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Data sharing in transboundary waters: Current extent, future potential and practical recommendations

Key messages

- ***Data exchange in transboundary waters is insufficient.*** To achieve effective river basin management and efficient progress toward global development targets, a substantial augmentation in the volume and frequency of data exchange is needed. The Global Acceleration Framework (UN-Water 2020) puts data and information, and its exchange, at the core of attaining development targets.
- ***Data exchange benchmarks can benefit from adapting to basin contexts.*** While global legal instruments (e.g., the 1992 *Water Convention* and 1997 *Watercourses Convention*) set out general commitments to exchange data, basin-specific cooperation requires those general commitments to be adapted to particular contexts.
- ***Data exchange can start with a 'first-step' set of baseline parameters.*** Given the widespread challenges of data exchange, it may be beneficial to start on a small scale initially and scale up progressively. Ideally, initial data exchange efforts should be focused on parameters of the greatest data needs in *at least* three key categories: (i) water quantity data; (ii) water quality data according to locally relevant parameters; and (iii) water use data.
- ***Periodic assessments of data exchange needs can ensure that data exchange aligns with evolutions in needs.*** Periodic review of data sharing needs may help to ensure that data exchange modalities remain up-to-date. Such data exchange needs assessments could form part of activities such as river basin plans and data exchange protocols.
- ***Need for data exchange can be promoted by encouraging the practical application of data.*** The use and application of data can be stimulated. Collaborating with universities and research institutes, for example, may enhance the use of data in activities such as modelling of alternative dam operations, water quality risk assessments, or environmental impacts.

Data exchange in transboundary waters is fundamental to advance cooperation in water management. Nonetheless, the degree to which data are actually shared is falling short of basin-level and international targets. A global assessment revealed that a reasonable proportion of river basins exchange some data, but the breadth of such exchange is often limited and not regular. More in-depth examination of African basins nonetheless suggests that a real need for, and use of, water data appears to motivate exchange. Indeed, evidence suggests that data exchange needs which are more directly felt enhance exchange, e.g., the direct need to minimize flood impacts or manage transboundary infrastructure. As such, data sharing is much more likely to be considered as being successful if it responds to a palpable need and serves practical uses. Also, in developing data exchange programs, it may be prudent to adopt a focused and sequential approach to data exchange that starts with a short-list of most needed parameters.

Downloading data in a monitoring borehole on the Tuli Karoo transboundary aquifer (*photo:* F. Ramusiya).

Introduction

Why data exchange in river basin management? Intrinsic interconnections of natural systems call for integration of data to enable holistic management of natural resources for sustainable development. In river basins that cross international borders, development in one state can negatively affect other states. Further, integrated management – based on integrated data – can optimize the total benefits derived from water management and support cooperation. For example, in the Mekong River Basin, monitoring and exchange of data on river flows helps to balance the benefits derived from ecological processes and hydropower generation (MRC 2021). In contrast, fragmented management – based on disaggregated data – can limit the benefits derived from water management and drive tension.

International principles, practical challenges and knowledge gaps. Under the 1992 *Water Convention* and the 1997 United Nations *Watercourses Convention*, countries in a shared watercourse are obliged to exchange data and coordinate on water management. As reasonable as this may seem, evidence (e.g., Thu and When 2016; Plengsaeng et al. 2014) suggests that several challenges routinely impede the smooth flow of data. In the Mekong, for example, challenges include a lack of trust, limited availability of data and inefficient data sharing systems. Basic assessments of whether or not data are exchanged have been conducted as part of Indicator 6.5.2 (proportion of transboundary basin area with an operational arrangement for water cooperation) of the United Nations Sustainable Development Goals (SDGs) (UN-Water 2021). However, global assessments have been unable to analyze the extent of data exchange or the drivers of and constraints to data exchange. The investigations synthesized in this brief represent the first systematic examination of the breadth of, and variation in, data exchange in a set of transboundary watercourses (Figure 1). It is also the first attempt to understand the degree to which practical data needs drive exchange.

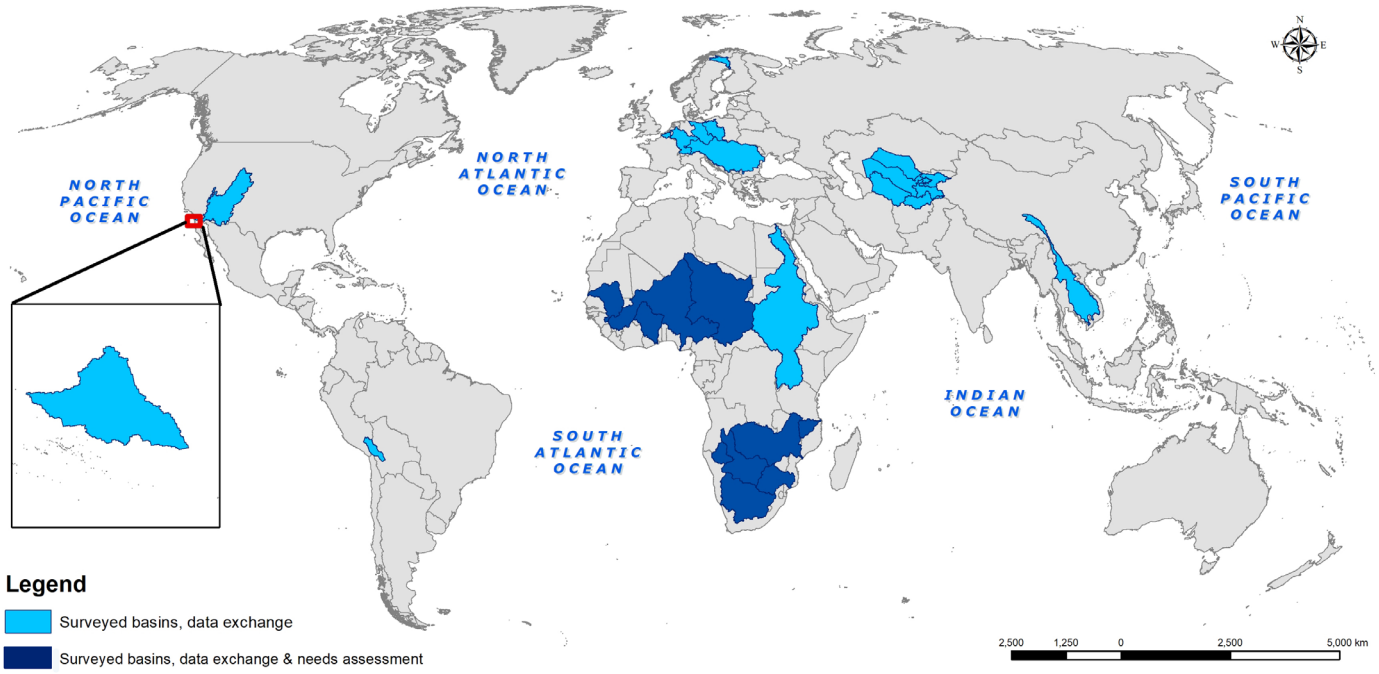

Figure 1. River basins surveyed for data exchange and needs assessment in this study (*design:* Ranjith Alankara).

Approach. A framework was developed to capture the main elements of data exchange across transboundary river basins: scope of exchange, frequency of exchange and the modalities of exchange (Table 1). Within the scope of exchange, the breadth of exchange was assessed through parameters related to surface water and groundwater levels, water quality and water use. In order to be meaningfully utilized and translated into decisions, data have to be exchanged within viable time frames. It was, therefore, important to assess the frequency at which data are exchanged, e.g., real time, daily, monthly, quarterly, annually or in an ad hoc fashion. To assess the modalities of data exchange, two indicators were selected: (i) existence of formal data exchange protocols among basin countries; and (ii) means of transmitting data, e.g., telephone, email, online platform. Data exchange needs were also assessed for basins in Africa by developing and populating an analogous framework through a questionnaire survey.

Table 1. Data exchange assessment framework.

Category	Parameters
Scope of exchange	• Surface water parameters - river flow, dam storage • Groundwater parameters - groundwater levels • Water quality data - electrical conductivity, suspended sediment, nitrates, pH, microbiological quality • Water use - surface water abstraction
Frequency of exchange	• Real time • Daily • Monthly • Quarterly • Annually • Ad hoc
Modalities	• Existence of formal data exchange protocols • Means of transmitting data
Data exchange needs	• Agriculture • Hydropower • Environmental water requirements • Urban water supply • Disaster risk management

Findings

How much data are exchanged?

Limited scope of exchanged data. River flow data are shared most widely and exchanged in 76% of the river basins albeit at varying frequencies (Figure 2). Water quality data are shared in less than half the basins and only 32% of the basins exchange groundwater data. While it is encouraging that 76% of the basins exchange river flow data, there are concerns regarding the remaining 24% of basins which do not exchange river flow data.

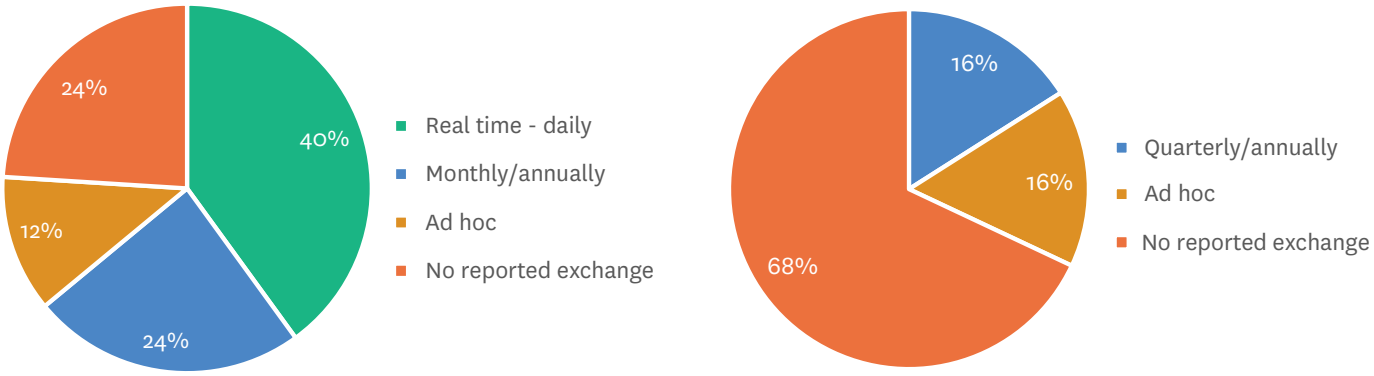

Figure 2. Exchange of (a) river flow data, and (b) groundwater level data.

Low frequencies and high latency in data exchange limit effective river basin management. The benefits of regular data exchange are numerous. These benefits include identification of extreme conditions (e.g., floods and droughts) that require urgent action, and identification of long-term climatic or water quality trends, for example, that require changes in planning. Unfortunately, ad hoc exchanges were commonly observed and this raises concerns over the extent to which such irregularity in data sharing constrains river basin management. Minimizing data latency – the time lag between measurement and sharing of data – is, therefore, of critical importance to inform processes such as flood and drought monitoring and forecasting to enable appropriate reaction times. Of the basins, 40%, 24% and 12% shared river flow data in real time, monthly/annually and in an ad hoc fashion, respectively, and 24% did not exchange any data at all (Figure 2).

Protocols have no clear impact on data exchange, but means of transmission may. Although it was thought that formal data exchange protocols would likely increase the flow of data across borders, basins with such protocols do not necessarily exchange river flow data more frequently. However, where multiple means of transmitting data (e.g., telephone, email and online platforms) were in place, more frequent exchange of river flow data was evident. Multiple

means of transmitting data were mostly used in combination. Although there may be technical barriers in less developed contexts, online platforms may enable greater exchange of data and provide a range of applications to reap the benefits of a harmonized database system.

Formulation of data exchange clauses in river basin agreements could encourage data exchange. Across river basin agreements, the responsibility for data exchange falls on either a River Basin Organization (RBO) secretariat or individual state parties. Further, the normative language within basin agreements and protocols varies from the use of firm wording as 'shall cooperate' (e.g., the Mekong) to 'softer' language such as 'cooperate in good faith' (e.g., the Zambezi), a formulation which may be interpreted as optional. In other cases (e.g., the Okavango), the obligation to exchange data is limited by '… the extent permitted by its own [national] laws and procedures'. These variations in the formulation of data exchange clauses in river basin agreements may impact the levels of exchange.

How much data exchange is needed?

Basin countries are thirsty for more data. Demand for data exceeds actual data exchanged. Basin countries were largely in need of data and there is a shortage of it. Expressed need across different parameters ranged from 70% to 100% with the highest need recorded for precipitation and river flow data and the lowest for data on agricultural return flows and wastewater discharge quantities. Although the challenges surrounding data availability are multifaceted, there was consensus on the need for more data to be exchanged among basin countries.

Where data needs are felt, data needs are satisfied. Assessing need satisfaction against a core set of parameters (river flow, reservoir storage, pH, electrical conductivity and precipitation) showed that needs were met in the Lake Chad, Pungwe and Zambezi river basins, but needs were not met in the Limpopo, Ruvuma, Okavango and Volta river basins (Table 2). Notably, the basins where needs were mostly met appeared to possess transboundary water infrastructure (Niger, Orange Senqu, Senegal, Zambezi) or a pressing disaster risk reduction challenge such as low lake levels (Lake Chad) or floods (Pungwe). Such issues are presumed to drive felt need – i.e., experienced on an operational level – for data exchange.

Table 2. Levels of need satisfaction in African river basins.

Levels of need satisfaction	Basin country units
0-24% Needs unmet	• Botswana, Mozambique and Zimbabwe in the Limpopo Basin • Mozambique and Tanzania in the Ruvuma Basin • Angola, Botswana and Namibia in the Okavango Basin • Ghana and Togo in the Volta Basin
25-50% Some needs met	• South Africa in the Orange-Senqu Basin • South Africa in the Limpopo Basin • Angola and Namibia in the Cuvelai Basin
50-74% Needs mostly met	• Mali, Niger and Nigeria in the Niger Basin • Malawi, Mozambique, Zambia and Zimbabwe in the Zambezi Basin • Guinea, Mali and Senegal in the Senegal Basin • Namibia in the Orange-Senqu Basin
75-100% Needs met	• Angola in the Zambezi Basin • Chad, Niger, Nigeria and Central African Republic in the Lake Chad Basin • Mozambique and Zimbabwe in the Pungwe Basin

Key findings

Current levels of data exchange are too low. Although there are encouraging levels of data exchange on one core parameter (river flow), the scope of data exchanged is limited; data on groundwater levels and abstraction, for example, are not widely shared. Part of the issue undoubtedly stems from the fact that data are not collected. In any case, the efficacy of formal data exchange protocols – seen as being important to structure data exchange – was not apparent as some basins with such protocols were not exchanging all stipulated data.

Practical implications. The bottom line is a less than ideal situation for effective river basin management and constrained progress towards achieving development goals. Across the 25 river basins assessed, the levels of exchange are low except for the exchange of river flow data. This was also the case in basins with advanced levels of water cooperation. Such limited data exchange potentially jeopardizes decisions related to, for example, water allocation, flood and drought management, or ecosystem services.

Start small. A gradual increase in the types of data exchanged may provide a more effective approach to the realization of data sharing than aiming for a comprehensive framework from the outset. In a transboundary watercourse where data have not previously been shared, the first step may be generating and exchanging essential data to understand the fundamentals of the shared resource (Box 1). Basin countries can then build on this initial step to expand the scope of exchange parameters in response to identified needs.

Box 1. Towards an integrated picture of the shared Tuli Karoo Aquifer.

The Tuli Karoo Transboundary Aquifer Area is shared by Botswana, South Africa and Zimbabwe (Figure 3). Not much was known about groundwater levels and how it flows and interacts with surface water resources. Basin countries agreed that there was a need to have harmonized monitoring across the aquifer to generate data. In an initial effort to achieve this, a monitoring system was designed and data loggers were installed in selected monitoring boreholes across the three countries. Data on groundwater levels, electrical conductivity and pH were collected each hour and transmitted (Figure 4) to a shared server, which could be accessed by each country.

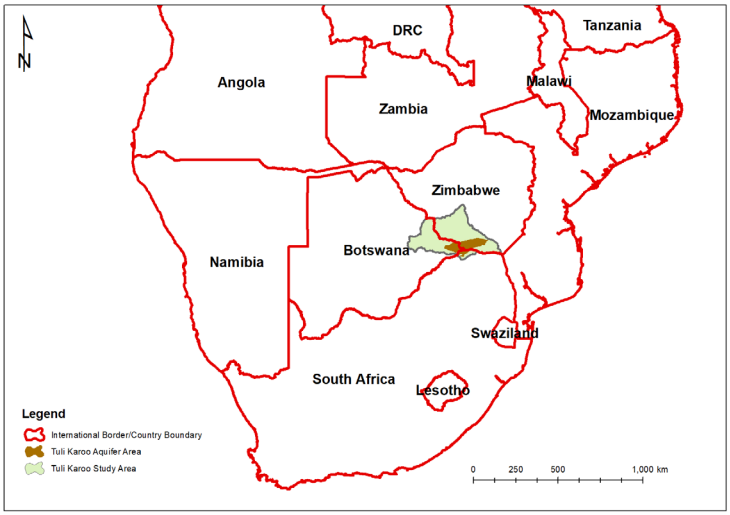

Figure 3. Map showing the Tuli Karoo Transboundary Aquifer Area shared by Botswana, South Africa and Zimbabwe (*design:* G. Y. Ebrahim).

Note: DRC - Democratic Republic of the Congo.

Figure 4. Testing data transmission (*photo:* F. Ramusiya).

Stimulate need. Incentives for data exchange may not be sufficiently evident to those involved in river basin management. One way to stimulate data sharing is to focus on a common need, e.g., flood or drought mitigation, or improving water quality to support ecosystem services. Such practical and tangible uses of data may serve as a catalyst that enables increased data flows (Box 2). Data-driven decisions and policies have become more critical, particularly with the increased frequency of extreme weather events as a result of climate change. Therefore, response times have to be shorter. An adequate flow of data is needed to enable such responses.

Data logger used for measuring soil moisture in Ghana (*photo:* Hamish John Appleby/IWMI).

Box 2. Data exchange needs assessments as an ongoing part of river basin management.

One of the first steps to enabling data exchange in transboundary river basins should be the assessment of data needs. While this may seem an obvious step to realizing data-driven river basin management, it is nonetheless not often implemented. Amplifying data needs assessments as a critical first step to enable greater exchange could help address barriers to data exchange. Needs assessments should be carefully formulated to capture actual needs as opposed to needs based on best practices and standards. When data are targeted at a particular need, they are more likely to achieve measurable outcomes. Spending more time on this first step could sensitize basin countries to data exchange needs and help set common objectives.

Implementation of a data needs assessment could follow four steps (Figure 5). Following this implementation, core parameters on which data exchange is agreed can be consolidated and codified. A working group can then be created to review the efficacy of data exchange efforts, and such efforts can be revised periodically based on evolving needs.

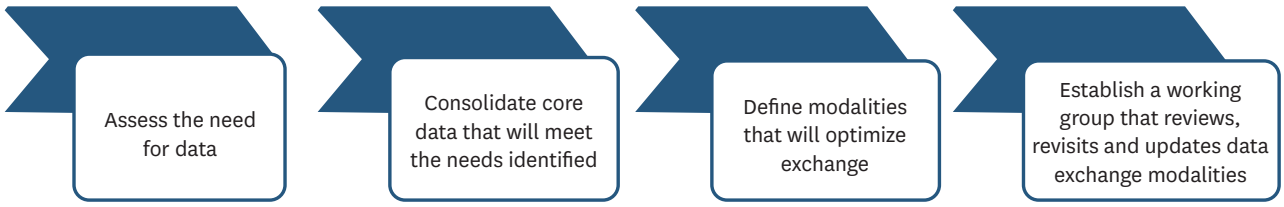

Figure 5. Steps to incorporate a data exchange needs assessment into river basin management.

Concrete Next Steps

Five key interventions targeted at basin and country levels could spur the exchange of water data to enable effective river basin management and speed up achievement of development goals.

1. ***Integrate data exchange into river basin activities.*** Data exchange should form an explicit part of ongoing activities within river basin management, such as development and disaster reduction projects. For example, streamlining data into activities (e.g., flood management, irrigation infrastructure development, establishing environmental flows, etc.) within climate adaptation plans can strengthen national data management processes and thus facilitate smoother transboundary data exchange.
2. ***Enhance and complement global directives through targeted benchmarks.*** Identifying core categories for data exchange, such as water quantity, water quality and water use, according to locally relevant needs may provide a practical basis for exchange. In addition, the potential of SDG Indicator 6.5.2 as a means to trigger increased transboundary data exchange may be further harnessed.
3. ***Develop and apply a tool for data needs assessments in shared waters***. Assessing needs is a critical step in providing a clear context and incentives for data exchange. Focusing data exchange efforts around common needs in a basin may potentially incentivize greater data exchange. An efficient needs assessment tool and procedure to facilitate the identification of such needs are thus central to increasing data exchange. It is also important to build capacity (both human and technical) to use such a tool.
4. ***Broker and establish modalities for review and evaluation of data exchange***. Through partnerships with river basin organizations, support can be provided for strengthening provisions in basin agreements and instruments, such as protocols, on specific parameters to be exchanged at specified frequencies. Where activities for sustained implementation can be elaborated, embedding the necessary flexibility within these provisions to satisfy the evolving nature of data exchange needs is critical.
5. ***Optimize and adapt the use of online platforms to enhance data exchange across river basins***. In the present context of a rapidly progressing digital era, transboundary data exchange platforms may unlock benefits from greater data processing efficiency. As such, addressing barriers to the use of online platforms is an important task particularly in developing countries, where adapting platforms to the realities of limited internet access and electricity shortages through low-tech user interface with low bandwidth settings or the use of mobile applications may prove more practical.

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Cahora Bassa Dam, lower Zambezi, Mozambique (*photo:* Richard Beilfuss).

Source

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