Chapter 3
Political Decentralization and Public Services

Can Data Observatories Advance the Nexus Approach to Environmental Governance?

Abstract In this chapter, we draw upon two cases that employ results-based financing strategies to discuss elements of a decentralization framework that can potentially support enhancement of water and sanitation services. We also devote a part of the chapter to discuss the role that web-observatories can play in identifying generalizable principles based on analysis of case studies of "success" and "failure" as they relate to public services. A key argument we make in this chapter is that observatories, by consolidating knowledge and supporting its translation into policy-relevant advice, can go a long way in enhancing accountability and autonomy in revenue and expenditure decisions surrounding infrastructure construction, operation, and maintenance with potential to impact positively on the achievement of service delivery outcomes in particular and development goals in general.

Keywords Data · Monitoring · Environmental Resources · Risks · Governance · Public Services · Case Studies · Nexus Observatory · Index · Visualization · Benchmarking · Scenario analysis · Trade-offs

1 Introduction

The delivery of critical public services such as water supply, irrigation or wastewater treatment in developing countries and/or emerging economies suffers from fragmented approaches to planning and policy implementation (World Water Council 2015). Infrastructure construction, operation, and maintenance are critical nodes at which the fragmentation in planning and policy implementation is exacerbated (Kurian and Ardakanian 2015b). This is because revenue and expenditure decisions that relate to infrastructure are characterized by a lack of accountability and autonomy. As a result, the disconnect between development goals and achievement of outcomes and impact in terms of poverty reduction and

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environmental sustainability continues to persist. In the previous chapter, we proposed the use of a co-provision framework and argued that accountability may be enhanced if greater attention is paid to the following issues (Kurian and Dietz 2013):

- Fiscal relations that influence incentives for Operation and Maintenance (O&M) of infrastructure relating to water, soil, and waste services.
- Administrative culture that influences the extent of discretion exercised by public officials in enforcement of rules relating to delivery of critical environmental services at different levels of government.
- Contract forms that influence the development of local leadership models to enforce rules for management of environmental resources.

In the introduction to this Brief, we pointed out that far from being a linear process involving uptake of scientific advice, decision-making may entail having to "muddle through" based on important political trade-offs that may neither promote equity nor efficiency goals. While scientists may strive to achieve precision with their results, an effective bridge to the policy domain should strive to make trade-offs more explicit through use of transdisciplinary approaches.[1] It is worth re-emphasizing that this fundamental shift in perspective has several implications. First, it acknowledges the significance of decentralization (political, fiscal, and administrative) and its potential to affect decisions and development outcomes at scale. Second, it acknowledges that once trade-offs are made explicit, individuals and public agencies will be encouraged to design incentives that promote synergies that address common challenges such as water scarcity or pollution. Third, it is important to recognize that for solutions to emerge, data that is reliable, frequent, and sufficiently well disaggregated is important to ensure that decision makers can predict the scale and intensity of the policy challenge and bring to bear a proportionate amount of human and financial resources to realize the achievement of clearly verifiable development outcomes and impact.

In this chapter, we draw upon two cases that employ results-based financing strategies to discuss elements of a decentralization framework that can potentially support enhancement of water and sanitation services. We also devote a part of the chapter to discuss the role that web-observatories can play in identifying generalizable principles based on analysis of case studies of "success" and "failure" as they relate to public services. A key argument we make in this chapter is that observatories, by consolidating knowledge and supporting its translation into policy-relevant advice, can go a long way in enhancing accountability and autonomy in revenue and expenditure decisions surrounding infrastructure construction, operation, and maintenance with potential to impact positively on the achievement of public policy outcomes in particular and development goals in general.

[1]For an elaborate discussion on transdisciplinary approaches see Chap. 2 of this Brief.

2 Political Decentralization and Environmental Services: Key Considerations

The first chapter of the brief discussed three case studies that elaborated upon issues related to management of environmental resources—water, soil, and waste. The discussion considered the concept of the Poverty-Environment nexus and highlighted the importance of scale in determining whether environmental management actually impacted incidence of poverty. In this context, it is pertinent to point out that the delivery of services, such as irrigation, water supply or soil retention, are usually influenced by infrastructure considerations. When it comes to infrastructure, three factors (huge sunk costs, economies of density/scale and consumption) lead to politicization of pricing and operations in the water sector (Savedoff and Spiller 1999). Further, for a particular water infrastructure, increasing the number of connected households reduces the network's average operating costs. Consumers, especially in the developing world, normally associate water services as free goods. As a result, politicians can sometimes use the argument regarding pricing as an instrument for political mobilization (Kurian 2010).

The natural characteristic of water enables it to flow across multiple spatial scales. The provision of water services given the high capital costs involved and recurring maintenance expenditure necessitates coordinated management involving two or more political jurisdictions (United Nations Task Team on Habitat III 2015). The literature on the subject of coordination emphasizes three important principles of accountability, autonomy, and subsidiarity (Kurian and Ardakanian 2015b). The advancement of a number of the above principles highlights the importance of establishing a link between public expenditure on infrastructure construction and maintenance and revenues in terms of taxes and tariffs. Establishing a link between revenue, expenditure, and service delivery outcomes is predicated upon the availability of data that is disaggregated, reliable, and frequent. In this connection, assessments of "success" or "failure" of inter-governmental transfers in facilitating incremental improvements in service delivery would benefit from adopting a comparative framework (*based on locally identified indicators of quality, quantity, affordability or adequacy*), as opposed to an evaluation framework that is guided by transcendental policy goals (*examples include a 10 % community contribution toward the cost of operating a water system*). Real-time information flows that are multi-directional in nature (involving citizens and governments) can also go a long way in enhancing accountability of revenue and expenditure decisions at multiple levels of government (Kurian 2010).

In the wake of the Thatcher-Reagan revolution of the 1980s, privatization experiments involving public water utilities were undertaken. It was subsequently realized that privatization might not necessarily yield optimum results in terms of advancing efficiency or equity. In the developed world, experiments with forms of organization that lie between conventional public agencies and private companies were undertaken that included corporatization and performance-based organizations. Under the corporatization experiment, decision makers are removed from the

influence of personnel, procurement, and budget restrictions that characterize public agencies. The focus instead is on identifying viable incentives. Performance-based organizations (PBO) on the other hand are government agencies that remain under public control, but in which agency officials are rewarded on the basis of performance.

In the case of developing countries, there is much to be said about the commitment to devolve revenue and expenditure decisions to local authorities (Kurian and Meyer 2015). A case in point being property taxes, which represent only 3–4 % of local revenues in developing countries, compared to 40–50 % in Australia, Canada, France, UK, and the US (United Nations Task Team on Habitat III 2015). More recently, several countries have begun experimenting with innovative schemes of municipal financing that are focused on improving service delivery. For example, Colombia has experimented with use of municipal funds as an instrument of sub-sovereign infrastructure finance, while cities in Mexico have begun encouraging local governments to improve their credit rating as a pathway to improve municipal finances and expand their financial resources. The case studies that follow discuss key lessons emerging from results-based financing initiatives in Asia and South America.

3 Results-Based Financing: Lessons on Planning and Implementation of Water Services Reform Projects

Two case studies of water services reform projects are presented in this section. They focus on results-based financing schemes that tie outcomes to funding in order to enhance the quality of service provision and strengthen accountability among the involved actors.[2] One of the most common results-based mechanisms used by international agencies, namely by the World Bank, on the delivery of basic infrastructure and social services to the poor is output-based aid (OBA). The OBA approach relies on a clear and realistic definition of objectives that can be measured and compared to the results accomplished. The first case study (UNU-FLORES 2015a) describes one of the first pilot projects, conducted by Global Partnership Output-Based Aid (GPOBA), designed to show that the OBA approach improves transparency and efficiency in the use of public resources, as well as the effectiveness in getting low-income families connected to water services networks. The second case study (UNU-FLORES 2015b) explores a pilot project, also conducted by GPOBA, to implement an OBA facility in Honduras to provide water and sanitation services to low-income families. The project tested whether it was possible to implement at the national level the type of subsidy scheme that GPOBA was using.

[2]See Veiga et al. (2015) for an overview of the recent experience in service delivery and financing models.

(a) *Case study 1*: *Output-Based Aid—Metro-Manila water supply improvement project*

Reducing the gap in the provision of safe water and sanitation services to low-income families continues to be an important challenge in many developing countries that traditional financing mechanisms do not seem to be able to address. Frequently, low-income households cannot afford to pay the connection fees required to access the services and have to resort to other alternatives, such as water tankers or other vendors, generally more expensive and of less quality. This case study focuses on one of the first pilot projects implemented by GPOBA to show that the OBA approach can be an effective way to help the poor, while enhancing the use of public funds in a transparent, accountable, and effective way. With OBA, the disbursement of funds depends on independent verification of the agreed results. Funds should be enough to guarantee that subsidies reach all intended beneficiaries, but final beneficiaries should have enough capacity to pay a proportion of the cost to access the service. This ensures a stronger sense of ownership of the project and a stronger commitment to pay the ongoing water and sanitation tariffs.

The study focuses on the water network in Metro-Manila in the Philippines. In the late 1990s, the government decided that the best way to improve water and sanitation services was to privatize the services. In 1997, two 25-year concession contracts, based on a geographic division of the region, were signed with two private firms. The contracts imposed several requirements in terms of the expansion of the coverage of water supply, sewerage, and sanitation services; the quality of the services; and the installation of public faucets in areas where individuals could not afford individual connection fees. One of the firms, the Manila Water Company (MWC) made important progress toward the fulfilment of the established objectives and was financially sound. However, the other firm faced financial problems and was unable to achieve the requirements. This led the government to re-tender the concession in 2007, and the new concessionaire showed good performance afterwards. The OBA pilot project was designed in 2007 and GPOBA decided to work only with the MWC given that the new concessionaire was initiating its activity.

In order to improve access to water in low-income areas, new pipelines were installed and the MWC worked closely with community leaders in the consultation and decision process. Although the programs improved the new consumers' access to water and reduced the associated costs, the connection fee was still too high for some households. Initially, to reduce connection fees, the MWC offered a shared meter option, where several households could share one mother meter and install individual sub-meters, with one household managing collection and remittance of payments to the concessionaire. Later, the MWC changed to a scheme of shared bills. Each community would manage a mini water distribution system, with a single account and a mother meter for the entire community. Each member of the community would have individual connections and sub-meters, but the community would be responsible for billing and collection for all its members. Even though prices were reduced, individual households were paying more than the community paid the concessionaire, and there was evidence of illegal tapping. To increase

accuracy in meter reading and reduce illegal tapping, the MWC started installing several individual meters side-by-side inside protected structures (bank-arrangement), in accessible and strategic locations. However, there were still equity concerns, since some individual households free ride while the MWC was reluctant to disconnect the whole community. To overcome both problems at the same time, the MWC adopted a bank-arrangement scheme, combined with individual connections, with the support of an OBA scheme funded by GPOBA.

To ensure that the subsidies were provided to those that could not afford the services on their own, geographical targeting was used, since poor households are grouped in specific areas of Manila. Additionally, potential beneficiaries were asked to submit a certificate attesting that they were indigent. Given the sound operational and financial situation of the MWC, the GPOBA decided to adopt a single subsidy payment scheme after a single output was independently verified. The output was the provision of a working household connection that provided an acceptable service over a three-month period. Once the output was verified, GPOBA disbursed the unit subsidy multiplied by the number of verified connections to the MWC.

In sum, despite the clear effort of the government of the Philippines to enhance the efficiency and effectiveness of water service provision by selling concessions to private providers, the fee established by the service regulator proved to be too high for low-income households. The use of targeted results-based subsidies was crucial in ensuring more equity in water service access, and proved to be a transparent and efficient use of public funds to help low-income families becoming regular customers. Besides this direct effect, the project had other positive impacts, such as the reduction of water related diseases, reduction of household expenditure on water, and time savings for women per household.

This case study also demonstrated the need for a nexus approach to providing services to low-income areas. The project was successful in ensuring the connection of low-income families to the water supply network, but did not present a solution for how to dispose of the increased volume of wastewater. This unresolved wastewater problem prevented households from fully enjoying the benefits of the piped water, forcing them to use less than the desired volume of water because of the inappropriate sanitation facilities. A nexus approach by contrast would recognize the interdependence of resources and, that the management of one resource (access to water service) often creates challenges for other resources (wastewater management).

From the perspective of OBA, the Manila pilot project was deemed a successful case. It showed that OBA is an effective mechanism to improve equity of access to basic services, and promotes transparency and accountability in the use of public funds. The project provided relevant evidence that was later incorporated in the design of other projects implemented in several countries, using results-based financing mechanisms to improve the standard of living of the population. From a nexus perspective, however, the case study emphasized the need for approaches that acknowledge inter-dependence in use of environmental resources. The case also served as a basis for cross-fertilization of ideas based on implementation of service

delivery reform projects in other parts of the world. This is why we argue in this Brief that data observatories have much to offer in terms of making the results of comparative case study analyses available in the form of generalizable principles that decision makers can draw upon to design, monitor, and evaluate developmental interventions covering water, soil, and waste resources.

(b) ***Case study 2*: *Honduras Social Investment Fund: Using Output-Based Aid to provide water and sanitation services to low-income families***

Given the success of the OBA approach implemented by international agencies, as documented by the previous case study, pilot projects were carried out to test potential scale up mechanisms of having national governments implementing OBA schemes. The Manila case study highlighted the importance of a process of incremental learning that focused on modalities for targeting subsidies at the poor, independent verification of project outcomes, and design of concession contracts. The second case study from Honduras documents the challenges of scaling-up of institutional good practices to establish a national OBA facility in a country, to provide water and sanitation services to low-income families. From a nexus perspective, the Honduras case study has much to offer in terms of advancing transdisciplinary approaches to research, training and policy advocacy.

Honduras is one of the poorest countries in Central America. In a country where the service coverage for potable water and sewage was already deficient, rapid urbanization worsened the problem by creating peri-urban areas with no infrastructure to provide the services. Conscious of these problems, the government of Honduras adopted measures to improve the service provision through decentralization. In 2003, a new law was approved to restructure the water and sanitation sector. The national public monopoly was dismantled and local authorities were enabled to decide the service provision modality: public, private or mixed provision. Local service providers should be autonomous and financially viable, and operate under the oversight of a national regulator. Given the insufficiency of public resources to satisfy investment needs of water and sanitation in municipalities, national authorities were willing to explore alternative financing sources and schemes, creating an opportunity to introduce the OBA approach.

The GPOBA, on the other hand, had a good track record in the implementation of OBA to individual water and sanitation projects, and was open to experiment lending support in the setting up of an OBA facility in Honduras. They relied on the experience of a national entity (*Fondo Hondureño de Inversión Social*—FHIS) in the implementation of water and sanitation projects in the country. Data on local projects from FHIS was compared with data published in international reviews of project experience to develop unit costs to various outputs. The design of subsidy amounts for various elements of the project was guided by the following principles: 1. one of cost subsidies and not consumption subsidies; 2. disbursement of subsidies after independent verification of outputs; 3. Subprojects' tariffs should cover at least operation and maintenance costs; 4. pre-financing for private providers should be from internal cash generation or commercial loans; and 5. for public implementers (national and municipal institutions) pre-financing should be made

available through loans provided by the OBA facility. The OBA facility was, therefore, housed within FHIS and supported by specialized consultants. It was responsible for screening, electing, prioritizing, and providing funding to subproject proposals fulfilling the FHIS and OBA eligibility criteria. The OBA facility also provided technical assistance in the design and implementation of the projects. The FHIS was fully responsible to the GPOBA for the compliance of the execution of the project.

The OBA facility started operating in 2008. After a first year of slow progress, several difficulties were identified in its implementation. It became clear that the OBA facility had not adequately consulted local authorities, GPOBA, potential contractors, NGOs, and community representatives. Meetings with the stakeholders were organized and adjustments were made to the project by FHIS and GPOBA allowing it to become a successful example of the first ever OBA facility to be implemented.

The implementation of this pilot project made it clear that, when designing future OBA facilities, it is important to: (1) Successfully integrate the facility in the overall financing framework of the sector; (2) Explain the innovative features and functionality of the OBA funding scheme to the stakeholders (local authorities, banks, contractors and service providers, and the population in general); (3) Assess the technical and analytical skills of the staff responsible for managing the facility, as well as their motivation to implement the new financing scheme; (4) Make sure that the implementers have the technical capacity to deliver the agreed upon results; (5) Adjust the geographical reach of the facility to the available subsidy resources in order to keep supervision and verification costs in check[3]; and finally, (6) Guarantee funding to implement a program at a scale adequate to the needs of the population, correctly synchronizing the OBA scheme with the overall financing architecture for water and sanitation projects.

The Honduras' national OBA facility pilot project was a source of inspiration for other national governments, such as that of Indonesia, to adopt results-based financing mechanisms. It proved that the implementation of a national OBA facility increased the effectiveness and transparency in the allocation of resources to sub-projects aiming to reduce the access gap to water and sanitation services of low-income families. In nexus terms the Honduras case study highlights the importance of addressing issues of equity in addition to issues of technical and system efficiency. We have argued elsewhere that inter-governmental fiscal relations, notably, the role of taxes, transfers and tariffs are important considerations in advancing equity concerns in discussions on political decentralization and service delivery (Veiga et al. 2015).

[3]The transaction costs of the project were considered high relative to the size of the project, reducing its efficiency. This is not surprising since the project had a local focus. As Veiga et al. (2015) point out, notwithstanding the effectiveness of projects implemented according to results-based financing models, such as output-based aid, the high costs of data collection and project auditing are drawbacks that need to be tackled.

4 How Can Data Observatories Help Disseminate Institutional Good Practice?

4.1 Key Principles and Science-Policy Domain Goals

Case studies like the ones discussed in the previous section provide rich anecdotal evidence and descriptive detail for analysis. However, some important steps could support robust analysis of cases with the objective of identifying generalizable principles. These steps include creation of databases, design of databases, design of data collection protocols, data analysis procedures, and use of sampling criteria to specify units and levels of research. In many instances, several agencies and individuals may have already begun work on various dimensions of this challenge. In the case of environmental resources, such as water, soil, and waste, a number of UN agencies, government research institutes in the developing and developed world, and resource users have access to data in disparate forms (see Table 1). Data observatories have the potential to aggregate data from several sources and by using different medium (*for example, paper-based versus mobile*) to perform three functions that are crucial from the point of view of supporting evidence-based decision-making: data classification, knowledge consolidation, and knowledge translation.

The idea of a data observatory is founded on a few core principles as outlined below (Hall and Tiropanis 2012).

1. Access to distributed repositories of data, open data, online social network data, and web archive (Hall and Tiropanis 2012).
2. Harmonized access to distributed repositories of visual/analytical tools to support a variety of quantitative and qualitative (transdisciplinary[4]) research methods that are inter-operable with either published or private datasets.
3. Shared methodologies for facilitating the harvesting of additional data sources and the development of novel analytical methods and visualization tools to address societal challenges and to promote innovation.
4. A forum for discussion about an ethics framework on the archiving and processing of web data and relevant policies.
5. A data-licensing framework for archived data and the results of processing those data.

It can be argued that data observatories, if effectively managed, can contribute toward bridging the science-policy divide. To achieve this goal successfully observatories may strive to realize the goals as given in Table 2 along both science and policy domains (Kurian and Ardakanian 2015c).

[4]See Chap. 2 of this Brief.

Table 1 Three levels of engagement

Data (classification)	Knowledge (consolidation)	Information (conveyance)
UN agencies	Scale/boundary conditions/feedback loops	Trade-offs/synergies/resource optimisation
Member states	Scale/boundary conditions/feedback loops	Trade-offs/synergies/resource optimisation
Private data sets	Scale/boundary conditions/feedback loops	Trade-offs/synergies/resource optimisation

Table 2 Policy and science domain goals from the point of view of environmental resources, services, and risks

	Domain	Goals
From the point of view of environmental resources, services, and risks	Policy	1. Knowledge transfer through regional consultations and international conferences 2. Field testing new approaches to planning and management 3. Identify policy/program management triggers based on data visualization 4. Incubation of policy-relevant research questions based on proposal writing workshops emerging in the wake of regional consultations 5. Dissemination of good practice guidelines through publication of policy briefs
	Science	1. Specification of boundary conditions to heighten the applicability of research outputs 2. Specification of scale conditions to determine the applicability of research outputs 3. Identification of nexus intersections through examination of nodes in the biophysical, institutional, and socio-economic domains that influence the management of environmental resources, services, and associated risks 4. Identification of nexus interactions through examination of biophysical and institutional processes that impact upon the management of environmental resources, services, and associated risks 5. Identification of feedback loops that transmit the effects of policy/program interventions on human behavior and their consequences for the management of environmental resources, services, and associated risks

For a more detailed description, see Kurian and Ardakanian (2015a); especially pp. 225–229

4.2 From Decision Support Systems to Web-Observatories

The importance of availability of and accessibility to relevant, up-to-date, and reliable data and information that clarifies trade-offs and synergies have already been highlighted in this Brief. It was also demonstrated that this includes the classification of data as well as the consolidation, translation, and transfer of knowledge[5] (Kurian and Meyer 2014). Above all, the digital revolution is opening new cost-effective, easily attainable opportunities for knowledge management, analysis, and transfer. To support complex decision-making and problem solving, decision support systems emerged, which have been widely used in environmental risk management and covered in the literature.[6] Decision support systems in many instances are supported by technology that typically comprises tools that allow for easy management of data and knowledge, functionalities for modelling, and an interface that is accessible, interactive and easy to navigate (Shim et al. 2002). Through these components, decision makers, at the appropriate level, can approach problems from a more comprehensive perspective that draws on evidence and information that may lead to better choices with regard to management of environmental resources.

Bui points out that the use of decision support systems promotes "a changing consciousness about environmental responsibility" that will result in better informed decision-making, but cautions that "success or failure of sustainable development depends more on political and managerial leadership than on advanced technology" (Bui 2000: 3–4). Highlighting the reliance on individual decision makers underscores the limits of decision support systems, which need to be overcome, while offering great potential for producing sustainable outcomes. Therefore, governance processes and consideration of alternative options, such as those described in the case studies above, form an integral part of environmental planning and management as well as in the delivery of related services (e.g. water and sanitation).

Another weakness of many decision support systems related to sustainable development issues, is their specialized, local, and thematic problem focus (e.g. at village or watershed level) (Bui 2000), which does not promote cross-fertilization across regions. Additionally, these specified boundary and scale conditions do not necessarily account for political and/or institutional parameters, which define the spatial and temporal competencies of decision makers.

Apart from decision support systems on specific issues, such as water resources management or environmental impact assessment (Kersten and Lo 2000), a new

[5]Bui (2000) provides a more detailed, nevertheless not comprehensive, list for the definition of decision-making tasks: "comprehensive classification of problem types, information requirements, decision making procedures, selection of decision makers involved in the process and … the spatial and temporal impacts of sustainable development decisions."

[6]For an assessment of various Decision Support Systems, see Kersten et al. (2000).

trend is emerging, the use of web-based observatories. These observatories rest on the premise that they allow for the linking of various data sources. Doing so enables the integration of data as well as the closing of data gaps, so long as the reliability and quality of data can be guaranteed (see Table 1) (Fundulaki and Auer 2014; Terry et al. 2014). Links and interconnections between already available data will contribute to a "web of data" that is greater than the sum of its parts. Bundled into this "web of data," observatories will not only allow for greater accessibility to data and databases relevant to a particular theme, but also engender a systematic, time and resource efficient resolution to identify gaps and overlaps, as well as possible discrepancies between various sources of the same or similar data (Kyzirakos et al. 2014).[7] It also increases the frequency of available information, allowing for the use of near real-time data. Coupled with a mix of visual and analytical tools for quantitative and qualitative research, evidence-based decision-making can be strengthened and promoted. In the context of the envisaged Nexus Observatory, this is realized by focusing on the nexus between water, soil, and waste, thereby, making explicit the inherent synergies, trade-offs, and feedback loops across sectors (Kurian and Ardakanian 2015c; Kurian and Meyer 2014).

Considering the issue of overcoming data gaps further, the efforts surrounding the establishment of monitoring frameworks for Sustainable Development Goals (SDGs) targets is notable (GEMI 2015). Novel data collection approaches, examining the role of new technologies, should be considered to close such gaps. A useful entry point for supplementing often-incomplete data and information is the use of earth observation systems. These include satellite imagery, remote sensing, geoinformation systems (GIS), and in situ data collection that complement use of big data (Independent Expert Advisory Group on a Data Revolution for Sustainable Development 2014).[8] Web-based observatories have the potential to assist with the integration of earth observation data with other sources of information, such as surveys, legal documents, local registries, economic data, private data (see Table 1) etc. (United Nations 2014). Additionally, where it is viable to make available near real-time, high quality and reliable data that can be analyzed quickly, it would be possible to manage environmental risks, such as floods and droughts.

A key hypothesis we explore in the next chapter of this Brief is that improved accountability and autonomy in fiscal decision-making can lead to better management of environmental risks and outcomes.[9] Such an integrated approach for progress monitoring in interconnected sectors and clusters, where data harmonization has occurred and comparable standards have been established, will lead to

[7]This is to some extent comparable to astronomical observatories, where professional and hobby astronomers are encouraged to add any discoveries to an interactive web-based planetary observation system. Due to the increased number of actors monitoring different parts of the hemisphere, the scientific results can be multiplied enormously.

[8]For additional information, please refer to the United Nations Global Pulse initiative on big data, available at http://www.unglobalpulse.org/.

[9]See Chap. 4 of this Brief.

better results, generate political buy-in, and direct investment (human and financial resources) toward integrated and transdisciplinary development research, methods, and programs that advance sustainable development in general and equity goals more specifically.

4.3 The Appeal and Benefits of Using Web-Observatories

The academic discourse on web-observatories is still limited, focusing mainly on the issue of linking data through open data applications (ERCIM News 2014). The way in which the value of data observatories informing sustainable development discourse is presented in the present Brief is at the cutting edge of nexus research and implementation. A thorough analysis of nexus cases, such as those described above, offers greater insight into inherent complexities in varying situations, presents alternative options for arriving at sustainable solutions and permits comparisons between cases that may help identify research/implementation gaps (e.g. providing water connections, but overlooking the interconnections to wastewater and sanitation provisions) or generate generalizable, scalable principles qualified by regional or local specificities.

It comes as no surprise that comprehensive observatories that offer a holistic point of data and information for decision-making are gaining in relevance. This is possible due to advances in Information and Communication Technology (ICT), as well as the ever-increasing realization that we are living in an interconnected, interdependent world, which requires real world problems to be addressed in an integrated manner. Post-2015 development agenda debates are also supportive of the above analysis, emphasizing nexus approaches that focus on solving complex sustainable development problems taking into account economic, social, and environmental factors (United Nations 2014, 2015). As discussed in Chap. 2 of this Brief, employing transdisciplinary methods is a first step toward development of a more complete and comprehensive evidence-base that can effectively engage with nexus challenges.

The move toward web-observatories, in particular, in the field of sustainable development offers a number of opportunities. By their nature, as indicated previously, observatories have the potential to provide more comprehensive assessments, aggregate information to overcome fragmentation, allow working across disciplines, bridge the science-policy divide, and illuminate synergies and trade-offs, involving economic, social and environmental processes, and institutional structures. A web-observatory, as envisaged for the Nexus Observatory, will establish cross-sectoral assessments and evaluations of progress that highlight such interlinkages, synergies, and trade-offs as they apply to the nexus of water, soil, and waste. An approximation of science and policy can, thus, occur by taking advantage

of scientific research on the nexus approach, multi-stakeholder engagement, and advances in ICT.[10]

As highlighted above, observatories, in contrast to decision support systems, generally address a number of issues, which belong to a particular theme. One example of such an observatory is the UN-Habitat Global Urban Observatory (GUO), which places urbanization processes and considerations at the center of enquiry (UN-Habitat 2012). The design of an observatory would then allow for a more holistic assessment with regard to these overarching themes. GUO was called into existence to assist with the monitoring of the implementation of the Habitat Agenda and target 11 of the Millennium Development Goals (MDG),[11] hence, measuring the progress of the state of urban development. GUO mainly serves as a database of urban statistics and indicators that are stored, presented, and analyzed through presentation tools. The data and information gathered [primarily through Geographical Information Systems (GIS)] as part of the monitoring activities contributes to a Global Urban Indicators Database, monitoring of urban inequities, and an Urban Info Database, covering a number of topics related to the urban context (e.g. housing, education, crime). Additionally, GUO provides evidence on urban development for related reports, including those on the MDGs (UN-Habitat 2012).

It is not apparent from the GUO platform, whether any topics or issues that are being monitored are analyzed in an integrated manner in order to promote sustainable resource management solutions (e.g. the role of local governments, decentralization or options for service delivery). Furthermore, whereas dissemination of data and information of progress and potential shortfalls in meeting internationally agreed targets are communicated through reports, the inclusion of an interface in which data or knowledge gaps can be identified and overcome using the web-observatory could enhance progress, development, and implementation even further. Hence, the science-policy divide remains insufficiently addressed. However, the significance of GUO's contribution to data and information aggregation, monitoring efforts, and achievements in multi-stakeholder engagement (mainly ministries at the national level) must not be overlooked.

Nonetheless, it is clear that a web-observatory with a primary focus on monitoring coordination of the use of indicators offers limited advantages from a nexus perspective. Even at present, a number of important aspects have received only partial attention. These relate to the identification of emerging issues, provision of substantive capacity building, contributions to/of scientific research (including research funding) that can in turn inform policy,[12] and alternative management options that impact service delivery and fiscal systems. Case studies, such as the

[10]This is also in line with proposed SDG Goal 17, which highlights technology, capacity building, multi-stakeholder partnerships, and data, monitoring and accountability among other issues.

[11]MDG Target 11: Have achieved by 2020, a significant improvement in the lives of at least 100 million slum dwellers, http://www.unmillenniumproject.org/goals/gti.htm.

[12]As mentioned above, this also relates to insufficient cross-fertilization, where integration across sectors and disciplines do not occur and comparative and/or collaborative research at regional

ones discussed in this chapter, can shed light onto these processes. Observatories in our view have a very powerful function in transferring the insights gleaned from case studies in a form that can be understood and used by decision makers.

Similar to UN-Habitat, the World Health Organization (WHO) has developed a Global Health Observatory and is currently in the process of developing an additional Global Observatory on Health Research and Development (R&D) (WHO 2015; Terry et al. 2014). As observatories, including GUO, created and regulated by international organizations with specific mandates and guided by internationally negotiated goals and targets, such as the Millennium Development Goals and from 2016 the Sustainable Development Goals, it is not surprising that the aggregation of relevant data, monitoring against international targets, and measuring progress over time are main priorities. However, with reference to the WHO Global Observatory on Health R&D, there seems to be an understanding that the mapping of research and associated funding may be sufficient to arrive at an understanding of data, knowledge, and capacity gaps. It focuses on "How to finance research and development where normal market forces are absent" (Terry et al. 2014: 1302). In the same way as the aforementioned case studies on results-based financing engage with questions of public services provision and financing, so too does the Global Observatory on Health R&D address questions of utilization of limited resources in line with policy priorities in the public health domain (Terry et al. 2014). This leads us to conclude that observatories have the potential to improve coordination in and across both the science and policy domains, in particular, with a view to identifying generalizable principles.

In the case of environmental resources management and governance, a web-observatory has the potential to contribute considerably to advancing research, discourse, and implementation on the nexus approach to the management of water, soil, and waste. The holistic architecture of such an observatory allows for a more realistic grasp of real-world problems, while promoting the interface between science and policy. The Nexus Observatory at UNU-FLORES is an ambitious undertaking as it endeavors to integrate a vast amount of knowledge, methodologies, data, tools, capacity building programs, etc. related to the nexus of water, soil, and waste into one web-based system (Kurian and Meyer 2014). In contrast to the separation of tasks of observatories, like those by WHO, UNU-FLORES endeavors to create an integrated experience that moves beyond systems that are focused only on making available data, monitoring or research classification and instead aims to create an interface that allows for research to inform capacity development and policy processes and vice versa.

While the conceptualization of the Nexus Observatory with its various components is a demanding task and research is ongoing, development of its numerous elements will have to take place gradually, continuously improving based on

(Footnote 12 continued)

(e.g. East Africa) or cross-regional (e.g. Africa–Asia) do not occur. See also Chap. 2 of this Brief and regional consortium formation (Kurian and Meyer 2014).

experience. Due to technical challenges and the state-of-the-art nature of the Nexus Observatory, sustainability of the platform depends on durable commitments, buy-in, and support. It follows that the full set of functionalities can only become operational over time, depending on resources (both human and financial), the willingness of partners to collaborate over an extended period of time, to provide relevant data, information and other inputs, and work toward a common goal. The consortium approach that we will elaborate on in Chap. 4, has proved effective in generating trust and political buy-in based on agreements for data sharing and collaborative research that can inform investments in sustainability research. The cooperation agreements that support the consortium approach are premised on demands and priorities determined by Member States and articulated at regional consultations that were organized in Africa and Asia.[13]

Compared to other observatories, such as the ones described above, the Nexus Observatory is characterized by its state-of-the-art links between scientific research and implementation, while allowing for application of transdisciplinary methods and approaches through acknowledgement of sites of knowledge and design of hybrid methodologies for data collection and analysis. Additionally, taking a nexus perspective and particularly including waste as a resource offers a new dimension that has not previously been addressed. It goes beyond thematic categorization and approaches sustainable development research in clusters of interconnected factors (Kurian and Ardakanian 2015a). A web-observatory, as defined in this Brief, therefore, through comprehensive and holistic analysis, elucidates intersections and interactions[14] (e.g. by analyzing case studies, such as those presented here) and provides an evidence-base for better decision-making.

5 Conclusions

The nexus approach has emphasized the management of environmental resources—water, soil, and waste. The biophysical domain has been highlighted in discussions on the nexus approach so far. The research community has illuminated issues of inter-dependence and interconnections among "compartments" and put a spotlight on "fluxes" and "flows." These are all-important parts of the discussion, but in our view, demand for elements of the nexus approach will be driven primarily by its applications in practice. Decision makers work in an environment where they have to make continuous and sometimes quick decisions with regard to allocation of scarce budgetary and human resources. Those decisions are not driven purely by the

[13]A regional consultation is characterized by the participation of at least five states represented by researchers and/or decision makers (mostly ministerial level).

[14]Intersection and interaction refer to factors that define the scope and relevance of the nexus approach as well as vertical and horizontal impacts and structures of feedback loops affecting the management of environmental resources respectively. For a detailed account see Chap. 2 of Kurian and Ardakanian (2015a).

need to promote "resource" conservation but in many instances by the need to "sustain" delivery of critical public services such as irrigation, water supply or wastewater treatment. This takes us back to the question we posed in the introduction to this Brief that relates to why statistical significance of research results does not always coincide with political action.

The literature on political and administrative decentralization emphasizes the importance of revenue and expenditure considerations that guide decision-making when it comes to public services. Analysis of accountability, administrative culture, and contract models involving public-private partnerships assume great importance when it comes to enhancing the delivery of public services. In this context, infrastructure considerations are important in framing discussions on decentralization. Economies of scale, population density and sunk costs of infrastructure and distribution of benefits and costs arising from operating and maintaining infrastructure assume extreme importance. This chapter argued that a nexus approach must move beyond an exclusive focus on environmental resources to one that engages with challenges of balancing "efficiency" and "equity" goals that considerations of infrastructure impose upon decision-making structures and processes. For this purpose, improved data and its analysis as well as translation of knowledge into evidence that can be used by decision makers is an issue of critical importance.

This chapter offers a refreshing new perspective on how we may bridge the gap between a conceptual focus on resources and services in discussions on the nexus approach. We employed two case studies on results-based financing to highlight the links between technology choice and fiscal systems as they play an important role in mediating the delivery of water and wastewater services in the Philippines and Honduras respectively. The Philippines case study discussed issues relating to independent verification of project outcomes, contract models that engage the private sector and design of subsidy schemes that target poor consumers. The Honduras case study on the other hand highlighted the complicated political and administrative process that very often determines the success of scaling up development interventions. The role of international donors, capacity development, and data collection and analysis were discussed in this context.

Perhaps, the most important feature of this chapter is the section where we discussed the role of observatories in providing a context for analysis of "success" and "failure" of individual interventions. We argue that data observatories can play a powerful role in bridging the gap between science and policy by providing a seamless interface between big data applications, capacity development, and policy engagement. Moreover, data that has been properly classified and knowledge that is well organized by theme or regional priorities can lead to generation of generalizable principles that can guide decision-making. To support our arguments, we examined the experience with two ongoing initiatives that relate to the use of observatories within the UN system. We discussed the lessons we can learn from existing initiatives and asked how we may improve upon them to devise a Nexus Observatory that informs design and monitoring of interventions as they relate to management of environmental resources and services.

In the next and final chapter, we take the discussion on observatories forward by examining the application of a nexus index in informing decisions relating to management of risks as they apply to environmental services. For that discussion, we focus on two specific challenges that have been identified by the SDGs and African Member States as important policy priorities; notably droughts and floods.

References

Bui, T. X. (2000). Decision support systems for sustainable development: An overview. In G. E. Kersten, Z. Mikolajuk and A. Gar-On Yeh (Eds.), *Decision support systems for sustainable development: A resource book of methods and application.* New York: Springer.

ERCIM News. (2014). Special theme: Linked open data. *ERCIM*.

Fundulaki, I., & Auer, S. (2014). Linked open data. *ERCIM, 96*, 8–9.

GEMI. (2015). Monitoring wastewater, water quality and water resources management: options for indicators and monitoring mechanisms for the post-2015 period. *A discussion paper for GEMI*. Global Expanded Water Monitoring Initiative, 1st stakeholder consultation, Geneva, 29 and 30 January 2015. Retrieved from http://www.unwater.org/fileadmin/user_upload/unwater_new/docs/Topics/SDG/Discussion_Paper_Gemi_Geneva_Meeting_29-30Jan2015_FINAL2015-04-27.pdf

Hall, W., & Tiropanis, T. (2012). Web evolution and web science. *Computer Networks, 56*, 3859–3865.

Independent Expert Advisory Group on a Data Revolution for Sustainable Development. (2014). *A world that counts: Mobilising the data revolution for sustainable development*. New York: Data Revolution Group.

Kersten, G. E., & Lo, G. (2000). DSS application areas. In: G. E. Kersten, Z. Mikolajuk and A. Gar-On Yeh (Eds.), *Decision support systems for sustainable development: A resource book of methods and applications* (pp. 391–407). New York: Springer.

Kersten, G. E., Mikolajuk, Z., & Gar-On Yeh, A. (2000). *Decision support systems for sustainable development: A resource book of methods and applications*. New York: Springer.

Kurian, M. (2010). Institutions and economic development—a framework for understanding water services. In M. Kurian & P. McCarney (Eds.), *Peri-urban water and sanitation services—policy, planning and method* (pp. 1–26). Dordrecht: Springer.

Kurian, M., & Ardakanian, R. (2015a). *Governing the nexus—water, soil and waste resources considering global change. Springer Briefs in Environmental Science*. Dordrecht: UNU-Springer.

Kurian, M., & Ardakanian, R. (2015b). The nexus approach to governance of environmental resources considering global change. In M. Kurian & R. Ardakanian (Eds.), *Governing the nexus: Water, soil and waste resources considering global change* (pp. 3–13). Dordrecht: UNU-Springer.

Kurian, M., & Ardakanian, R. (2015c). Policy is policy and science is science: Shall the twain ever meet? In M. Kurian & R. Ardakanian (Eds.), *Governing the nexus: Water, soil and waste resources considering global change* (pp. 219–230). Dordrecht: UNU-Springer.

Kurian, M., & Dietz, T. (2013). Leadership on the commons: Wealth distribution, co-provision and service delivery. *The Journal of Development Studies, 49*(11), 1532–1547.

Kurian, M., & Meyer, K. (2014). *UNU-FLORES nexus observatory flyer*. Dresden: UNU-FLORES.

Kurian, M., & Meyer, K. (2015). *The UNU-FLORES nexus observatory and the post-2015 monitoring agenda.* Retrieved from https://sustainabledevelopment.un.org/content/documents/6614131-Kurian-The%20UNU-FLORES%20Nexus%20Observatory%20and%20the%20Post-%202015%20Monitoring%20Agenda.pdf

Kyzirakos, K., Manegold, S., Nikolaou, C., & Koubarakis, M. (2014). Building virtual earth observatories using scientific database and semantic web technologies. *ERCIM, 96*, 10–11.

Savedoff, W., & Spiller, P. (1999). *Spilled water: Institutional commitment in the provision of water services*. Washington, DC: Inter-American Development Bank.

Shim, J. P., et al. (2002). Past, present, and future of decision support technology. *Decision Support Systems, 33*, 111–126.

Terry, R. F., Salm, J. F, Jr, Nannei, C., & Dye, C. (2014). Creating a global observatory for health R&D. *Science, 345*(6202), 1302–1304.

United Nations. (2014). *Prototype global sustainable development report. Online unedited edition, issued 1 July 2014.* New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development.

United Nations. (2015). *Global sustainable development report: 2015 edition, advanced unedited version.* New York: United Nations Department of Economic and Social Affairs, Division for Sustainable Development.

UNU-FLORES. (2015a). *Output-based aid—Metro Manila water supply improvement project*. Dresden: UNU-FLORES Nexus Observatory.

UNU-FLORES. (2015b). *Honduras social investment fund: Using output-based aid top provide water and sanitation services to low income families*. Dresden: UNU-FLORES Nexus Observatory.

UN-Habitat. (2012). *Global Urban Observatory (GUO).* Retrieved from http://unhabitat.org/urban-knowledge/global-urban-observatory-guo/

United Nations Task Team on Habitat III. (2015). *Habitat III issues papers: 7—Municipal finance*. New York: United Nations Task Team on Habitat III.

Veiga, L. G., Kurian, M., & Ardakanian, R. (2015). *Intergovernmental fiscal relations—questions of accountability and autonomy. Springer Briefs in Environmental Science*. Dordrecht: UNU-Springer.

World Health Organization (WHO). (2015). *Global Health Observatory (GHO) data.* Retrieved from http://www.who.int/gho/about/en/

World Water Council. (2015). *Integrated water resource management: A new way forward*. Discussion paper, 7th World Water Forum.