



Research papers

Monitoring of transboundary water cooperation: Review of Sustainable Development Goal Indicator 6.5.2 methodology

Melissa McCracken^{a,*}, Chloé Meyer^b^a Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, 104 CEOAS Admin Bldg., Corvallis, OR 97330, USA^b Paris Nanterre University, Département de Géographie, Bat. Max Weber, 200 Avenue de la République, 92001 Nanterre Cedex, France

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ABSTRACT

Water is central to sustainable development; making transboundary cooperation among riparians a core aspect of Agenda 2030 and the Sustainable Development Goals (SDGs). SDG 6 on water and sanitation includes an indicator, SDG Indicator 6.5.2, to assess cooperation over transboundary waters by measuring the “*Proportion of transboundary basin area with an operational arrangement for water cooperation.*” The definitions developed by the methodology for calculating the Indicator have the potential to significantly impact the resulting structure and type of cooperation that are assessed and that will develop. Indeed, the composition of this indicator will both directly and indirectly influence water diplomacy, international policy, and water law. In this research, we analyze the methodology for assessing SDG Indicator 6.5.2, examine how operational cooperative arrangements are defined, and identify the strengths and limitations of the method for measuring transboundary water cooperation. This is done by simulating the application of the methodology and calculating the Indicator in three national case studies (Bangladesh, Honduras, and Uganda) and in a global overview. The unequal distribution regionally of operational cooperation is evident, as well as the gap in coverage between transboundary surface waters and aquifers. However, the normative and binary nature of the Indicator obscures the political complexity of establishing cooperative processes and has the potential to present a false depiction of the extent of cooperation that is occurring over shared waters. In this article, we also discuss bias that can be introduced with using surface area as a metric to assess cooperation that results in weighting larger basins and aquifers over smaller basins in the calculation of the Indicator. This paper presents a basis for further analysis of SDG Indicator 6.5.2 and the possible adaptations of the Indicator design to better assess transboundary water cooperation.

1. Introduction: Water Diplomacy and Transboundary Water Cooperation

Transboundary waters are surface waters and groundwaters that “*mark, cross, or are located on international political boundaries between two or more States*” (UNECE, 1992). Globally, 310 international transboundary river basins cover 47.1% of the world’s land surface, while there are at least 592 transboundary aquifers, underlying about 20% of the world’s land surface (IGRAC, UNESCO-IHP, 2015; McCracken and Wolf, Forthcoming) (See Fig. 1). Nearly half of the world’s population lives within a transboundary river or lake basin or over a transboundary aquifer; thus, these waters are important for ensuring global, national, and individual water security (TFDD, 2016). Due to global reliance on transboundary waters, the implications for sustainable development, and the political nature of shared waters, encouraging transboundary cooperation and diplomacy over shared waters is an important but complex component of the international development agenda.

Diplomacy is the process of interactions between States with the goal of preventing hostility (Islam and Susskind, 2013). It relies on the promotion, creation, and maintenance of cooperation. Cooperation is the coordination between States where they collaborate to achieve common interests with mutual benefits (Leb, 2015; Zartman, 2008). Therefore, the role of water diplomacy in the context of international waters is to foster transboundary cooperation over shared waters between States.

Managing water is complex, as it requires addressing the unequal distribution of water resources in both space and time, exacerbated by climate change and the increasing demands for domestic, agricultural, and industrial uses. Demands are further expanding with population growth, economic development, and changing lifestyles; water quality and environmental needs further impact management and governance, with all aspects combining to increase competition and risk of conflict over shared resources. Political borders add a layer of complexity, and as States develop their internationally shared waters, they experience

* Corresponding author.

E-mail addresses: mccrackm@oregonstate.edu (M. McCracken), c.meyer@parisnanterre.fr (C. Meyer).

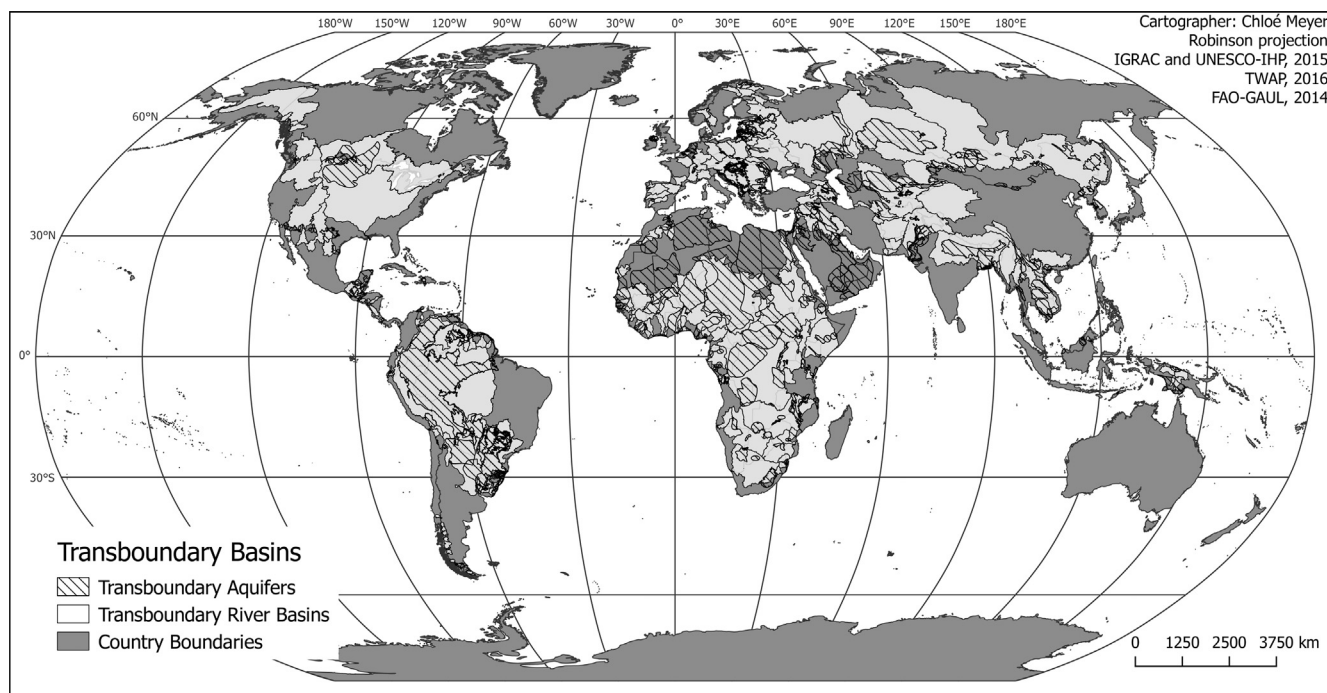


Fig. 1. The World's Transboundary River Basins and Transboundary Aquifers. This map shows the delineations of internationally shared river basins and aquifers. Basin delineations are from the Transboundary Freshwater Dispute Database (TFDD) and aquifer delineations are from UNESCO's International Hydrological Programme (UNESCO-IHP) and International Groundwater Resources Assessment Centre under the auspices of UNESCO (IGRAC) (TFDD, 2016; IGRAC, UNESCO-IHP, 2015).

this complexity – which requires diplomacy and cooperation to avoid negative impacts to the nation or to the shared resource (Mitchell and Zawahri, 2015).

Transboundary cooperation presents opportunities for riparian States to identify shared interests and develop actions towards mutual benefits. These benefits can be directly related to the resource, but can also extend beyond it, such as monetary or energy exchange (Sadoff and Grey, 2002; Wolf, 1998). Shared interests and mutual benefits are readily apparent in cooperative arrangements, such as treaties and negotiated agreements (Giordano et al., 2013). Treaties, agreements, river basin organizations, or positive international relations are examples of institutional capacity, which is an indicator of the potential for dispute or cooperation over shared waters (Wolf, 2007). Adequate institutional capacity in a shared water system has the ability to absorb rapid physical or institutional change, which can lower the potential for conflict (Wolf et al., 2003). Diplomatic and cooperative efforts are needed to establish and maintain institutional capacity. For example, the signing of a treaty in a transboundary basin increases the potential for future water cooperation (Brochmann, 2012). A basin or aquifer that is categorized as having cooperation does not exclude it from conflict or tension; therefore, cooperation and conflict do not necessarily occur in isolation from each other (Zeitoun and Mirumachi, 2008). The political will of riparian States determines if cooperation will occur (Wouters, 2013); therefore, water diplomacy is essential to increase trust and develop the political desire to establish and maintain cooperation.

Cooperation between countries for the management of shared water resources is ubiquitously supported by scholars. However, various definitions of transboundary water cooperation coexist, which translate into the absence of a single accepted means to measure it (Saruchera and Lautze, 2015; Tarlock, 2015). The conceptualization and measurement of transboundary water cooperation takes a wide range of forms (De Stefano et al., 2010, 2017; Mirumachi, 2007; Strategic Foresight Group, 2015; Tarlock, 2015; UNEP-DHI, 2016). These multiple understandings present difficulties in monitoring and encouraging

cooperation, because there is not a consistent and comparable measurement method. The complexity surrounding transboundary cooperation contributes to the variability in defining and monitoring cooperation. Developing a globally applied method must simplify the complexity by selecting elements to represent the level of cooperation, in addition to overcoming the political nature of determining which elements should be used as a proxy.

The signing of the *2030 Agenda for Sustainable Development* and the SDG framework present an opportunity to promote transboundary water cooperation through water diplomacy by providing a method of defining and measuring transboundary cooperation globally, while also integrating the water goals with the rest of the 2030 Agenda. This method could also serve as a limited proxy for the effectiveness of water diplomacy.

It is expected that SDG Indicator 6.5.2 for transboundary cooperation (Described in Section 2.2) will influence the development and structure of cooperation over shared surface waters and groundwaters, as countries enact elements of operational cooperation in order to achieve the Indicator through 2030. Therefore, it is important to better understand the benefits, limitations, and implications of this global framework for transboundary water cooperation. This paper analyzes the methodology for SDG Indicator 6.5.2, examines how operational cooperative arrangements are defined, and identifies the strengths and limitations of this method for measuring transboundary water cooperation.

2. Background

2.1. Agenda 2030: From SDG 6 on water and sanitation to SDG Indicator 6.5.2 on transboundary cooperation

In 2015, the UN General Assembly signed resolution A/RES/70/1 *Transforming our world: the 2030 Agenda for Sustainable Development*, which builds on: i) the conclusions of the Rio + 20 Conference on Sustainable Development, ii) the results of two years of international

consultations and engagement with civil society, and iii) the Millennium Development Goals (UN, 2015). The 17 SDGs and the 169 targets increase the scale, ambition, and interconnection of the international development agenda (UN, 2015). During the development process, members of the global community pushed to include a specific water-related goal. Recognition of the importance of water to sustainable development resulted in Goal 6 “Ensure availability and sustainable management of water and sanitation for all” and its six targets ranging from drinking water access and sanitation to ecosystem protection, as well as two means of implementation (UN-Water, 2016a).

Support and position papers for the water goal emphasized the inclusion of a target on water resources management (AMCOW, 2013; Taylor, 2013; UNGC, 2013); several position papers promoted the importance of including transboundary cooperation (Schweizerische Eidgenossenschaft, 2013; UN-Water, 2014; Sindico, 2016). The resultant Target 6.5 states “By 2030, implement integrated water resources management at all levels, including through transboundary cooperation as appropriate” (UN, 2015), and has two indicators to monitor progress (UN-Water, 2016a):

- Indicator 6.5.1: Degree of integrated water resources management (IWRM) implementation
- Indicator 6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation

The target promotes an IWRM framework, which has the potential to assist in balancing the other water targets and to help integrate the water goal with the other SDGs, with SDG Indicator 6.5.2 incorporating the transboundary context. Indicator 6.5.1 measures four components of IWRM - enabling environment, institutions, management tools, and financing - using a self-assessment survey instrument (UN-Water, 2017e). The score for the indicator is calculated using a percentage approach that is based on thresholds reached for each question, then averaged to produce a score for each component, and again averaged for an indicator score (UN-Water, 2017e).

SDG Indicator 6.5.2 provides a tool agreed upon by UN Member States, which aims to evaluate the extent of existing cooperative arrangements over shared waters (UN-Water, 2017a). By illustrating areas that lack cooperative arrangements, the indicator has the potential to encourage States to cooperate, formally, over shared waters. Over the course of the next 15 years, the Indicator is expected to track improvements in the extent of transboundary cooperation.

2.2. SDG Indicator 6.5.2

The SDG Indicator 6.5.2 was considered by the Inter-Agency and Expert Group on Sustainable Development Goals Indicators (IAEG-SDGs) at the 47th Session of the Statistical Commission in March 2016 (IAEG-SDGs, 2016). UNESCO-IHP and the UNECE Water Convention Secretariat were appointed as custodian agencies for the Indicator and are responsible for compiling and verifying country reported data, developing regional and global data aggregates, and for submitting data reports to the UN Statistics Division.

Under the UN-Water umbrella, UNESCO-IHP and the UNECE Water Convention Secretariat coordinated a working group to develop the methodology for SDG Indicator 6.5.2, as a part of the Global Expanded Monitoring Initiative (GEMI) – an inter-agency mechanism to coordinate monitoring efforts and data collection and management for SDG Targets 6.3 through 6.6. In April 2016, a *Draft Step-by-Step Monitoring Methodology for Indicator 6.5.2* was published (UN-Water, 2016b), and the methodology was tested in five pilot countries - Jordan, the Netherlands, Peru, Senegal, and Uganda (UN-Water, 2017c). In parallel, there was a consultation process on the Indicator’s proposed methodology with a wide group of UN-Water members and related experts (UN-Water, 2017c). The final *Step-by-Step Monitoring Methodology for SDG Indicator 6.5.2* was published in January 2017; this

included minor changes from feedback during the testing and consultation process (UN-Water, 2017a). In April 2017, the Indicator was approved to Tier II¹ status by the IAEG-SDGs, meaning the Indicator has an established methodology but data are not regularly collected (IAEG-SDGs, 2017).

Under the SDG framework, countries are responsible for collecting data, measuring, and reporting on the extent of transboundary water cooperation to the two custodian agencies. Through a questionnaire² jointly developed by UNESCO-IHP and the UNECE Water Convention Secretariat, countries will provide their own statistics for transboundary basin area as well as information on cooperative arrangements. The reporting mechanism for the 1992 UNECE *Convention on the Protection and Use of Transboundary Watercourses and International Lakes* (hereafter UNECE Water Convention) has been integrated with the SDG Indicator 6.5.2 reporting questionnaire (UNECE Water Convention Secretariat, 2016). As a result, countries that are parties to the UNECE Water Convention report to both mechanisms at once. SDG Indicator 6.5.2 data collection began in spring 2017, with the first report on the status of SDG Indicator 6.5.2 due in June 2018.

In the context of this paper and SDG Indicator 6.5.2, ‘transboundary basin area’ represents both surface water and groundwater systems. Within the transboundary basin area of a country are the country’s Basin Country Units (BCU) and Aquifer Country Units (ACU). A BCU is the area of a transboundary river basin within a riparian State. Similarly, an ACU is the area of a transboundary aquifer that underlies the country of interest. A transboundary river basin or aquifer, therefore, has a minimum of two BCUs or ACUs depending on the number of States that share the waters. The summation of a country’s BCU and ACU area is the country’s total transboundary area.

In the *Step-by-Step Monitoring Methodology for Indicator 6.5.2* (UN-Water, 2017a), a country’s initial step in calculating SDG Indicator 6.5.2 is to identify international transboundary river basins and aquifers in the country, and then to determine if a cooperative arrangement exists for each transboundary river basin or aquifer identified. A cooperative arrangement is defined by the methodology as “a bilateral or multilateral treaty, convention, agreement or other formal arrangement, such as memorandum of understanding, between riparian countries that provides a framework for cooperation on transboundary water management” (UN-Water, 2017a, p. 3). If a cooperative arrangement exists, then it must be determined if it is ‘operational’, i.e. if it meets all the following criteria (UN-Water, 2017a, p. 3):

- “There is a joint body, joint mechanism, or commission (e.g. a river basin organization) for transboundary cooperation;
- “There are regular (at least once per year) formal communications between riparian countries in [the] form of meetings (either at the political or technical level);
- “There is a joint or coordinated water management plan(s), or joint objectives have been set, and;
- “There is a regular exchange (at least once per year) of data and information.”

Although all criteria must be met in order for a cooperative arrangement to be considered operational, it is important to note that they do not have to be stated explicitly in the cooperative arrangement, as long as they are occurring in practice (UN-Water, 2017a). These criteria are based on principles of international water law that are

¹ The Tier Classification System divides the SDG indicators based on the level of methodological development and data availability. The classification does not imply importance, but rather is to aid the development of strategies for implementation (IAEG-SDGs, 2018).

² The template for the questionnaire was approved during the Eleventh Meeting of the Working Group on IWRM on 18–19 October 2016 in Geneva: http://www.unecce.org/fileadmin/DAM/env/documents/2016/wat/10Oct_18-19WGIWRM/WG.1_2016_INF5_reporting.pdf.

codified within the 1997 UN *Convention on the Law of the Non-Navigational Uses of International Watercourses* (hereafter UN Watercourses Convention), the UNECE Water Convention, and the draft *Law of Transboundary Aquifers* (UN Statistics, 2016). The goal of structuring the Indicator in this manner is to encourage countries to establish new operational arrangements or to update existing arrangements to be operational (UN-Water, 2017a). In that sense, the criteria serve to provide guidance to UN Member States on where improvements can be made.

This methodology incorporates the feedback from the pilot testing and consultations on SDG 6 (UN-Water, 2017b, 2017c). There are only minor alterations from the April 2016 draft (UN-Water, 2016a,b). These consist of the addition of a set frequency – ‘at least once per year’ – for the regularity of meetings and exchange of information criteria, and they allow for the calculation of the Indicator at the sub-basin level (UN-Water, 2017d).

3. Methodology

The objective of this paper is to test the methodology and conceptualization of SDG Indicator 6.5.2 by simulating its calculation, in order to evaluate its application and its ability to measure transboundary water cooperation. We approached this through both national³ and global⁴ overviews, explained below. The results are from research conducted in 2016 using the *Draft Step-by-Step Monitoring Methodology for Indicator 6.5.2* (UN-Water, 2016b). The differences between the draft and final methodology do not alter the outcomes of this analysis.

The first component of the analysis simulates the calculation of the Indicator from the perspective of an individual country for three case studies - Bangladesh, Honduras, and Uganda. This was completed as part of research supported by the Global Water Partnership (GWP); these countries were selected because they are part of the GWP SDG Preparedness Facility, which aims to assist countries in their implementation SDG 6 (GWP, 2016). Most importantly, the three countries present different contexts for evaluating the Indicator; they represent three different regions, with varied extents of transboundary river basins and aquifers. For transboundary areas, we used global datasets, including the TFDD's Spatial Database and the IGRAC and UNESCO-IHP delineations of transboundary aquifers (IGRAC, UNESCO-IHP, 2015; TFDD, 2016). Information on cooperative arrangements was collected from in-country representatives using the questionnaire⁵ and through secondary literature. The criteria for operationality were evaluated based on both the formal agreements and other aspects of cooperative arrangements that were not explicit in the agreements; these were identified using secondary literature.

Second, since Agenda 2030 is a global framework that will be viewed, monitored, and analyzed as a global dataset, we also applied the methodology consistently across all countries, in a global overview through research supported by UNESCO-IHP. This allowed us to consider the Indicator from a broader perspective. The same *Draft Step-by-Step Monitoring Methodology for Indicator 6.5.2* methodology was applied; however, data collection and sources differed between the national and global overviews. Given the scope of the global overview, the extensive research required to evaluate the criteria at the depth of the

national perspective was not feasible; therefore, the criteria were only evaluated against the articles and provisions within the formal arrangements on transboundary rivers, lakes, and aquifers. These arrangements were primarily found in global datasets including *inter alia* the TFDD's International Freshwater Treaties Database, the International Water Law project, and FAOLEX. As a result, the second component of the analysis provides an overview of transboundary cooperation as formalized in legal arrangements, but not necessarily as carried out in practice. We acknowledge that through the use of global datasets it is likely that some existing agreements have not been included.

By considering this methodology from the national and global perspectives, we hope to understand both the strengths and limitations of the definition of transboundary cooperation implied by SDG Indicator 6.5.2 and its methodology.

4. Analysis of SDG Indicator 6.5.2

4.1. National overview

To analyze the application of the Indicator's methodology, we considered transboundary water cooperation for three case studies: Bangladesh, Honduras, and Uganda, which have varied transboundary water systems. Bangladesh and Uganda (Figs. 2 and 4) are similar in that they both are nearly contained within one international transboundary river basin – the Ganges-Brahmaputra-Meghna and the Nile, respectively. Despite this, they differ in upstream–downstream orientation. Honduras (Fig. 3), on the other hand, has six international transboundary river basins, but combined, these only compose about 20% of the country's surface area. In terms of transboundary aquifers, Bangladesh has one major aquifer system, compared with Honduras and Uganda, which have several smaller transboundary aquifers. However, in all three countries – as with much of the world – aquifers have not been extensively assessed or mapped⁶.

Hydro-politically, the three countries also exhibit different levels and types of cooperation. For example, India and Bangladesh have signed the 1996 Ganges Water Sharing Treaty and participate in the Indo-Bangladesh Joint Rivers Commission (Hossain, 1998; Sood and Mathukumalli, 2011). In the Nile River Basin, there is a long history of conflict and cooperation; major agreements include the 1929 *Nile Waters Agreement* and the 1959 *Agreement for the Full Utilization of the Nile Water between Egypt and Sudan*. Recently, there has been several notable cooperative efforts throughout the basin, including the *Cooperative Framework Agreement* signed in 2010 – though not in force – and the Nile Basin Initiative, which was established in 1999 (Salman, 2013). Honduras has limited formal, State-to-State cooperation occurring on its internationally shared waters; the only agreement is the *Tratado entre las Repúblicas de El Salvador, Guatemala, y Honduras para la Ejecución del Plan Trifinio*, also known as the Trifinio Plan, that addresses water resources in the Upper Lempa river basin (López, 2004; UNEP, 2007). Much of the cooperation in transboundary river basins and aquifers is informal, local, or through the backing of third party international organizations.

For this study, the transboundary river basin area and transboundary aquifer area within Bangladesh (Fig. 2), Honduras (Fig. 3) and Uganda (Fig. 4) were mapped, specifying whether the area is under an operational arrangement for cooperation.

Following the methodology, the Indicator, as presented in Table 1 Column 2, results in the percent of the total transboundary area that has an operational cooperative arrangement. This value combines both

³ See: GWP. 2017. *Measuring transboundary water cooperation: options for Sustainable Development Goal Target 6.5*. Authored by Melissa McCracken. TEC Background Paper No. 23. Stockholm, Sweden.

⁴ See: Meyer, Chloé. 2016. *Cartographie de l'indicateur 6.5.2 des Objectifs du Développement Durable des Nations Unies, sur la coopération transfrontalière pour la gestion des ressources en eau partagées*. Master Thesis: Université Paris Ouest Nanterre La Défense.

⁵ The template for the questionnaire used in the national overview study was from the Eleventh Meeting of the Working Group on IWRM on 18–19 October 2016 in Geneva: http://www.uneca.org/fileadmin/DAM/env/documents/2016/wat/10Oct18-19WGIWRM/WG.1_2016_INF5_report.pdf.

⁶ The global IGRAC and UNESCO-IHP delineations of transboundary aquifers (IGRAC, UNESCO-IHP, 2015) were used for aquifer areas. This global dataset provides a good representation of the location and area of transboundary groundwaters. In the future, the accuracy of the SDG 6.5.2 calculation could be improved with additional assessment of aquifer systems.

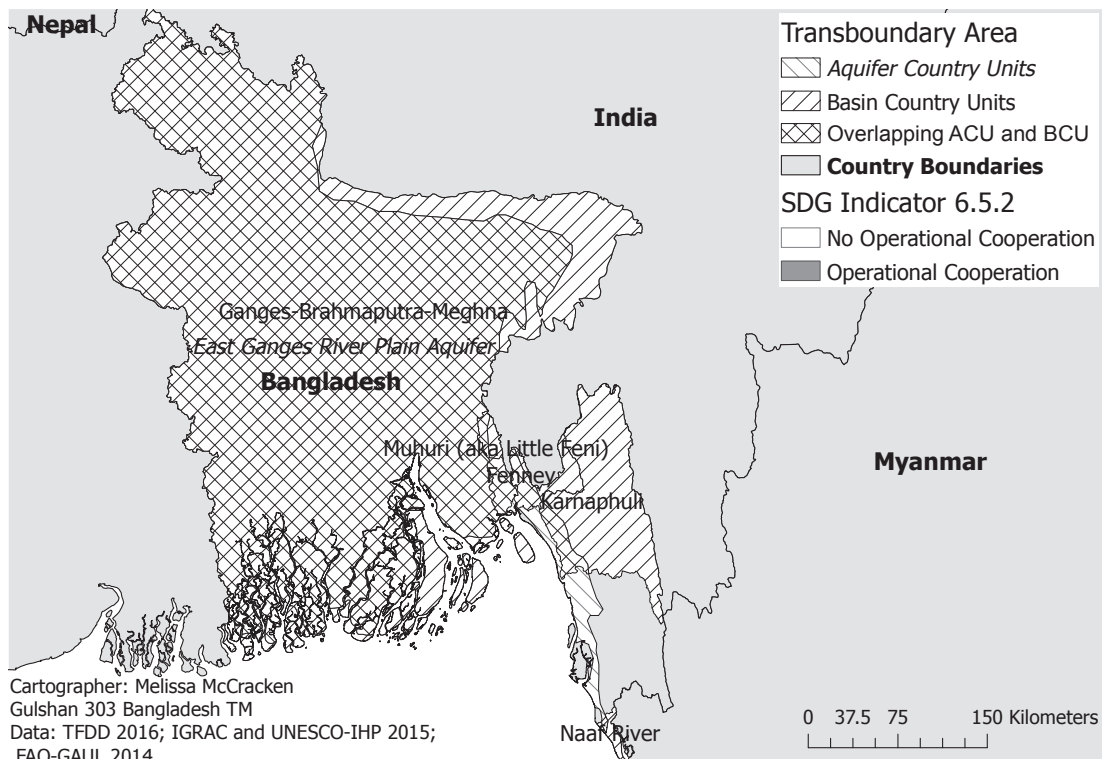


Fig. 2. Operational cooperation in Bangladesh’s transboundary area. This map shows Bangladesh’s BCUs and ACUs with and without operational cooperation according to SDG Indicator 6.5.2. (TFDD, 2016; IGRAC, UNESCO-IHP, 2015; FAO-GAUL, 2014).

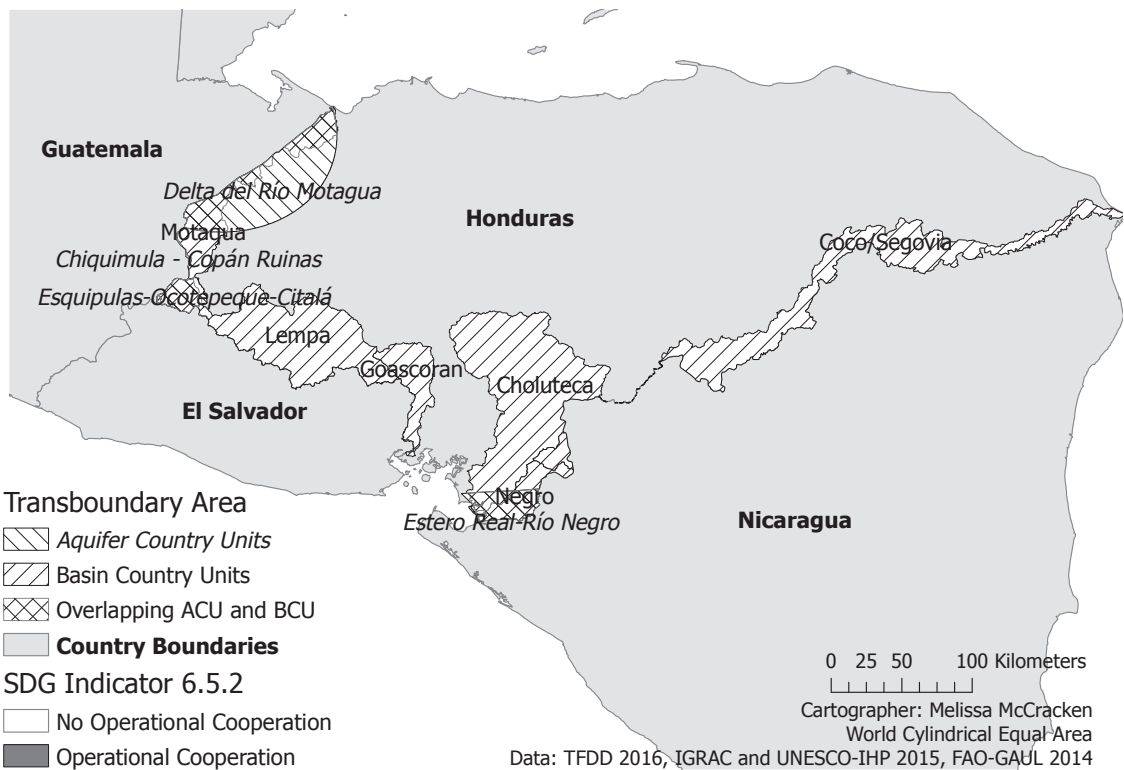


Fig. 3. Operational cooperation in Honduras’s transboundary area. This map shows Honduras’s BCUs and ACUs with and without operational cooperation according to SDG Indicator 6.5.2. (TFDD, 2016; IGRAC, UNESCO-IHP, 2015; FAO-GAUL, 2014).

transboundary river basin and aquifer areas, which may obscure cooperation occurring or hide a lack of cooperation because of the weight implied by the use of area in the calculation. Generally, there is significantly more cooperation occurring over transboundary river basins

than transboundary aquifers. The composition of the SDG Indicator allows for the values to be disaggregated by type of water resources, i.e. to calculate the Indicator for transboundary river basin area and transboundary aquifer area separately, which is illustrated in Table 1

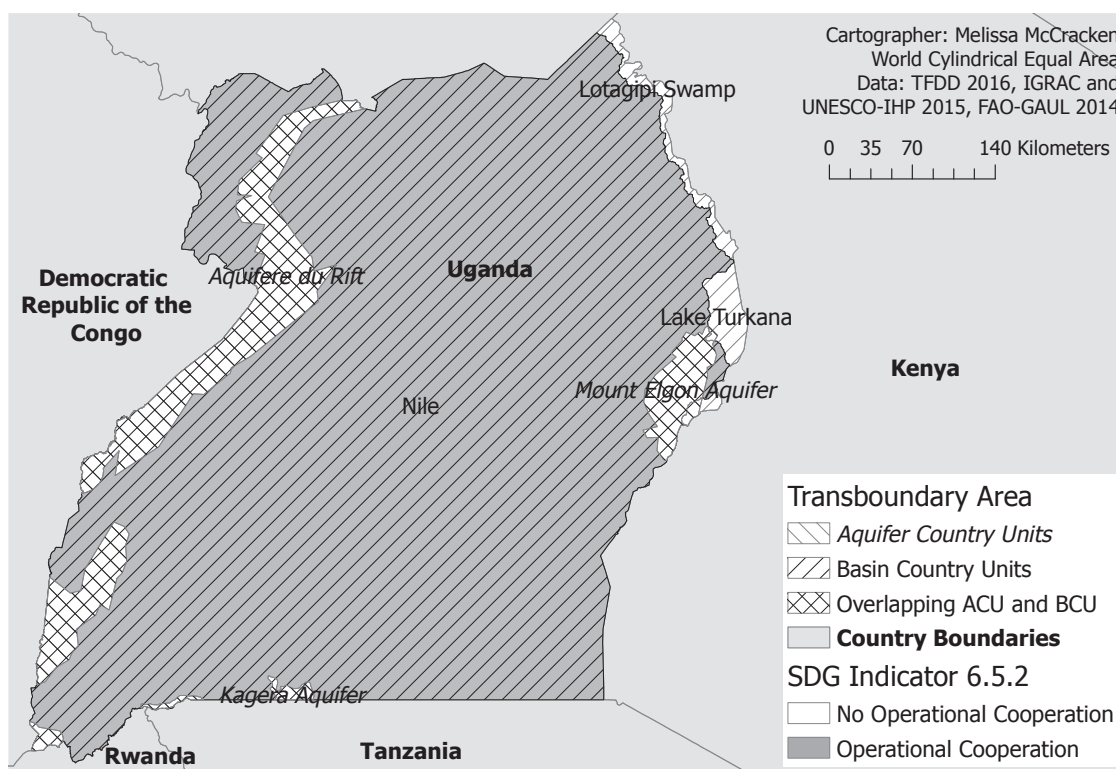


Fig. 4. Operational cooperation in Uganda's transboundary area. This map shows Uganda's BCUs and ACUs with and without operational cooperation according to SDG Indicator 6.5.2. (TFDD, 2016; IGRAC, UNESCO-IHP, 2015; FAO-GAUL, 2014).

Table 1

Results of calculating SDG Indicator 6.5.2 for Bangladesh, Honduras, and Uganda. Table 1 presents both the overall Indicator (Column 2) and disaggregated values (Columns 3 and 4) (GWP, 2017).

1: Country	2: SDG Indicator 6.5.2: Proportion of Total Transboundary Area with an operational arrangement	3: Proportion of Transboundary Aquifer Area with an operational arrangement	4: Proportion of Transboundary River Basin Area with an operational arrangement
Bangladesh	0%	0%	0%
Honduras	0%	0%	0%
Uganda	90%	0%	98%

Columns 3 and 4. Disaggregating the Indicator will be important to provide a more accurate picture of where cooperation is occurring within the country and will aid in determining where diplomatic efforts may need to be targeted to increase the level of cooperation.

As can be seen in Figs. 2–4 and Table 1, neither Bangladesh nor Honduras have any transboundary area – river basin or aquifer – that has operational cooperation, as not all the criteria required by the methodology has been met. As seen above, Uganda has operational cooperation occurring within the Nile River Basin. Because the Nile River Basin constitutes majority of Uganda's transboundary area, it yields a high value for the Indicator of 90 percent. This high value for SDG Indicator 6.5.2 hides the lack of operational cooperation on transboundary aquifers, which is made apparent when results are disaggregated, as demonstrated in Table 1. Furthermore, the structure of the Indicator may hide components of cooperation that are occurring but are not enough to satisfy all the criteria for operational cooperation. This is made apparent when disaggregating the Indicator by its four criteria as shown by Table 2, which presents the break down for the fulfillment of criteria for the BCUs and ACUs for the three case studies.

The national overview highlights the need for significant knowledge

of cooperative processes in order to accurately determine the operability of an arrangement. It appears essential to look beyond the single Indicator value to better understand and represent the cooperation process that might be occurring. Therefore, countries should be invited to acknowledge the complexity of cooperative processes and provide as detailed information as possible when monitoring and reporting on the Indicator. Similarly, agencies and organizations using the Indicator should be aware of the complexity and take account of the detailed information provided by the reporting countries.

4.2. Global overview

From a global perspective, SDG Indicator 6.5.2 varies widely between regions and countries (Fig. 5). Based on existing arrangements, States with the highest proportion of transboundary area under an operational arrangement for water cooperation are located in Europe, Africa, and North America. East and West Africa present mixed values for the Indicator, as do Central and South America. SDG Indicator 6.5.2 is generally very low throughout the Middle East as well as in Asia and the Pacific; there are notable exceptions in Central and Southeast Asia.

Large BCUs and ACUs that compose the majority of a country's area, such as in Bangladesh and Uganda as discussed in Section 4.1, may artificially weight the value of the Indicator positively or negatively depending on whether the area has operational cooperation. This may cause smaller BCUs or ACUs to be overlooked, as they will not affect the value of the Indicator as much as larger basins. The weight from these large areas can result in clusters of States with a particularly high or low proportion of transboundary basin area with an operational arrangement. For instance, in Central Europe, many countries have a high Indicator value, due to the existence of operational water cooperation within the Po, Rhine, and Danube River Basins. The latter basin spans 19 States, of which 15 are contracting parties to the *Convention on Cooperation for the Protection and Sustainable Use of the Danube River* (1994). Central Asia presents a similar case with the Aral Sea Basin,

Table 2

List of ACUs and BCUs for Bangladesh, Honduras, and Uganda and whether there is operational cooperation, a cooperative arrangement, and which criteria for operational cooperation have been fulfilled.

Country ACUs and BCUs	Operational Cooperation (Yes/no)	Cooperative Arrangement	Joint body, mechanism, or commission	Regular Meetings	Joint management plan	Regular data and information exchange
Bangladesh BCUs						
Fenney	No	No	Yes	Yes	No	No
Karnaphuli	No	No	Yes	Yes	No	No
Muhuri (aka Little Feni)	No	No	Yes	Yes	No	No
Ganges-Brahmaputra-Meghna	No	Yes	Yes	Yes	No	Yes
Naaf River	No	No	No	No	No	No
Bangladesh ACUs						
East Ganges River Plain Aquifer	No	No	No	No	No	No
Honduras BCUs						
Choluteca	No	No	No	No	No	No
Coco/Segovia	No	No	No	No	Yes	No
Goascorán	No	No	Yes	Yes	Yes	No
Lempa	No	Yes	Yes	Yes	Yes	No
Motagua	No	No	No	No	No	No
Negro	No	No	No	No	No	No
Honduras ACUs						
Esquipulas-Ocotepeque-Citalá	No	No	No	No	No	No
Estero Real-Río Negro	No	No	No	No	No	No
Chiquimula - Copán Ruinas	No	No	No	No	No	No
Ostua-Metapán	No	No	No	No	No	No
Delta del Río Motagua	No	No	No	No	No	No
Uganda BCUs						
Lotagipi Swamp	No	No	No	No	No	No
Lake Turkana	No	No	No	No	No	No
Nile	Yes	Yes	Yes	Yes	Yes	Yes
Uganda ACUs						
Mount Elgon Aquifer	No	No	No	No	No	No
Kagera Aquifer	No	Yes	No	No	No	No
Aquifere du Rift	No	Yes	No	No	No	No

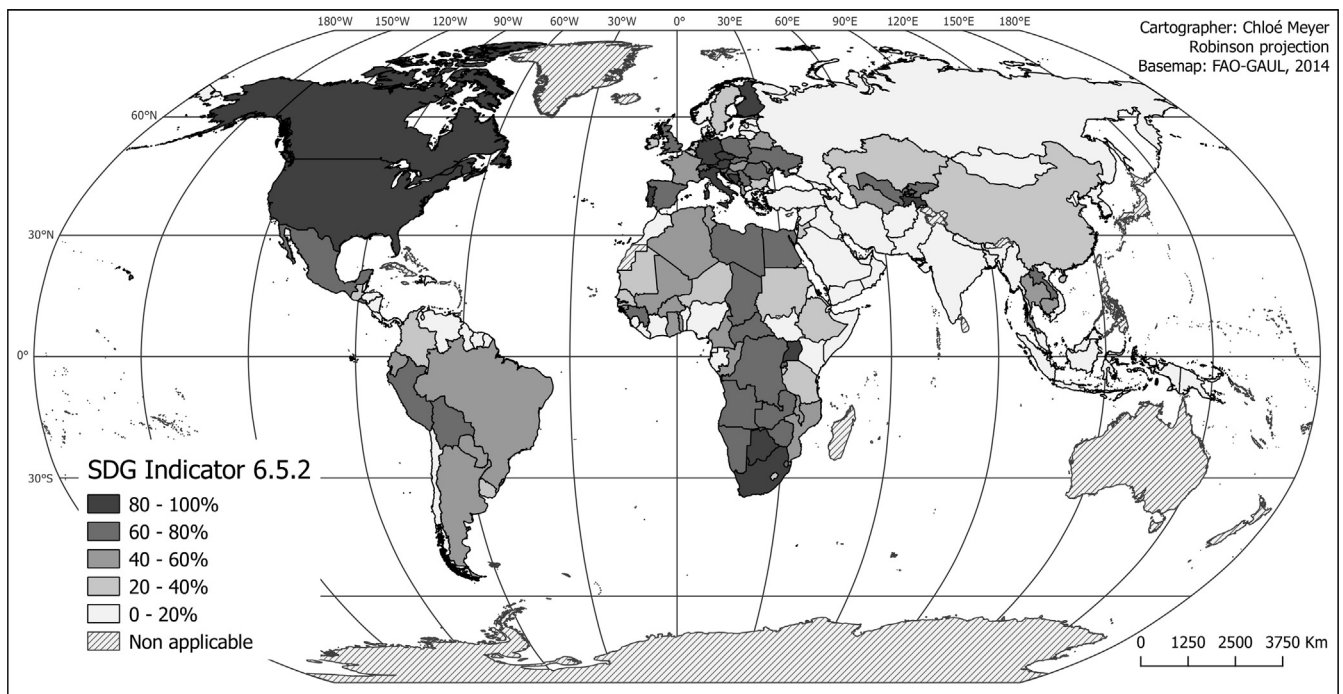


Fig. 5. Global overview of SDG Indicator 6.5.2. This map shows, for each country, the proportion of transboundary basin area with an operational arrangement for water cooperation. (FAO-GAUL, 2014).

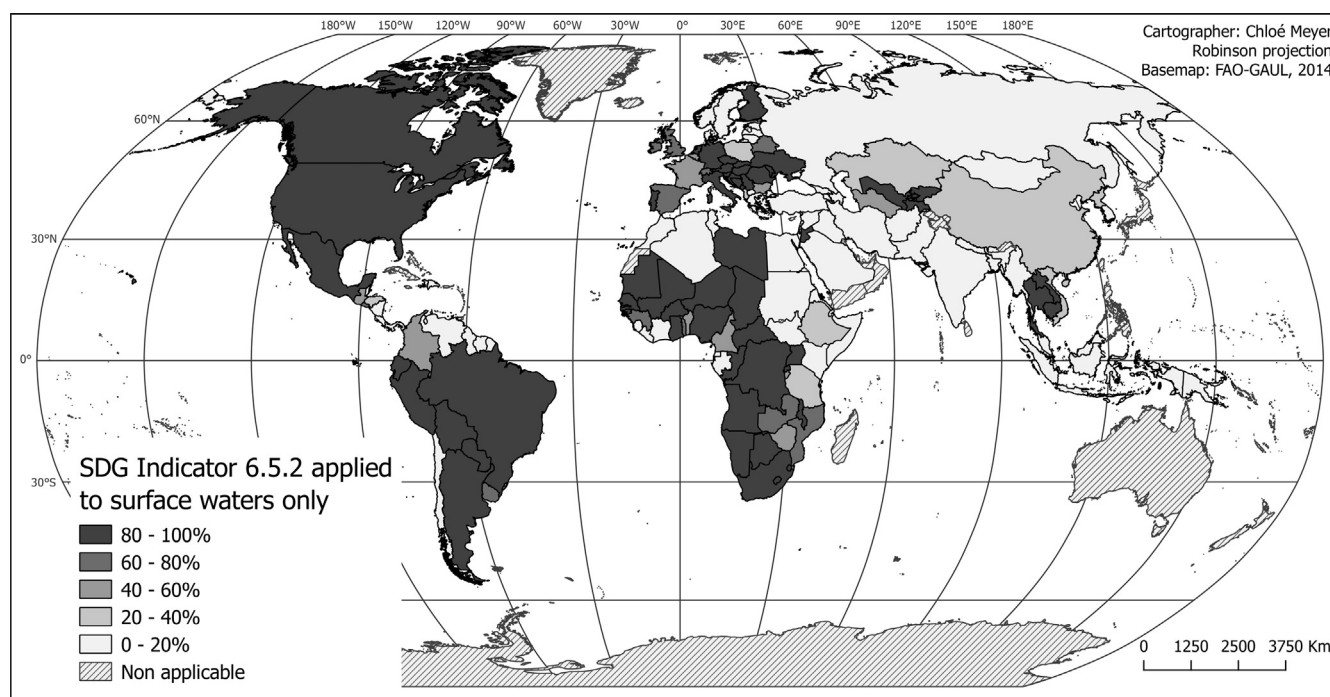


Fig. 6. SDG Indicator 6.5.2 for surface water only. This map shows, for each country, the disaggregated Indicator for the proportion of transboundary surface water basin area with an operational arrangement for water cooperation. (FAO-GAUL, 2014).

shared between Afghanistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan. With the exception of Afghanistan, all the riparian countries have agreed to the *Statute of the Interstate Commission for Water Coordination of Central Asia* (2008), an arrangement that meets all the conditions for operability of SDG Indicator 6.5.2.

Although SDG Indicator 6.5.2 gives a specific overview of cooperation that may not capture the full spectrum of cooperative processes between riparian countries. This confirms the observation made

in the national overview analysis that in order to better represent the extent of cooperation, it is essential to disaggregate data by type of water resources – surface water and groundwater, as evidenced in Figs. 5 to 7. When disaggregated, the data exemplify the lack of formalized operational cooperation for transboundary aquifers compared to transboundary river basins, as also shown in Table 3. This makes apparent the ability of operational cooperation in transboundary river basins to mask the lack of operational cooperation in transboundary

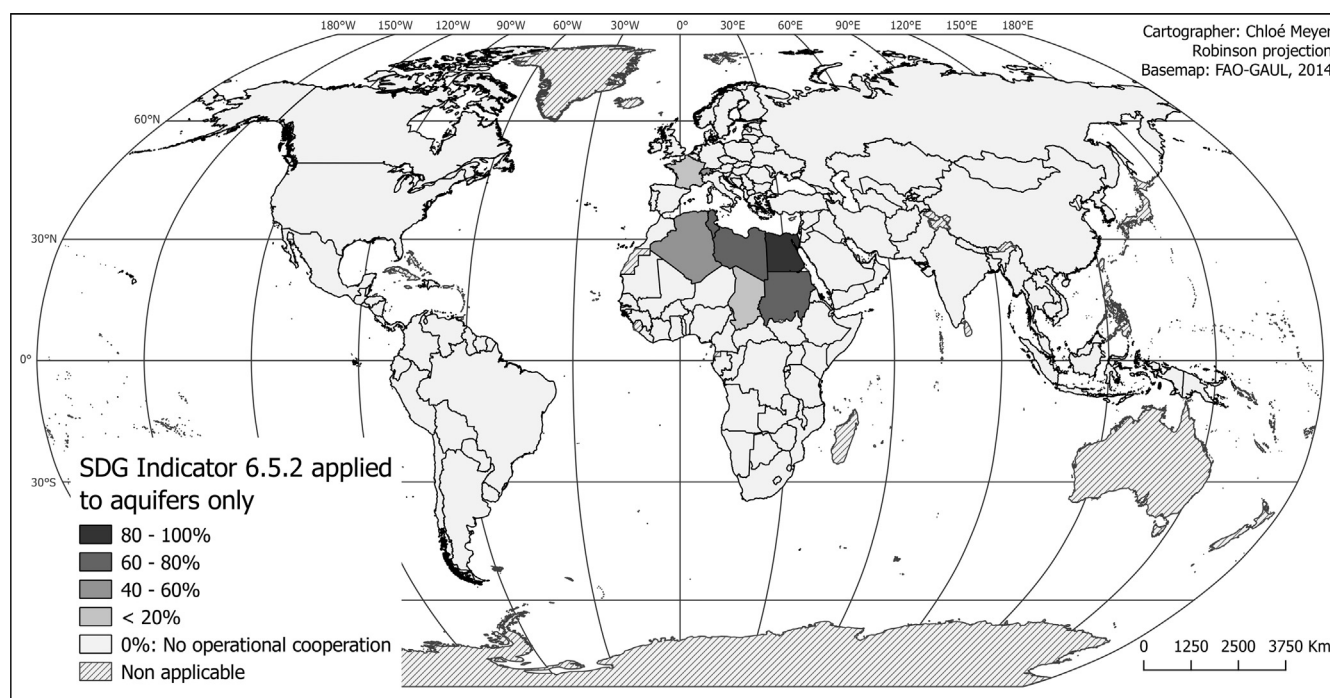


Fig. 7. SDG Indicator 6.5.2 for aquifers only. This map shows, for each country, the disaggregated Indicator for the proportion of transboundary aquifer area with an operational arrangement for water cooperation. (FAO-GAUL, 2014).

Table 3

Results of calculating SDG Indicator 6.5.2 for the global overview. Table 3 presents SDG Indicator 6.5.2 (Column 2) and the disaggregated values per type of water resources (Columns 3 and 4).

1: Region	2: SDG Indicator 6.5.2: Proportion of Total Transboundary Area with an operational arrangement	3: Proportion of Transboundary Aquifer Area with an operational arrangement	4: Proportion of Transboundary River Basin Area with an operational arrangement
Africa	52.0%	28.6%	67.1%
America	64.9%	0%	90.8%
Asia and the Middle East	8.4%	0%	11.7%
Europe ^a	27.5%	0.1%	31.7%

^a It should be noted that discrepancies between the European Framework Directive definition of transboundary groundwater bodies and the internationally adopted definition for transboundary aquifers could result in minor differences in measuring the SDG Indicator 6.5.2 for some EU countries.

aquifers.

Table 3 illustrates the gap between transboundary surface water and groundwater in terms of development of operational cooperation. Worldwide, only three transboundary aquifers have an operational arrangement for water cooperation: the Genovese aquifer shared by France and Switzerland, the Nubian Sandstone aquifer system, which is shared by Libya, Egypt, Chad, and Sudan, and the Northwestern Sahara aquifer system, which is jointly managed by Algeria, Tunisia, and Libya. The lack of formal, operational cooperation over shared groundwater resources partially stems from, until recently, limited scientific and technical knowledge regarding their location, extent, and other physical characteristics.

Indeed, the first world map of transboundary aquifers was published in 2008 only, by the Federal Institute for Geosciences and Natural Resources (BGR) and UNESCO-IHP; it comprised 273 shared aquifers (BGR and UNESCO, 2008). Since then, the assessment of transboundary aquifers has continued to progress. In 2012, the map of the *Transboundary aquifers of the world* identified 445 aquifers, followed by 592 in the 2015 edition (IGRAC, UNESCO-IHP, 2012, 2015). This underlines the importance of disaggregating SDG Indicator 6.5.2 by type of water resources to get a clearer picture of where operational cooperation processes are happening or lacking. Furthermore, it is beneficial for water stakeholders and managers to understand the difference in extent of cooperation between surface and groundwater in order to highlight areas and hydrogeological units without operational transboundary cooperation (GWP, 2017). However, the recent progression of identification and delineation of aquifers highlights a potential difficulty States may encounter when reporting on the Indicator: lack of data and information about aquifers may make it difficult to report as well as difficult to develop cooperative arrangements.

Considering these results and processes through which we calculated SDG Indicator 6.5.2 for both the national and global overviews, several observations can be made about the Indicator and its methodology for defining and quantifying transboundary cooperation.

5. Discussion: Strengths and limitations of SDG Indicator 6.5.2 in measuring transboundary water cooperation

The criteria used to define operational cooperation – river basin organization, meetings, data exchange, and joint management plans – all support procedural rules within international water law. These criteria for the Indicator will support States in meeting their obligations, particularly for the newly in force 1997 UN Watercourses Convention and the newly opened to non-ECE States 1992 UNECE Water Convention (UNECE, 2016). These procedural rules and their derivative criteria support the research stating that States should be encouraged to develop adequate institutional capacity in order to reduce the potential for dispute (Wolf et al., 2003). The broad nature of the criteria related to meeting and joint management allows for the inclusion of wide forms of cooperation, although the lack of a precise definition leaves room for interpretation and could lead to discrepancies in reporting between riparian countries. Furthermore, the Indicator is relatively

straightforward to calculate and yields a singular value that can be easily quoted. The methodology also allows for the disaggregation of results by type of water resources, which provides better insight into where operational cooperation is missing. Although not highlighted in the methodology, the design of SDG Indicator 6.5.2 also offers the possibility to disaggregate data by criteria of operationality, which can illustrate the procedural elements that are lacking in cooperative arrangements. Overall, this aids in making the Indicator a potentially effective tool for encouraging policy change. In that sense, SDG Indicator 6.5.2 constitutes a first stage towards the monitoring of transboundary cooperation and seems to fit the needs for global monitoring within Agenda 2030.

Even though this Indicator and its interpretation are based on international water law and current academic thinking regarding increases in institutional capacity, the Indicator presents a high level of complexity and several limitations. Thus, we present and discuss those limitations as illustrated by the national and global overviews.

In general, a zero percent for SDG Indicator 6.5.2 indicates that there is no operational cooperation, but this also may imply that there is no cooperation at all, which is not the case for many shared waters. This results from the binary, categorical structure of this conceptualization of operational cooperation. To be operational, an arrangement must meet all the four criteria embedded in the methodology, meaning a cooperative arrangement is either operational or not – there is no in-between. As a result, SDG Indicator 6.5.2 masks cooperative processes that do not meet all the criteria, as shown in Table 2. For example, in Bangladesh's BCU for the Ganges-Brahmaputra-Meghna River Basin only one criterion is not met – the implementation of joint plans or joint objectives – 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 managed by the Trifinio Plan and Tri-National Commission. These two examples exemplify areas where cooperation is occurring but is not recognized as operational under the Indicator. The *Draft Step-by-Step Monitoring Methodology for SDG Indicator 6.5.2* (as well as the Final January 2017 Version) 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, the binary – yes or no – nature of the Indicator is likely to mask positively evolving cooperation and stepwise progress made towards operationality during the monitoring and reporting timeframe, unless each criterion of SDG Indicator 6.5.2 is satisfied. For example, negotiations for the Ganges Water Sharing Treaty started in 1950; four decades later the agreement was finally signed in 1996 (Hossain, 1998). Still, the arrangement on the Ganges is not considered operational under the Indicator. Achieving operational cooperation as conceptualized by SDG Indicator 6.5.2 may never be attainable for some basins and aquifers due to the hydro-political context. Given the importance of political will in establishing transboundary cooperation, as discussed in the Introduction, recognizing steps made towards

cooperation is essential for encouraging countries in their efforts. The evolution of the methodology for SDG Indicator 6.5.2 will have to include parameters to overcome the difficulty in accurately displaying all progress made towards cooperation. This is particularly important, as it has the potential to encourage countries to continue pursuing and developing cooperation, and to prevent the diversion of funding and other resources from transboundary basins and thus, countries, that artificially – through the Indicator – do not show progress towards cooperation.

Compared to the Draft April 2016 Version, the January 2017 final *Step-by-Step Methodology for Indicator 6.5.2* has been updated to allow for the consideration of operational arrangements that are at the sub-basin scale. This allows transboundary sub-basin areas to count toward the Indicator even if the basin, as a whole, does not have a cooperative arrangement or an operational cooperative arrangement (UN-Water, 2017a). This adjustment could allow for a more precise depiction of transboundary cooperation. However, it also raises several questions related to its implementation: i) how to address arrangements that do not cover all the area of a transboundary basin? ii) how to address arrangements that only cover a limited set of substantive rules or issues? For example, the Ganges Water Sharing Treaty determines the allocations between India and Bangladesh at the Farakka Barrage. This treaty is limited in scope and extent, as it only addresses allocation at a particular point in the basin. If all the criteria were to be fulfilled by Bangladesh and it was considered to be an operational cooperative arrangement, which area would this apply to for the calculation of SDG Indicator 6.5.2 – the whole basin or the point at Farakka? Furthermore, should the cooperative arrangement be considered equivalent to an arrangement that includes additional issues that impact the transboundary management of the basin, such as environmental flows, fisheries, or water quality concerns. Do and should the substantive issues that are encompassed in a cooperative arrangement matter when evaluating its operationality? Although the current methodology for the calculation of SDG Indicator 6.5.2 does not aim at evaluating the scope of arrangements, it does present a critical issue when comparing the degree of cooperation between countries. The nature of indicators lends to comparison; however, operational cooperative arrangements are not comparable nor equivalent as represented in the Indicator.

Another methodological issue is how to account for the overlapping of hydrological management units with differing arrangements. For example, the Democratic Republic of Congo is party to two operational arrangements under SDG Indicator 6.5.2: one for the management of the Congo basin, and a second for the management of the Tanganyika Lake Sub-Basin. As a result, the Tanganyika Lake Sub-Basin is covered by two operational arrangements with different scopes and provisions. In that case, and considering that a transboundary basin area should only be accounted once, which agreement should be taken into account for the calculation of the Indicator?

Overlapping hydrological features are also physically observed, since transboundary surface waters are often underlain by a portion of or a full transboundary aquifer (Fig. 1). Given the significant disparity in coverage of operational cooperation between transboundary basins and aquifers, a solution could be to integrate the management of those groundwater resources with the agreements of the shared surface waters. This is already observed in some transboundary surface water basins. Although, the scope of such conjunctive treaties is still limited to institutional issues (Lautze et al., 2018). It is unlikely that such treaties would fit the requirements of SDG Indicator 6.5.2 in terms of operational cooperation for transboundary groundwaters. Additionally, since transboundary aquifers rarely lie entirely underneath a single transboundary river basin and can even underlie several river basins, conjunctive treaties have the potential to spatially fragment and further complexify the management of shared aquifers.

As law and governance discourse have migrated toward the use of the basin scale as the main unit of consideration, the use of area as the base metric for calculating the extent of transboundary cooperation is

understandable. However, the use of area in the Indicator's calculation implies a weight to larger basins and aquifers, which may not correlate with the importance of the basin or aquifer nor align with where cooperative and diplomatic efforts need to be emphasized. Other alternatives to area could be considered, such as volume of water, number of people dependent on the resource or number of agreements. For example, the *Draft 3rd State of the Nile Report Indicators* includes a measure of transboundary water cooperation that is determined by the percent of countries a country has cooperative agreements with (AbuZeid 2016). However, metrics, such as volume, may similarly imply a weight to basins in more humid climates.

Although SDG Indicator 6.5.2 focuses on State-to-State cooperation, much of the cooperative processes may be occurring at the regional or local level, since the political context may not allow for cooperation at the level of the national governments. Additionally, cooperation may be easier to initiate at a local scale than over a large area in an international context. In Honduras, for example, much of the cooperative processes have been occurring at the local level. In that case, the role of third parties was also particularly important; IUCN, UNEP, and UNESCO-IHP were critical in initiating the cooperative efforts. Without national government involvement, the local scale cooperation is likely to remain dependent on third parties for financial support. This results in an unsustainable framework, and cooperative efforts may not be effective or may fail over time due to the lack of support.

The *Step-by-Step Methodology for Indicator 6.5.2* recognizes some of its limitations and gives particular attention to the fact that not all riparians may be parties to a transboundary arrangement. The document states that “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, 2017a, p. 3). This acknowledges that the focus on the country scale may mask gaps in cooperation within a basin or aquifer. For example, in the Uganda case study discussed earlier, the Nile River Basin was found to have operational cooperation; however, not all riparians participate in the Cooperative Framework Agreement – Egypt, the Democratic Republic of the Congo, South Sudan, and Sudan are yet to sign the agreement. Therefore, the methodology recommends aggregating the data across the basin, in addition to the national scale. While the exclusion of riparians from cooperative arrangements is not ideal, the methodology recognizes that it is still important for the indicator to acknowledge partial cooperative efforts that are occurring in multilateral basins and aquifers, given that full multilateral and operational arrangements may not be possible depending on the social or political context. However, the inclusion or exclusion of a riparian from a cooperative arrangement would only be apparent when considering the Indicator across a single river basin or aquifer rather than just the country scale. The national focus on country level indicators is a requirement of the SDG framework to which the SDG Indicator 6.5.2 must adhere; however, this is inconsistent with the push towards basin- or aquifer-scale governance and management, which countries should be cognizant of when utilizing the Indicator and developing cooperative arrangements.

Ultimately, SDG Indicator 6.5.2 presents at first sight a simple, straightforward methodology that seems to meet the requirements of Agenda 2030. However, the challenge of developing a sole global indicator for assessing transboundary water cooperation, given its inherently high political nature, has resulted in several limitations in the definition of the Indicator and its measurement of operational cooperation for transboundary waters. When calculating the Indicator, this implies limited results and a binary, biased depiction of cooperation in terms of forms and locations. The scope, including the substantive issues, extent of coverage of a cooperative arrangement, weight and importance of a particular shared water source, and the political and social context needs to be considered in addition to the procedural criteria that the Indicator reflects. In addition, there is significant value

in considering the disaggregated data within a particular basin or aquifer from all the different riparians, as well as the aggregated data for a basin or aquifer; this captures an alternative view of transboundary cooperation that may not be visible with national level data, particularly in multilateral basins. Nonetheless, SDG Indicator 6.5.2 offers a first-step, monitoring tool that could be used by States to initially gather information and initiate interest for developing mutually beneficial transboundary cooperation. Considering the 15-year timeframe of the SDG process, there is potential and need for the methodology to be improved, particularly with feedback from countries over the course of the next fifteen years

6. Way forward

As countries and agencies work with the Indicator, they should be aware of data reliability. A key element for accurate calculation and monitoring of SDG Indicator 6.5.2 is the State's capacity to access and gather reliable data on their shared waters, the existing arrangements, and the four criteria for operationality. The quality of data from countries is likely to be inconsistent across the globe. This may be due to the data gap faced by some countries - particularly developing ones; the difficulties experienced in accessing and collecting relevant information, or the incorrect or incomplete submission of the reporting questionnaires. In particular, the accuracy of responses to questionnaires depends on how they are filled out and on which stakeholders participate to the reporting process. If needed, countries could use open -access databases such as the TFDD River Basin Organization and Treaties Databases, FAOLEX⁷, and EUR-Lex⁸, as secondary sources of information on river basin organizations and cooperative arrangements. Other open-access databases such as the Transboundary Waters Assessment Programme⁹, the UNESCO-IHP Water Information Network System¹⁰, and the TFDD's Spatial Database¹¹ can also provide countries with access to spatial data on their transboundary river basins and aquifers. This may be particularly helpful for the delineation of transboundary aquifers, which countries often lack and may face difficulties in producing over short time frames or due to lack funds and capacities. As the aforementioned databases only provide information at the transboundary basin scale, disaggregation and reporting of the Indicator at the sub-basin scale may only rely on spatial data from States, which may not be available in every country. Without proper delineations, reliable calculation of the Indicator will not be possible. In that sense, the role of the UNECE Water Convention Secretariat and UNESCO-IHP as custodian agencies will be critical, in order to provide Member States with support and guidance in the monitoring and reporting of the Indicator, but also to ensure quality reporting on SDG Indicator 6.5.2.

In order to be more consistent and accurate in capturing transboundary water cooperation, the methodology could be updated in the future to allow for the recognition that each basin or aquifer is unique with a different set of physical and hydro-political conditions that result in different structures, scopes, extents, etc. of cooperative arrangements. One potential recommendation would be to transform SDG Indicator 6.5.2 into an index. In this vision of the Indicator, the presence of i) a joint commission/authority/organization, ii) regular meetings, iii) exchange of data and information, and iv) joint management plans and/or objectives, would be accounted for separately. This would give a more nuanced picture of cooperation. It would also track progress towards the criteria for operationality that are currently masked by the binary nature of the Indicator. Additionally, the index

could be expanded to also consider substantive rules or particular issues such as allocation, water quality, conflict resolution, and environmental protection, which are currently absent in the present iteration of the Indicator. This would potentially address the current assumption that arrangements are equivalent if they meet the procedural criteria. Furthermore, addressing the level of implementation of the cooperative arrangement could help identify paper tigers, i.e. when formalized cooperation is not reflected in practice or when the arrangement does not address the issues at hand. For example, despite the operational arrangement within the Aral Sea Basin, the institutional framework lacks integration and cooperation and is often inhibited by conflicts of interest and insufficient coordination (UNEP, 2014). Future updates to the Indicator could include accounting for the quality of cooperation and not just the presence or absence of specific criteria.

SDG Indicator 6.5.1 presents an example of an index based on a percentage approach in comparison to SDG Indicator 6.5.2's binary construction. The methodology for the degree of implementation of IWRM in SDG Indicator 6.5.1, as briefly mentioned in the Background section, allows countries to rate their progress towards each question in the survey by six thresholds, which are then averaged to yield an index value for the SDG Indicator 6.5.1. Similarly, it allows for the disaggregation of the index to provide an assessment of the degree of implementation of the four components measured by the survey on IWRM (UN-Water, 2017e). An index variation of SDG Indicator 6.5.2 could allow for additional development of the criteria for operationality to identify the state of cooperation and acknowledge what cooperation is occurring. For example, the criterion for data and information exchange could be separated into levels, such as 1) transfer of data, 2) data harmonization, and 3) joint data collection. SDG Indicator 6.5.1 presents an interesting comparison to how an index could be developed for SDG Indication 6.5.2.

7. Conclusion

The 2030 Agenda, with Target 6.5 and SDG Indicator 6.5.2, presents a unique opportunity at the international policy level to promote and measure transboundary cooperation and encourage water diplomacy, by building institutional capacity that allows States to adapt and respond to the increasing demands on shared water resources, the changing climate, and the evolving hydro-political context. We simulated the calculation of SDG Indicator 6.5.2 in two overview analyses - a global overview analysis and a national overview analysis of three case studies. The results illustrate the high variability in the occurrence of operational cooperation across the globe, with countries in Europe and Africa meeting more of the criteria for operationality. In addition, operational cooperation occurs more frequently over shared surface waters than over shared aquifers. While indicators are useful to inform decision-making, they can have embedded aspects that support a specific approach or position (Hezri, 2004). It is important for countries, agencies, and users to recognize the assumptions made in developing the Indicator and that it is endogenous to the cooperative processes it is measuring. Therefore, SDG Indicator 6.5.2 should not be considered a panacea to improve all efforts towards transboundary cooperation, but rather as a reflection of the current positions on thinking surrounding transboundary cooperation from an international development perspective. As a result, we must recognize the benefits and limitations of SDG Indicator 6.5.2 and its framework as a first global step for measuring transboundary water cooperation. The discussion in Section 5 identifies several benefits, including the development of institutional capacity, support for international water law, and the versatility of aggregation and disaggregation of the Indicator. Similarly, several limitations and considerations were demonstrated including oversimplification of the hydro-political context; normative and procedural criteria; exclusion of substantive issues; overlooking of informal cooperation, non-state actors, and the role of third parties; and the focus on national scale of analysis compared to a basin or aquifer scale.

⁷ FAO Legal and Policy Database: <http://www.fao.org/faolex/en/>.

⁸ EUR-Lex Access to EU Law: <http://eur-lex.europa.eu/homepage.html>.

⁹ TWAP River Basins Interactive Data Portal: <http://twap-rivers.org/indicators/>.

¹⁰ UNESCO IHP-WINS: <http://en.unesco.org/ihp-wins>.

¹¹ TFDD: <http://www.transboundarywaters.orst.edu/>.

Finally, Section 6 discusses a potential way forward as the Indicator evolves and adapts during the 15-year SDG time frame in response to country feedback.

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