http://www.unece.org/fileadmin/DAM/env/documents/2016/wat/10Oct_18-19WGIWRM/WG.1_2016_INF5_reporting.pdf

[26] Survey responses were only received from Bangladesh and Honduras. Evaluation of Uganda's transboundary cooperation only used the results of secondary research and available literature.

[27] The International Freshwater Treaties Database and the International River Organization Database are available as part of the Transboundary Freshwater Dispute Database at: http://www.transboundarywaters.orst.edu/.

[28] Consistency in responses to the questionnaires varied, therefore additional research was used to supplement survey responses to determine if cooperative arrangements meet required criteria.

5. Sum the ACUs with operational arrangements and divide by the total transboundary ACU area to obtain the disaggregated proportion of transboundary aquifers that have transboundary cooperation.
6. For the indicator, sum the BCU and ACU areas with operational arrangements and divide by the total area of all the BCUs and ACUs in the country.
7. For the three case study countries, using the results of the survey, additional literature, and the methodology outlined above, the results were as follows:

Country	Transboundary river basin area with an operational arrangement (%)	Transboundary aquifer area with an operational arrangement (%)	Total transboundary area with an operational arrangement (%)
Bangladesh	0	0	0
Honduras	0	0	0
Uganda[29]	98	0	90

Table 3: Results for SDG Indicator 6.5.2 using Method 1: draft methodology

Discussion of results for Method 1

Table 3 displays the results of the Method 1 calculations for SDG Indicator 6.5.2. Displayed in the table is the indicator at the national level in both aggregated and disaggregated form. Columns two and three present the indicator calculated for the transboundary river basin area and transboundary aquifer area separately. Column three presents the aggregated indicator for the total transboundary area per country. As is shown, both Bangladesh and Honduras have no ongoing operational cooperative arrangements, either for transboundary river basins or aquifers. The only area that was calculated as having an operational cooperative arrangement was the transboundary river basin area in Uganda, which contributes to the 90 percent of the total transboundary area in Uganda that has an operational cooperative arrangement.

The zero percent indicator values for Bangladesh and Honduras identify that there is no *operational* cooperation occurring in either country, but it also implies that there is no *cooperation* occurring, which is not the case. The structure of the indicator in this method is categorical; to be operational, a cooperative arrangement must meet all the criteria – there is either cooperation or there is not. The binary nature of this conceptualisation of operational cooperative arrangements overlooks transboundary cooperation that is occurring without meeting all the criteria. For example, in Bangladesh's BCU for the Ganges-Brahmaputra-Meghna River Basin

[29] Evaluation was only based on secondary research, as a survey response was not received.

only one criterion was not met[30], causing the area not to contribute to the SDG indicator calculation. Similarly, the area for the Upper Lempa River in Honduras does not contribute to the indicator, because it lacks formal data and information exchange regarding the shared water resources through the Trifinio Plan and Tri-National Commission. The Draft Step-by-Step Monitoring Methodology for Indicator 6.5.2 attempts to address this issue by stating, "the operationality of cooperation is more dynamic as it evolves with the expansion of cooperation. The operationality can be expected to evolve over shorter time frames, and in a year or two, progress could potentially be observed" (UN-Water, 2016b). However, unless each criterion is satisfied, progress will not be demonstrated in short-term monitoring of the indicator at a global scale. The binary – yes or no – nature of the definition of operational will mask any stepwise progress when the data are reported.

In the calculations for Method 1, we make an assumption regarding the participation of riparians in cooperative arrangements in basins or aquifers that are multilateral. The *Draft Step-by-Step Monitoring Methodology for Indicator 6.5.2* states, "In situations where more than two riparian countries share a basin, but only some of them have operational cooperation arrangements, the indicator value may mask the gap that a riparian country does not have cooperation arrangements with both its upstream and downstream neighbours." (UN-Water, 2016b). What is unclear in the methodology is whether all riparians must be participating in the cooperative arrangement or a specific criterion for the requirements for operational to be satisfied. Therefore, we focused the evaluation of the cooperative arrangement on the specific BCU or ACU. If a criterion existed in the BCU or ACU of interest, then it counted towards meeting the requirements for an operational cooperative arrangement, whether or not all riparians to the multilateral basin or aquifer were included. For example, the Indo-Bangladesh JRC and the Joint Committee satisfied the requirement for a joint body, joint mechanism, or commission for transboundary cooperation within the Ganges-Brahmaputra-Meghna River Basin because they exist within the BCU in Bangladesh, even though only two riparians – India and Bangladesh – of the five are included in the institutions. While the exclusion of riparians may not be ideal, it is important to recognise cooperative efforts that are occurring in multilateral basins or aquifers, as multilateral arrangements may be unattainable given political or other context-specific situations. Looking only at the aggregated country-level data, however, misses the entire picture of cooperation in a basin or aquifer. Comparing disaggregated data for BCUs/

[30] The Ganges-Brahmaputra-Meghna BCU in Bangladesh has a cooperative arrangement, several joint institutions and committees, and has some data and information exchange related to specific issues, but there is no coordinated management plan or joint objectives for the basin.

ACUs within a single basin or aquifer or aggregating data within a basin captures an alternative picture of transboundary cooperation in multilateral basins that is overlooked with country-level data (UN-Water, 2016b).

The final point of discussion for Method 1 is the emphasis in the definition of operational on procedural criteria: a cooperative arrangement, joint body, formal communication, joint water management plan, and data and information exchange. These operational requirements are normative, or they dictate how best to approach transboundary water cooperation. This prescriptive focus on process has the potential to limit adaptation and creativity in cooperative efforts that reflect unique context and place-based specifics. Water governance and transboundary cooperative efforts should allow for context and the socio-political environment that each basin or aquifer is located in (Giordano and Shah, 2014; Jensen, 2013). Flexibility is needed in cooperative agreements so that they are able to respond to changing conditions in the basin or aquifer (McCaffrey, 2003). For example, in Saruchera and Lautze's (2015) review of transboundary water cooperation indicators, they recommend against the inclusion of requiring the establishment of a river basin organisation, as that may encourage a particular type of institutional cooperation that may not be applicable in all contexts. The Columbia River Basin, which is a well-studied and referenced example of positive transboundary cooperation, does not have an established river basin organisation and would not be considered as having an operational cooperative arrangement under Method 1. Furthermore, the focus on specific procedural criteria may overlook or devalue alternative cooperative efforts that do not 'check all the boxes'. For example, the Goascorán River Basin in Honduras was found to not have an operational transboundary cooperative arrangement using this method. The basin, however, has an alternative cooperative effort in the Binational Management Group[31], which is a multi-level effort that includes local and regional entities as well as members from the public and private sectors. The effort does not have a formal arrangement between Honduras and El Salvador nor does the organisation have support from state actors, which creates a reliance on international donors (Fundación Hondureña de Ambiente y Desarrollo VIDA, 2008; MacQuarrie et al., 2013; Medina, 2014). Despite this, the cooperative effort is progressing within the political reality and should not be discounted within the scope of the SDG Indicator 6.5.2. Overall, this method presents a good starting place for measuring transboundary cooperation within the constraints of

[31] The Binational Management Group was originally founded in 2006; it went dormant from limited funds and was regenerated through the help of the IUCN BRIDGE Program in 2011 (MacQuarrie et al., 2013; Medina, 2014).

what is feasible for the SDGs and global monitoring efforts. However, users of the results calculated by Method 1 should recognise the limitations of a normative procedural framework for transboundary cooperation that does not have the flexibility to capture different contexts, places, socio-political situations, or alternative methods of transboundary cooperation.

Method 2: Flexibility in levels of operational cooperation

The second method presents a slight variation from Method 1 – the proposed methodology for SDG Indicator 6.5.2. Method 2 is based on a recommendation put forward by Sindico in *Transboundary Water Cooperation and the Sustainable Development Goals,* a UNESCO-IHP Advocacy Paper. The paper recommends an alteration to the definition of the indicator that was presented in a UN Statistics document. This document stated, "Regular meetings of the riparian countries to discuss IWRM and for the exchange of information are required for an arrangement to be defined as 'operational'." (UN Statistics, 2016a). Sindico recommends an alteration in that an agreement be considered operational if there are, "regular meetings of the riparian countries to discuss IWRM and/or exchange information." (Sindico 2016). While this older definition of operational is not consistent with the current criteria that an arrangement is required to fulfil to be operational, the minor difference between these two statements – changing 'and' to 'and/or' – helps to increase the ability of the SDG Indicator to incentivise transboundary cooperation. Requiring both discussion of IWRM and the exchange of information is a narrow interpretation of what transboundary cooperation is, which would exclude some cooperative arrangements from the indicator (Sindico, 2016).

Rather than this older conceptualisation of operational, Method 2 uses the same definition of cooperative arrangement and the same criteria for determining if an arrangement is operational as Method 1. The difference between Method 1 and Method 2 is that of 'and' and 'or'. In Method 2, all the criteria do not have to be met for a cooperative arrangement to be considered operational. For this method, if any of the criteria are met then the arrangement is considered operational and the area is included in the calculation of the SDG. There are levels of cooperation depending on the number of criteria that the arrangement meets. This method attempts to address the critique of the binary nature of Method 1. By creating levels, the SDG Indicator would help to encourage countries to move towards the goal of transboundary cooperation. The indicator would track progress towards this goal through monitoring, and could reward progress by illustrating growth and attempting to prevent loss of cooperative efforts that may already be in

place in a country. For example, a zero percent indicator value identifying a lack of cooperation in a country that meets all but one of the criteria could be discouraging and potentially have a negative impact on the current efforts. But with levels of cooperation, that country's progress could be rewarded, with the indicator serving as an incentive to meet the last criterion.

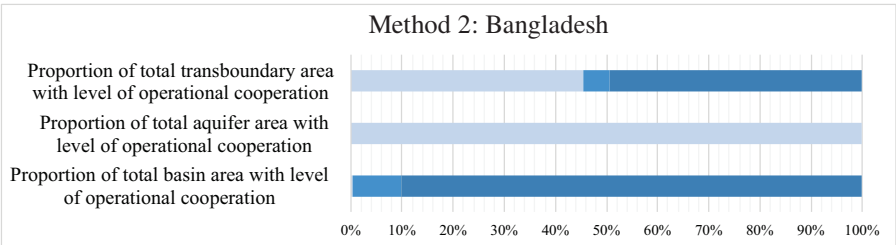
An arrangement will be considered operational, if it meets at least one of the criteria. Having a formal agreement or similar arrangement will also be included as a criterion for determining levels of operational cooperation for this method. The level of cooperation is determined by the number of criteria met, e.g. if two criteria are met then the area is within Level 2 of operational cooperation. Level 0 will be used to identify those areas that meet none of the criteria, and Level 5 represents the fulfilment of all criteria. The following are the criteria for determining the level of operational cooperative arrangements:

- existence of a formal cooperative arrangement[32] or agreement
- existence of a joint body, mechanism, or commission for transboundary cooperation
- regular meetings or formal communication
- existence of a joint management plan or objectives
- exchange of data and information.

As in Method 1, data from the UNECE Water Convention reporting survey, available literature, and information from global datasets will be used to determine which criteria are met. The steps taken to calculate the indicator are the same as the steps described in Method 1. However, instead of three results – one for the extent of transboundary basins, one for extent of transboundary aquifers, and one for the extent of total transboundary area – there will be a value for every level of operational cooperative arrangement. To calculate this, the area of the BCUs or ACUs with the same level cooperation are summed and divided by the respective total area.

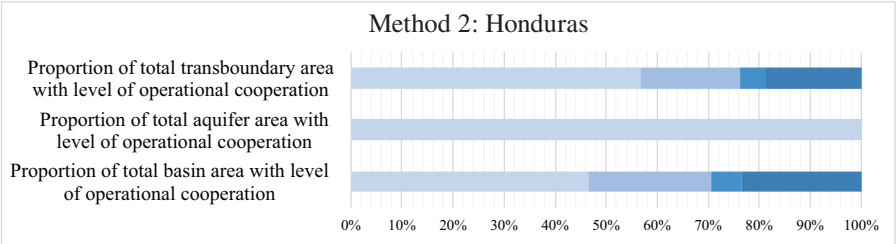
The results of Method 2 are included in the following bar charts and tables. Each chart shows the percentages of total transboundary area, transboundary river basin area, and transboundary aquifer area within a specific level of cooperation.

[32] Arrangement is defined by the same definition as in Method 1 and discussed in the common terminology section.



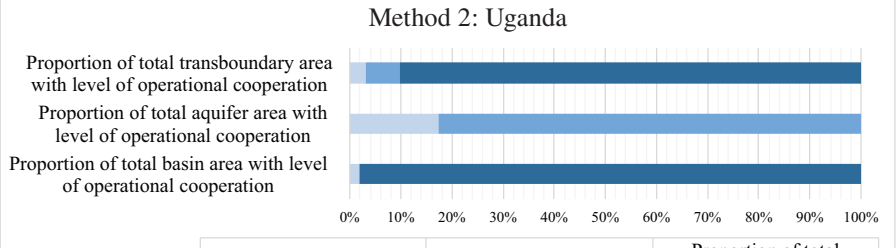
	Proportion of total basin area with level of operational cooperation	Proportion of total aquifer area with level of operational cooperation	Proportion of total transboundary area with level of operational cooperation
Operational level 0	0%	100%	45%
Operational level 1	0%	0%	0%
Operational level 2	0%	0%	0%
Operational level 3	10%	0%	5%
Operational level 4	90%	0%	49%
Operational level 5	0%	0%	0%

Figure 5: Results of Method 2 for Bangladesh



	Proportion of total basin area with level of operational cooperation	Proportion of total aquifer area with level of operational cooperation	Proportion of total transboundary area with level of operational cooperation
Operational level 0	46%	100%	57%
Operational level 1	24%	0%	19%
Operational level 2	0%	0%	0%
Operational level 3	6%	0%	5%
Operational level 4	23%	0%	19%
Operational level 5	0%	0%	0%

Figure 6: Results of Method 2 for Honduras



	Proportion of total basin area with level of operational cooperation	Proportion of total aquifer area with level of operational cooperation	Proportion of total transboundary area with level of operational cooperation
Operational level 0	2%	17%	3%
Operational level 1	0%	0%	0%
Operational level 2	0%	83%	7%
Operational level 3	0%	0%	0%
Operational level 4	0%	0%	0%
Operational level 5	98%	0%	90%

Figure 7: Results of Method 3 for Uganda

Discussion of results for Method 2

Figures 6, 7, and 8 display the results of Method 2 in two ways. The stacked bar charts present a visual representation of the proportion of basin, aquifer, and total transboundary area in the six levels of operational cooperation. The percentages are presented in associated tables. Upon initial comparison of the results of Method 1 and Method 2, it is apparent that more cooperation is occurring than is illustrated in the binary categories of Method 1. Both Honduras and Bangladesh have cooperative efforts that meet several of the criteria for operationality, but were excluded in Method 1. For example, as discussed above, the Ganges-Brahmaputra-Meghna River Basin in Bangladesh did not have operational cooperation; when evaluating using the criteria in Method 2, the area has cooperative efforts at an Operational Level 4 – meaning 54 percent of Bangladesh's transboundary area has some degree of cooperation compared to zero percent, a significant increase. Upon further inspection of the results for Bangladesh, it is apparent that only the waters shared with Myanmar do not have some level of cooperation. The Lempa River Basin in Honduras presents a similar situation for Honduras, as it also has Operational Level 4 for its cooperative efforts.

The level of cooperation also helps to better track and demonstrate transboundary cooperation that is occurring in shared aquifers. In Method 1, none of the transboundary aquifer area was found to have an operational cooperative arrangement. This result is expected as aquifers present more difficulties to cooperation given their inherent complexities (see discussion on transboundary aquifers), plus there are few examples of cooperation over shared aquifers, particularly when compared to the number of cooperative agreements that have been developed for shared surface water. However, by acknowledging lesser levels of cooperation, more cooperation over shared groundwater may be occurring than is generally thought. For example, in Uganda 83 percent of the transboundary aquifer area has cooperative efforts at an Operational Level 2. The two aquifers that contribute to this number underlie the Nile River; the Cooperative Framework Agreement specifically mentions groundwater and some projects assessing groundwater done by the Nile Basin Initiative with donor agencies have collected and shared data.

Having levels of cooperation, rather than a strict definition for operational cooperation, will give more visibility to the progress countries make towards transboundary cooperation in the international arena. Monitoring will track this progress and support the efforts countries make. Establishing a cooperative arrangement is a slow process – drafting and signing an agreement make take decades – therefore, a more nuanced means to monitor cooperation may provide more encouragement to continue the process.

Furthermore, by not requiring the fulfilment of all five criteria to be operational, Method 2 allows for some degree of acknowledgement of alternative cooperative efforts. The Goascorán River Basin, as discussed in the Method 1 section, is recognised as having an Operational Level 3 cooperative effort despite lacking an agreement between Nicaragua and Honduras, which excludes it as an operational cooperative arrangement in Method 1.

This method still has the same issues as Method 1 in that the definition of arrangement, operational, and the criteria that must be satisfied are procedural and normative. There is a greater degree of flexibility in how progress is monitored and reported, but the definitions still present a constrained view on what is appropriate transboundary cooperation given the context, place, and socio-political situation (see Method 1 for elaboration). What is lacking from both Method 1 and Method 2 is the inclusion of substantive rules as a criterion for measuring transboundary cooperation. Substantive rules establish the rights and obligations of states sharing waters, which could also apply to other actors depending on the scale and context of cooperative efforts. Perhaps customary laws, such as 'reasonable and equitable use' or 'no significant harm', should be included as criteria for operationality. This idea leads to the development of Method 3. Can the methodology for SDG Indicator 6.5.2 ensure that the transboundary cooperation that is being measured is effective if only procedural components are considered? A reframing of operational cooperative arrangements away from inputs and towards the substantive elements and the outputs of cooperation may present an alternative for measuring effective transboundary cooperation over shared waters.

Method 3: Typology of cooperation promoting effective water management

The third methodology for measuring transboundary water cooperation approaches the calculation of SDG Indicator 6.5.2 from a different perspective than Method 1 or Method 2. The current proposed indicator (Method 1) and Method 2 define an arrangement as operational based on the process of cooperation. While the regular meeting of parties, exchange of information, joint management plans, and RBOs are firmly based in international law, they are strictly procedural in nature. Good process, however, does not automatically result in cooperation and effective management of shared waters. Therefore, Method 3 aims to evaluate transboundary cooperation through a substantive lens rather than from a procedural perspective. The goal is to present an alternative understanding of how transboundary cooperation can be conceptualised and evaluated based on the outcomes of

a cooperative effort rather than strictly on the process of cooperation – or an emphasis on output cooperation over input cooperation (GWP, 2015). Furthermore, this perspective acknowledges that process is often context specific; each place, basin, aquifer, country, etc. has a unique context in which to develop integrated management that enhances cooperation and effectively manages shared waters. Therefore, this method has an alternative definition for cooperative arrangement and what constitutes 'operational'. A *cooperative arrangement*, in Method 3, is the cumulation of the cooperative efforts between riparians in a transboundary basin or aquifer. Cooperative efforts include formal agreements, organisations and other institutions, joint projects and plans, informal agreements, and organisations as well as efforts by non-state actors. The systems of cooperative efforts are then evaluated to determine if they are operational.

Operational, in Method 3, is defined as substantive cooperation that results in effective water management or an increase in water security. Operational is not determined by a set of criteria that must be met, but rather by a measure of the type of cooperation that occurs within the country basin or aquifer area; it is defined by the type of cooperation, described below, and the benefits that it produces. For the calculation, the type of operational cooperation is identified for each BCU or ACU. While the types of cooperation imply steps, countries do not need to progress through all the steps to achieve the final type of cooperation: a Continuing comprehensive cooperation. Further, depending on the context, one type of cooperation may be the most appropriate, where the final type – Continuing comprehensive cooperation – may not. For example, in a BCU that constitutes very little of the total area of the basin and contributes very little to nothing in terms of volume of water to the catchment, Non-cooperation, or Preliminary cooperation for that BCU may be a more appropriate type of cooperation than Continuing comprehensive cooperation. The types of cooperation and the focus on outcome cooperation are adapted from the GWP TEC Background Paper: *Promoting Effective Water Management Cooperation among Riparians* by D. Tarlock (GWP, 2015), and are as follows:

Non-Cooperation	Preliminary Cooperation	Issue Cooperation	Emerging Comprehensive Cooperation	Continuing Comprehensive Cooperation

- *Non-cooperation:* This type of cooperation is no cooperation. There is no formal or informal cooperative arrangement between the riparians, including agreements, RBOs, or dialogues.
- *Preliminary cooperation*: In this type of cooperation, riparians have

expressed the intent to cooperate; this cooperation, however, has not been defined either substantively or procedurally. Riparian states can, for example, sign an agreement to develop transboundary cooperation or an RBO in the future. Signing an agreement is not required in this type of cooperation; countries can verbally express intent to cooperate or be entering negotiations.

- *Issue cooperation*: A cooperative arrangement exists between riparian countries to address a specific issue(s); management or governance issues are addressed in isolation with limited efforts towards shared benefits between the riparians or other actors. Alternatively, a state could act unilaterally to prevent harm or resolve conflict with another riparian. This could include the development of a joint agreement or commission to construct infrastructure or manage floods. Issues are categorised according to areas of primary interest initially developed by Hamner and Wolf (1997) and since adapted by Wolf et al. (2003), Giordano et al. (2013), and in this paper. These issues are: water quality, water quantity, aquatic ecosystem, hydropower, navigation, fishing, flood control/relief, economic development, joint management, irrigation, infrastructure/development, technical cooperation/assistance, border issues, and territorial issues. Each of these issues are defined in the Glossary.
- *Emerging comprehensive cooperation*: Riparian countries are developing or have recently developed a cooperative arrangement that establishes a legal framework for shared management of the basin. Informal processes may also exist. Not all relevant[33] riparians may yet be included in the arrangement. The intention behind the cooperative efforts is to create shared benefits, these may not have yet come to fruition. The cooperative arrangement addresses multiple issues[34] such as quantity, quality, etc. and includes coordination mechanisms. The issues included are appropriate for the basin and transboundary management; everything related to water management does not need to be included at the international level for there to be Emerging comprehensive cooperation. Collaboration at this level between riparians is more recent; outcomes of cooperation may not yet be realised. There may not be a history of cooperation with the country of interest and surrounding riparians.
- *Continuing comprehensive cooperation*: This type of cooperation is similar to Emerging comprehensive cooperation. Riparian countries have developed a cooperative arrangement for an ongoing legal framework for shared management of the basin. Informal (non-governmental)

[33] Relevant riparians are those basin states that contribute significant area or flow, have reasonable population size living in the basin area, or a substantial impact on the basin.
[34] The same issue categories will be used as detailed in issue cooperation.

coordination may also be in place to fill gaps or supplement formal institutions. All relevant riparians are included in the cooperative efforts, although multilateral arrangements are not required provided there is basin-wide coverage through alternative cooperative efforts. States have continued to collaborate to address multiple issues related to the shared waters and solutions include shared benefits. The issues included are appropriate for the basin; not all issues must be addressed at the international level for there to be Continuing comprehensive cooperation. Outcomes of the cooperative effort are apparent. The arrangement aligns with customary law; riparians may be signatories of international conventions or have addressed the framework of international law in elements of their cooperative arrangements. Continuing comprehensive cooperation is specifically different from Emerging comprehensive cooperation in that it has been actively occurring for at least a decade; this will be identified through positive interactions that have occurred between the country of interest and its riparians. In addition, it is different from Emerging comprehensive cooperation in the extent of basin coverage and inclusion of relevant riparians, as well as the issues and mechanisms addressed by the cooperative arrangement.

We recognise that this method does not meet the needs of the UN Statistics department as it is based on qualitative data and delivers categorical rather than numerical results for the indicator. However, the intent behind the development of this method is to highlight the deficits of the procedural-based methods proposed for the SDG Indicator 6.5.2. Also, Method 3 identifies the variability needed to have successful cooperation; as each place and shared waters are unique, governance should also be context specific. Lastly, the method is developed to provide additional guidance, as a complement to the finalised SDG Indicator 6.5.2, to countries to help them gain an alternative perspective on the state of their transboundary cooperation. Basin managers have the institutional and local knowledge to place their cooperative efforts within the spectrum of cooperation. Using Method 3, they can further develop cooperative policies and actions that work towards the type of cooperation that is most appropriate to their basin.

At its current level of development, Method 3 is not yet feasible for global-scale monitoring, as it requires extensive understanding of the current transboundary situation. However, specific standardised metrics to measure the effectiveness of a cooperative arrangement should be developed, which would aid in determining what type of cooperation is occurring in a BCU or ACU; this would improve the usability and versatility of the method.

The results of the survey data, a literature review, and international databases were used to determine the category of cooperation for each ACU or BCU. The results of the indicator calculation using Method 3 are displayed spatially in maps of each country and accompanied by an explanation of the results.

Bangladesh

Types of cooperation	Total basin area* (%)	Total aquifer area (%)	Total TB area* (%)
Non-cooperation	0	100	45
Preliminary cooperation	11	0	6
Issue cooperation	88	0	49
Emerging continuing cooperation	0	0	0
Continuing comprehensive cooperation	0	0	0

*Table 4: Results for Bangladesh using Method 3. *For Method 3, the type of cooperation was determined for the sub-basin of the Teesta River. The Teesta BCU area is included in the calculations for columns two and four.*

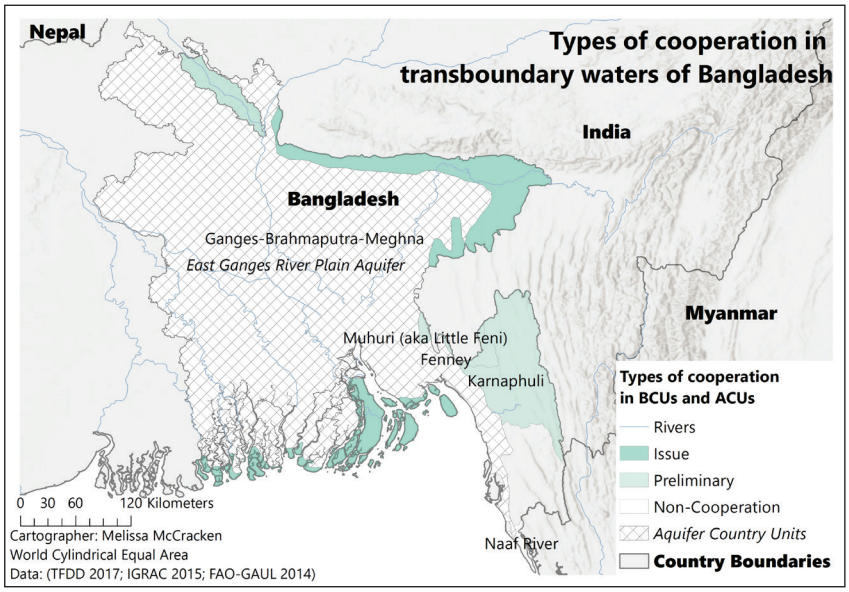


Figure 8: Types of cooperation in basin country units and aquifer country units in Bangladesh

Honduras

Types of cooperation	Total basin area (%)	Total aquifer area (%)	Total TB area (%)
Non-cooperation	46	100	57
Preliminary cooperation	24	0	19
Issue cooperation	0	0	0
Emerging Continuing cooperation	30	0	24
Continuing Comprehensive cooperation	0	0	0

Table 5: Results for Honduras using Method 3.

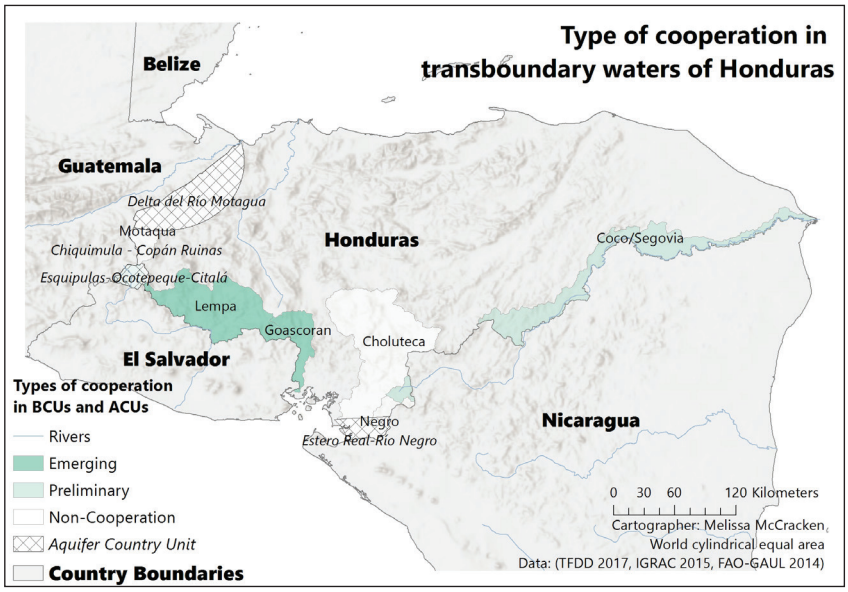


Figure 9: Types of cooperation in basin country units and aquifer country units in Honduras

Uganda

Types of cooperation	Total basin area* (%)	Total aquifer area (%)	Total TB area* (%)
Non-cooperation	1	17	2
Preliminary cooperation	0	83	5
Issue cooperation	0	0	0
Emerging continuing cooperation	77	0	72
Continuing comprehensive cooperation	21	0	20

*Table 6: Results for Uganda using Method 3. *For Method 3, the type of cooperation was determined for the sub-basin of Lake Victoria. The Lake Victoria BCU area is included in the calculations for columns two and four.*

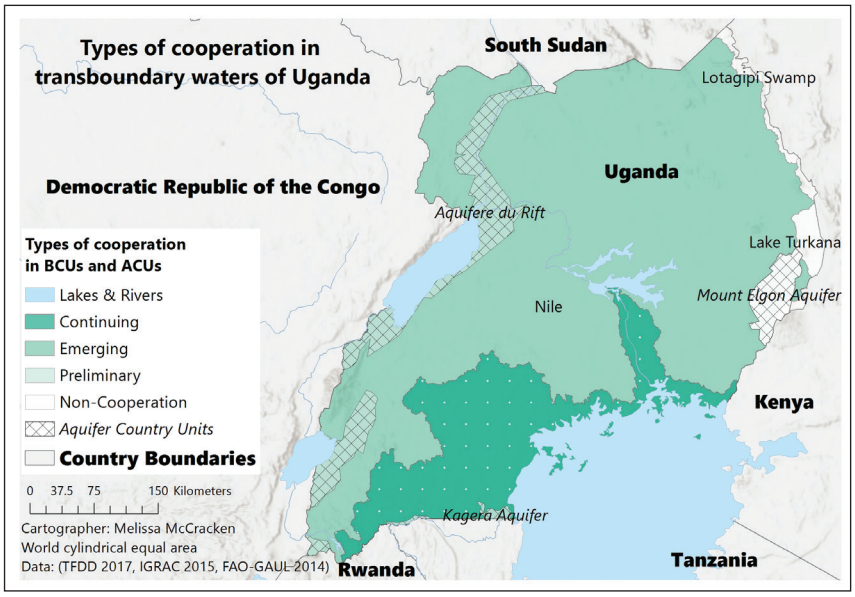


Figure 10: Types of cooperation in basin country units and aquifer country units in Uganda.

Overall discussion

Tables 4, 5, and 6 present the results for Bangladesh, Honduras, and Uganda, respectively. Overall, it is apparent that Method 3 delivers similar results to Method 2 (Figures 6, 7, and 8). Both Bangladesh and Honduras have around half of their transboundary land area in the Non-cooperation category. While this result may seem to place both states in a similar type of cooperation, it is important to recognise the impact of the area of these transboundary bodies in the calculation, in comparison with the number of basins and aquifers. Most of Bangladesh lies within the Ganges-Brahmaputra-Meghna River Basin and is underlain by the East Ganges River Plain Aquifer; the other basins make up only about 5 percent of the transboundary area. Non-cooperation in the East Ganges Plain Aquifer overshadows the cooperation that is occurring in all but one of the transboundary rivers (excluding the Ganges-Brahmaputra-Meghna) due to the magnitude of the area that weights the calculation. Honduras, in contrast, has several basins and aquifers of similar area; in half of the river basins there is Non-cooperation and in half some type of cooperation is occurring. Area in the SDG Indicator calculations weights the contributions of particularly large basins or aquifers heavily. When considering the values of the SDG Indicator 6.5.2, users should recognise this limitation, as the area of a transboundary basin or aquifer does not necessarily correlate with its importance or priority for transboundary cooperation. Alternative methods for the indicator have been proposed that do not consider area, but rather look at proportion of countries that are riparian and have an agreement (AbuZeid, 2016).

When comparing the Method 3 results in tables 4, 5, and 6 to the results for Method 2, there are similarities. However, there are several differences worth highlighting and discussing. First, the Nile Basin in Uganda was found to have operational cooperation with Method 1, Operational Level 5 in Method 2, and to have Emerging comprehensive cooperation in Method 3. These results are relatively consistent across the methods; the difference to note is in how the Lake Victoria Sub-basin, see Figure 10, compares with the greater Nile Basin. In both Method 1 and Method 2, the Lake Victoria Sub-basin would receive the same score as the Nile Basin in Methods 1 and 2; but in Method 3, the Lake Victoria Sub-basin has Continuing comprehensive cooperation. The Lake Victoria Sub-basin, while also managed through the Nile Basin Initiative and the Cooperative Frameworks Agreement (CFA), has additional cooperative efforts through the East African Community and the Lake Victoria River Basin Commission. All the riparian states within the sub-basin participate in the cooperative efforts, whereas the DRC, Egypt, Sudan, and South Sudan only participate through a portion of the cooperative efforts in the Nile, as they have not ratified the CFA. Furthermore, while the NBI – and its predecessors – have been operating since 1999, the CFA was not reached until 2010, whereas the Protocol for Sustainable Development of Lake Victoria Basin has been ratified since 2003.

The second difference between Method 2 and Method 3 is in the categorisation of the Ganges-Brahmaputra-Meghna River Basin. In Method 2, the BCU has Operational Level 4 cooperation, and in Method 3, the basin falls within Issue cooperation. The BCU met most of the criteria for an operational cooperative arrangement in Methods 1 and 2; however, Method 3 takes a more nuanced look at the cooperative efforts occurring. Since the Ganges Water Treaty[35] was signed in 1996, several MOUs have been signed between India and Bangladesh over the Ganges and the Indo-Bangladesh JRC has been operating since 1972; cooperation could thus appear to be Continuing. However, the other riparians to the basin have not engaged with any other cooperative efforts with Bangladesh over the shared waters. Nepal, India, and Bangladesh have broached collaborating to increase the storage potential and augment dry season flows, but the political situation prohibits any further collaborative efforts (Dhungel, 2013). In addition, the cooperative efforts between India and Bangladesh are issue specific: the Ganges Water Treaty and the Joint Committee handle water quantity issues while the Joint River Commission deals mainly with flood control/relief and technical cooperation/

[35] Full title: Treaty Between the Government of the Republic of India and the Government of the People's Republic of Bangladesh on Sharing of the Ganga/Ganges Waters at Farakka.

assistance. Issues relating to joint management appear to be dealt with in a 'siloed' fashion rather than through integration, which could potentially present unrealised shared benefits.

The final key difference to note is with the Goascorán Basin in Honduras. In Method 1 the basin had no operational cooperation and in Method 2 had Operational Level 3 cooperative arrangements. As discussed in the sections on Methods 1 and 2, the emphasis on procedural criteria overlooked the cooperative efforts ongoing in the basin. Method 3 places the basin within Emerging comprehensive cooperation. While national actors are not actively participating in the joint management of the basin and there is no formal agreement between the two riparians, regional and local actors as well as members of the public and private sector with the assistance of the IUCN Bridge programme have developed an institution for cooperation in the basin. While this effort restarted in 2011, recognising its efforts as Emerging comprehensive cooperation could provide an incentive for international donors to continue to support the process or place pressure on the states to become involved. Ultimately, these examples illustrate three key points: 1) Method 3 considers the basin-wide cooperative efforts and the coverage of transboundary cooperation when categorising the type of cooperation that is occurring within a particular BCU, 2) creating lasting cooperative efforts resulting in positive outcomes that continue to be effective is equally – if not arguably more important – than having all the 'key aspects' comprising transboundary cooperation, and 3) the type of cooperation established is dependent on the political will of the riparian states and context within which the waters are shared.

The three examples discussed above focus on differences arising from defining operational through a substantive lens versus defining operational through a procedural lens. Method 3, however, also adapts the definition of a cooperative arrangement. Method 3 broadens the conceptualisation of arrangement to include the accumulation of all cooperative efforts and evaluates their operationality based on the combination. Non-state actors often play an important role in transboundary cooperation (Giordano et al., 2013); this broadening of the definition acknowledges their contribution. Two basins in Honduras, the Lempa River Basin, and the Coco/Segovia River Basin, have non-traditional actors and alternative cooperative arrangements that contribute to the shared management of the rivers. The Lempa River, as discussed in a previous section (Discussion of results for Method 1), has a state-to-state agreement as well as a national-level joint management body. This arrangement, the combination of the Tri-National Commission and the

Trifinio Plan, emphasises sustainable development in the Trifinio Region, which includes the Upper Lempa River Basin. The focus historically has not been on the joint management of shared waters; previously only indirect benefits to the shared water occurred. It was not until recently that a shift towards IWRM has occurred at the national scale. To address development problems in the region, the lack of public policy from the national level, and the lack of public participation, 26 municipalities, plus actors from public and private sectors, established the *Mancommunidad Trinacional Fronteriza Río Lempa*; this was in response to the lack of focus on joint water management at the state-to-state level. The *Mancommunidad* has established a *Aguas Compartidas* programme to address these issues specifically related to the Upper Lempa Basin.

Similarly to the Lempa Basin, the Coco/Segovia Basin has alternative cooperative arrangements and non-state actors. The Coco River Basin, shared between Honduras and Nicaragua, has no national cooperative actions occurring to jointly manage the shared waters. Supported by UNEP, UNOPS led the programme Supporting Sustainable Water Management in the Coco River Basin; this programme aimed to strengthen local capacity for integrated water management at the micro-basin level and between the departments of Nueva Segovia, Nicrague, and El Paraíso, Honduras. The project concluded in 2012 and resulted in management plans for micro and sub-watersheds in the Coco River Basin. The situation in these two basins reflects the need to strengthen the definition of what constitutes a cooperative arrangement for SDG Indicator 6.5.2. Non-state actors and informal institutions that do not fit with the current conceptualisation of arrangement play a significant role, particularly when there is a lack of support or resources at the national level for transboundary cooperation.

As mentioned in the methodology section for Method 3, this method's typology of cooperation implies a stepwise path culminating in Continuing comprehensive cooperation that has lasting cooperative outcomes. However, despite this implication, having Continuing comprehensive cooperation may not be necessary for a particular basin or aquifer depending on context, nor do countries need to progress through every stage. The Lake Turkana Basin (Figure 10), shared between Ethiopia, Kenya, South Sudan, and Uganda, is an endorheic lake. The lake and most of its tributaries are in Ethiopia and Kenya; the BCU in Uganda contributes very minimally to the basin – both in terms of catchment area and volumetric flow. Ethiopia and Kenya have begun to discuss the creation of a bilateral agreement to jointly manage the basin. Given Uganda's minimal contribution to the basin, having

Non-cooperation may be an appropriate type of cooperation for its BCU, which may boost cooperation between the major basin states. Or perhaps, Preliminary cooperation could occur within Uganda's BCU by stating they would be willing to cooperate over the basin in the future, if needed, but in the meantime allowing Ethiopia and Kenya to jointly manage the lake. Essentially, the transboundary cooperation that is occurring is operational, whether or not it meets procedural or substantive criteria as defined by international law. If cooperative efforts are functioning within the political constructs and the context of the basin, and are resulting in effective positive outcomes – as defined in the basin or aquifer's context – then why should it not be considered operational?

There are limitations to Method 3 for measuring transboundary cooperation. Placement of a BCU or ACU within a type of cooperation is currently somewhat subjective and requires in-depth knowledge of the cooperative efforts. Therefore, it is not feasible to conduct a global-scale study, particularly at the data collection and monitoring scale required for the SDGs. Objective criteria that avoid emphasising a normative framework need to be developed for Method 3. The role and purpose of this method is to illustrate alternative means to evaluate the operationality of cooperative arrangements and what actually comprises a cooperative arrangement. The goal in developing Method 3 is to create a tool for basin managers and practitioners to evaluate transboundary cooperation without restricting how cooperative efforts are established or function. The typology of cooperation attempts to reflect the variety of cooperative efforts that can occur without placing too much emphasis on what is input. And, the typology attempts to create space for development of alternative or pragmatic cooperative solutions that are place-based and within the socio-political situation.

6 CONCLUSION

Summary

This paper sets out to provide guidance on SDG Indicator 6.5.2 for countries that are beginning to develop monitoring and implementation plans for the SDGs. With SDG Indicator 6.5.2 defined as "the proportion of transboundary area with an operational arrangement for water cooperation" (UN-Water, 2016c), it is important to critically evaluate how the methodology for this indicator is established, as this has the potential to shape the development and evolution of future transboundary water cooperation. Creating consistent and clear definitions for what is a cooperative arrangement and what is operational, ultimately defines what transboundary cooperation is in the context of the SDGs.

We define transboundary water cooperation as coordination and collaboration between riparians that achieve a common interest resulting in mutual benefits; this occurs with reciprocity and good-faith (Leb, 2015; Zartman, 2008). The duty to cooperate has become an element of customary international law. Out of this duty, international water law has developed to establish a set of procedural and substantive rules to govern the relations between countries over shared waters (GWP, 2013). The most common expression is through international agreements between riparian states, with an overwhelming majority of these agreements in place on shared surface waters. Agreements, such as treaties, are a type of institutional capacity that can add hydropolitical resilience to a shared water system to absorb change and reduce the potential for conflict to occur (Wolf et al., 2003b; Wolf, 2007). This idea highlights the value SDG Indicator 6.5.2 brings to the SDGs. Water is central to sustainable development and, with a significant proportion of the world's population dependent on internationally shared waters, achieving SDG Indicator 6.5.2 will aid in accomplishing the other water targets in SDG 6 as well as the targets indirectly related to water[36].

Therefore, to maximise the benefit from SDG Indicator 6.5.2, this paper evaluates three methodologies for calculating the indicator. Method 1 is the proposed method and is likely to be adopted as the technique for measuring this indicator. It defines a cooperative arrangement as being operational if

[36] See Sindico 2016 for a full discussion on links between SDG Indicator 6.5.2, SDG 6, and other SDGs.

it meets all the procedural criteria; these criteria are drawn from principles in the universal water conventions. The second method, Method 2, is founded on the same concept as Method 1. To determine if an arrangement is operational, this method does not require that all criteria must be fulfilled. As long as one criterion is met, the area is considered to have some form of operational cooperation. This creates levels of operational cooperation. Method 3 takes an alternative perspective based on substantive principles and focuses on the outcomes of effective cooperation, rather than procedural criteria. Operational, in Method 3, is based on substantive cooperation, which is determined by a typology of cooperation based on categories developed in *Promoting Effective Water Management Cooperation among Riparian Nations* (GWP, 2015).

SDG Indicator 6.5.2 Methodologies

	Strengths	**Weaknesses**
Method 1	• Operational criteria are based on water conventions • Criteria incorporate the value in countries having an agreement and joint body • Relatively straightforward to determine if operational • Results in a single numerical value that meets the needs for global monitoring • Results have the potential to be aggregated and disaggregated	• Arrangement has an inconsistent definition that could lead to confusion • Masks cooperation by requiring all criteria be fulfilled – binary • Criteria for operationality are procedural and normative • Spatial data for basin and aquifers may be hard to access or develop, particularly for areas lacking hydrogeological studies • Survey data collection for operational criteria and arrangements has the potential to be inconsistent between countries and may be limited
Method 2	• Operational criteria are based on water conventions • Criteria incorporate the value in countries having an agreement and joint body • Levels of Operational Cooperation recognise a greater extent of transboundary cooperation occurring • Allows for some flexibility in how basins develop their cooperative arrangements • Creates incentives for developing transboundary cooperation by tracking progress more explicitly	• Arrangement has an inconsistent definition that could lead to confusion • Criteria for operationality are procedural and normative • Spatial data for basin and aquifers may be hard to access or develop, particularly for areas lacking hydrogeological studies • Survey data collection for operational criteria and arrangements has the potential to be inconsistent between countries and may be limited • Does not present a single value for each country, which does not meet the needs for global SDG monitoring

Method 3	• Allows for flexibility in cooperative efforts • Recognises cooperation is dependent on the political will and social-political context of the shared water • Emphasises cooperative efforts that result in continued positive outcomes • Uses a widened definition of cooperative arrangement to include the cumulation of cooperative efforts • Acknowledges the roles of non-state and local actors in cooperative efforts	• Does not present a single value for each country, which does not meet the needs for global SDG monitoring • Spatial data for basin and aquifers may be hard to access or develop, particularly for areas lacking hydro-geological studies • Degree of subjectivity in assigning type of cooperation, objective criteria are needed pending further research • Requires in-depth knowledge of a variety of scales of the cooperative efforts occurring

Table 7: Summary of strengths and weaknesses of three SDG Indicator 6.5.2 methods

There are several key points to summarise from the evaluation of the three methods. First, it is necessary to have clear and consistent definitions of what is a transboundary basin, transboundary aquifer, an arrangement, and what makes an arrangement operational. Defining arrangement and operational are of particular importance for this indicator. The currently proposed definition of arrangement attempts to build flexibility and could lead to confusion when identifying an arrangement. Operational is used as the variable for comparing the three methods described in this paper; through this comparison, we see that how operational is defined has a significant impact on what cooperative arrangements – or efforts – are recognised by the indicator. The proposed definition of operational, used in Method 1 and adapted in Method 2, is based on procedural and normative criteria, which may exclude alternative cooperative arrangements. Further, the binary categorisation in Method 1 has the potential to mask ongoing cooperation that does not meet all the criteria, but is an effective means of cooperation. Furthermore, a prescriptive framework for transboundary cooperation has the potential to limit adaptability in forming cooperative arrangements that reflect the context of the basin. Cooperation between riparians is mostly determined by the political will of the riparian nations (GWP, 2013; Zeitoun and Mirumachi, 2008). For example, the socio-political context may not allow for the signing of an agreement or information exchange. Therefore, water governance and transboundary cooperation over shared waters should allow for place-based specifics and cooperative efforts that fit the socio-political environment (Giordano and Shah, 2014; Jensen, 2013). Similarly, measurement and monitoring of transboundary cooperation should equally reflect the diversity of cooperative efforts. Non-state actors, municipalities, and public and private sectors, for example, may develop cooperative efforts over shared waters, particularly if there is a limited response from national governments.

These efforts can result in effective outcomes of cooperation. Method 3's typology of cooperation places a greater emphasis on the substantive elements than the other two methods. While currently not feasible for a global study at the scale of the SDGs, Method 3 aims to be a tool for basin managers, academics, and shared water users to evaluate transboundary cooperation and provides an alternative viewpoint for measuring progress towards transboundary cooperation.

Recommendations and guidance

The rationale of this paper is to provide guidance on SDG Indicator 6.5.2 by demonstrating and comparing three methodologies with the hope that this will aid in better monitoring, understanding, and utilisation of the indicator. Therefore, we would like to conclude with the following recommendations and guidance:

Recommendations

- The definition for cooperative arrangement should be clarified for consistency in monitoring. Based on the current wording – while more political – agreement, instead of arrangement, is a clearer alternative.
- The criteria for determining operationality of arrangements is prescriptive; adding flexibility, such as levels, or lowering the number of criteria needing to be fulfilled to be considered operational, may allow for recognition of alternative cooperative efforts.
- Clarification is needed on how to evaluate cooperation occurring in multilateral basins or aquifers. This paper makes the assumption that the criteria would be evaluated on a BCU/ACU basis, rather than basin wide. If calculated in this manner, country-specific data and basin-specific data should both be reported to better understand the cooperative picture occurring at the different scales.
- Non-state actors and local-scale cooperative efforts should be included in the evaluation of transboundary cooperation.
- Transboundary cooperation should reflect the context, place, and socio-political situation. Cooperation that occurs within these constraints is still cooperation, even if it does not meet all the procedural requirements, especially since meeting specific requirements may prohibit cooperation from occurring.
- Transboundary cooperative efforts should work in conjunction with other SDG indicators and targets. SDG Target 6.5 and its Indicators 6.5.1 and 6.5.2 have the potential to significantly support meeting other water targets and non-water targets.

Guidance

- The current survey instrument does not report on which criteria a particular basin or aquifer has satisfied; therefore, monitoring progress at the level of the criteria on a global scale is not possible. Further, while the survey is combined with reporting for the UNECE Water Convention and collects valuable information, most is not relevant to SDG Indicator 6.5.2, as written. This has the potential to lead to inconsistent or incomplete responses to the questions and sections directly related to SDG Indicator 6.5.2. A separate survey instrument focused on SDG Indicator 6.5.2 could be shorter and more specific, which could lead to more consistent and complete responses.
- Users of the data should be aware that by basing the indicator on transboundary area, area weights the impact of the basin or aquifer in a country's score. Area is not always a proxy for the importance of a basin or aquifer. Priority in funding and efforts towards developing a transboundary cooperative arrangement should be based on factors in addition to area, including inter alia water demand, availability, and quality issues.
- Aggregated data presented for the transboundary area (combined surface and groundwater) may help give a general overview, but disaggregated data presented for total transboundary river basin and total aquifer area is more reflective of the extent of cooperation occurring. Areas in aggregation may distort and mask what is happening. Data presented at the BCU or ACU level may be the most beneficial for water managers to highlight areas without transboundary cooperation.
- Like IWRM, transboundary cooperation over shared waters is a process. As context and political will shift, cooperative efforts will need to adapt and address changes. The institutional capacity of these transboundary cooperative efforts will aid in decreasing the potential for future conflict.
- Comparing alternative measures of transboundary cooperation may be beneficial. This paper presents two alternatives (Methods 2 and 3) to the proposed method (Method 1) as well as providing an overview of several previous studies that measure water governance or transboundary cooperation.

In summary, we find that Method 1: Draft methodology for SDG Indicator 6.5.2 is the better of the three methods for calculating "the proportion of transboundary area with an operational arrangement for water cooperation" (UN-Water, 2016c). This methodology generally represents where transboundary cooperation on shared water is occurring and the extent of the cooperation. Furthermore, it presents the results in a digestible way that is in the format needed for global SDG monitoring, analysis, and comparison. Method 1 could be strengthened through the above recommendations, such as clearly defining arrangement and determining how to address operationality criteria fulfilment in a multilateral basin. We would recommend at the basin or aquifer level that managers or whoever is responsible for joint management use Method 1 in conjunction with Method 3 to better represent the cumulation of cooperative efforts occurring in a shared basin or aquifer and to acknowledge the nuances and variability that are inherent in these efforts.

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GLOSSARY OF TERMS

Agreement: A bilateral or multilateral formal legal instrument, such as a treaty, amendment, or protocol, between riparian countries regarding transboundary waters.

Aquifer country unit (ACU): The area of a transboundary aquifer that is within a particular nation. Given the nature of aquifers, the area referred to – and used in calculations – is the plan-view surface area of an aquifer and does not consider the aquifer thickness nor the potential volume of water. A transboundary aquifer has at least two ACUs; there will be an ACU for every country that is part of the aquifer area.

Aquifer or groundwater body: An aquifer is a geological formation that contains water. There are two main types of aquifers: 1) shallow unconfined geologic units that are hydrologically connected to the surface water system and their extents are contained within the delineation of river basin boundaries, and 2) geologic units that are not hydrologically connected to surface water, such as confined and fossil aquifers.

Arrangement: UN-Water defines an arrangement for water cooperation as "a bilateral or multilateral treaty, convention, agreement, or other formal arrangement, such as a MOU; between riparian countries that provides a framework for cooperation on transboundary water management. Agreements or other kinds of formal arrangements may be interstate, intergovernmental, interministerial, inter-agency, or between regional authorities." (UN-Water, 2016b, p.3). This definition of arrangement is used in Methods 1 and 2 of this paper.

Basin country unit (BCU): The area of a transboundary river basin that lies within a particular nation. A transboundary river basin has at least two BCUs. For example, if an international river basin has three riparians, then there will be three BCUs – one for each pair of basin and country combinations. (TFDD, 2016).

Cooperation: Coordination between states at a level where they collaborate to achieve a common interest that results in mutual benefits for all the states (Zartman et al., 2008 in Leb, 2015).

Cooperative arrangement: In Method 3 of this paper, a cooperative arrangement is defined as the cumulation of the cooperative efforts between riparians on a transboundary basin or aquifer. Cooperative efforts include formal agreements, organisations and other institutions, joint projects and plans, informal agreements, and organisations as well as efforts by non-state actors.

Endorheic lake (or endorheic basin): This is a closed drainage basin. All the area within a river basin drains to a lake or other inland water body; there is no outflow from the basin, such as to the ocean or sea. For example, the Aral Sea and the Dead Sea are endorheic lakes. The Jordan River Basin, which drains to the Dead Sea is an endorheic basin.

Groundwater: The water contained within a water-bearing geological formation (International Law Association, 2004).

International transboundary groundwater body or aquifer: A transboundary aquifer (or groundwater body) that is intersected by an international political boundary and is not hydrologically connected to a surface water system.

International transboundary river basin: An area that contributes both surface water and groundwater to streams that drain to an ocean, sea, or terminal lake – where perennial water intersects a political boundary (Wolf et al., forthcoming). A river basin is also known as a watershed or catchment and includes the groundwater bodies that are hydrologically connected to the surface-water system. In this paper, international river basin and transboundary river basin are used interchangeably, since in the scope of this research we are only discussing transboundary rivers where the boundary that is crossed is an international political boundary.

Issue: In Method 3 of this paper, typology of cooperation is determined with consideration to the issues addressed by a cooperative arrangement. Issues may be addressed in isolation by management with limited efforts towards shared benefits between the riparians or other actors. As part of Method 3, the following table is used to determine what issues are being addressed by the cooperative arrangements (adapted from Hamner and Wolf, 1997; Wolf et al., 2003b; and Giordano et al., 2013).

Issue addressed	Definition of cooperative arrangements
Aquatic ecosystem	Arrangements that address environmental concerns including environmental flows, water for ecosystems, and quality for environmental purposes
Border issues	Arrangements relating to rivers as shared borders/boundaries
Economic development	Arrangements related to general economic/regional/sustainable development
Fishing	Arrangements relating to fishing
Flood control/relief	Arrangements relating to flooding, flood control, flood damage, flood relief
Hydropower/hydroelectricity	Arrangements relating to hydroelectricity or hydropower facilities
Infrastructure/development	Arrangements relating to infrastructure or development projects, including dams, barrages, draining of swamps for development purposes, canals
Irrigation	Arrangements relating to irrigation of agricultural areas
Joint management	Arrangements involving joint management of basin or water resources, especially where the management concerns cover a range of issue areas
Navigation	Arrangements relating to navigation, shipping, ports
Technical cooperation/assistance	Arrangements relating to technical or economic cooperation or assistance, including project evaluations or river surveys and funds for ranges of improvements to water-related technology/infrastructure
Territorial issues	Arrangements relating to territorial claims, where the territory is associated with a water body, e.g. a river island
Water quality	Arrangements relating to water quality for human use
Water quantity	Arrangements relating to water quantity

Procedural rules: Within international water law and international legal frameworks, procedural rules provide the means to implement the substantive rules, i.e. procedure.

Relevant riparians: When considering which parties or nation states should be participating in cooperative management and governance, relevant riparians are those basin states that contribute significant area or flow, have reasonable population size living in the basin area, or a substantial impact on the basin or aquifer.

Riparian: This term is defined as relating to or next to a river or stream. It also refers to the nation states that are within an international river basin and contribute area that drains to the common terminus. For example, the Columbia River Basin is shared between Canada and the United States; therefore, Canada is a riparian of the Columbia River Basin.

Substantive rules: Within international water law and international legal frameworks, substantive rules are generally those that establish rights and obligations of states sharing waters, i.e. substance.

Transboundary area: The total transboundary area within a nation is the sum of the surface areas of the BCUs and ACUs in that nation. This sum may yield a value that is greater than the surface area of the country. This term is unique to this paper and the methods for calculating SDG Indicator 6.5.2.

Transboundary waters: Surface water and groundwater that cross a boundary are transboundary waters. In this paper, we reserve transboundary waters specifically for waters that cross an international political boundary.

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