WATER GLOBAL PRACTICE • DISCUSSION PAPER

JUNE 2019

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Dividing the Water, Sharing the Benefits

Lessons from Rural-to-Urban Water Reallocation

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This publication received the support of the Global Water Security & Sanitation Partnership (GWSP). GWSP is a multidonor trust fund administered by the World Bank's Water Global Practice and supported by Australia's Department of Foreign Affairs and Trade; the Bill & Melinda Gates Foundation; The Netherlands' Ministry of Foreign Trade and Development Cooperation; Norway's Ministry of Foreign Affairs; the Rockefeller Foundation; the Swedish International Development Cooperation Agency; Switzerland's State Secretariat for Economic Affairs; the Swiss Agency for Development and Cooperation; Irish Aid; and the U.K. Department for International Development.

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Cover design: CheryRamalho/Shutterstock
Cover photo: Jean Franz, Franz & Company, Inc.

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Acknowledgments

The authors of the report gratefully acknowledge the initiative and support of Winston Yu at the World Bank, as well as a wider set of feedback provided during a brown bag lecture and associated visit on September 16-17, 2017, and a decision meeting in late October 2017.

The authors are grateful to the 60 experts and stakeholders who shared their knowledge and perspectives during interviews in Monterrey, Melbourne, Mokopane, and São Paulo.

For their valuable contributions to the final report, we thank Kaye LaFond (mapping), Codi Kozacek (managing editor), Celeste Robitaille (editorial support), Jesper Svensson (research support), Daniel Chico and Charles Wight (mapping support), Abigail Juárez-Rivero (data processing and research support), José Polendo-Garza (data processing and research support), and Erin Barrett (production support).

Summary

Global urban populations are expected to grow by approximately 2.5 billion people by 2050, with 90% of this growth occurring in Africa and Asia. Rural regions, including agriculture, are often seen as key sources of urban water supply, creating pressure for reallocation and potential hotspots of competition for water between cities and agriculture. How effective and equitable is reallocation from rural to urban regions, and what have we learned from the global experience? This synthesis report draws lessons from global experience. It examines the drivers, processes, politics, and outcomes of reallocation based on a review of the literature and insights from four in-depth case studies where governments have reallocated relatively large volumes of water from rural to urban regions: Melbourne, Australia; Mokopane, South Africa; Monterrey, Mexico; and São Paulo, Brazil.

The findings suggest that water reallocation can play an important role in regional development. However, reallocation projects have also been controversial because of distributional conflicts regarding who wins and loses. The sources of disputes depend on local conditions. Despite these differences, the literature and case studies reveal several common challenges and flashpoints of conflict: (i) disputes about *water rights* and who owns the water, (ii) the treatment of *informal water users*, (iii) the level of *water use efficiency* (and perceptions of waste) in both the rural and urban regions, (iv) the arrangements for *monitoring* and level of confidence and trust in the data, and most important, (v) the type, amount, source, and recipients of compensation for the donor region. The concept of benefit sharing, long applied to transboundary river basin management, offers a framework for designing effective and equitable reallocation processes, shifting the focus from dividing the water to sharing the benefits among rural and urban regions. The report identifies seven key lessons for realizing the potential of reallocation, and limiting the risks:

1. **Benefit sharing requires a systems perspective**. Cities are part of urban-rural systems. Reallocation, therefore, involves multiple economic, social, and physical linkages between rural and urban regions, requiring a systems perspective to understand the changing patterns of water use and the associated redistribution of benefits and costs over multiple time scales. A systems perspective can improve reallocation processes in all phases, including the design of compensation mechanisms to share benefits with the donor region.
2. **Get the numbers—and the water balance—right**. Reallocation is an inherently political decision, but should be informed by reliable data, robust accounting, and sound modeling. This includes tracking changes in water supply, water use, and water use efficiency; designing alternatives for allocation rules; and understanding and measuring costs and benefits of reallocation and their distribution. A sound understanding of the water balance underpins effective and equitable reallocation, which in turn depends on robust accounting that prioritizes the data, monitoring systems and evaluation processes needed for designing and delivering reallocation projects.

3. **Water sharing agreements should be backed by sound governance.** Reallocation from rural to urban regions involves a form of water sharing agreement across sectors and sometimes political borders. Like other transboundary agreements, rules should guide the content, and also the governance processes. Clear rules should define the volume of water transferred, the timing and location of deliveries, monitoring and compliance, compensations, and the processes and parties involved in both planning and decision making. Moreover, effective agreements require conflict resolution mechanisms and well-functioning water governance. Coordination will ensure that agreements are compatible and complementary with national laws, regulatory frameworks, and other local and regional institutional arrangements. Regional authorities and river basin organizations can offer the platform for effective negotiation, conflict resolution, and agreements.
4. **Inclusion and transparency preempt future troubles**. Any durable reallocation requires effective engagement with the donor region and ensuring inclusion of key actors. This may require taking into account informal or illegal water users. Failing to do so during the initial planning stage can breed resentment, distrust, and even technical problems that will likely affect later stages of negotiation and implementation. For this, communication and transparency are essential at the outset and throughout the process. This can require having a good communication strategy in place and well-defined venues to ensure engagement. The process and manner for sharing the benefits and spreading the costs of reallocation should be deemed fair by the key actors to get buy in and broad support. Misinformation, distrust, rumors, and false myths can cost time and resources in the long run.
5. **Droughts and crises can tip the balance, but rushing carries risks**. Urbanization and economic development are the ultimate drivers for reallocation from rural to urban areas, but reallocation rarely happens until there is alignment of enabling conditions (physical, financial, institutional, social) and key triggers. For example, droughts often present windows of opportunity but raise the risk of rushed decisions. In other circumstances, the catalyst comes from political changes or financing. Seizing the opportunities, and limiting the risks, requires preparation of the technical analysis and engagement before these windows open.
6. **Benefit sharing can transform conflict into cooperation**. Broader approaches to compensation can help reduce conflicts and support regional development opportunities for cities and rural livelihoods. The scope and scale of compensation—who receives it, who pays, and how much—should account for the needs of the donor region as a whole, not only the individuals, to capture regional economic impacts of reallocation. Forms of compensation include financial payments, investment in infrastructure, and alternative water supplies. These should be guided by efficiency, fairness, and inclusiveness. It is also critical to measure and understand the socioeconomic impacts and implications of water reallocation

(avoiding or minimizing preventable negative impacts on poor households, which often suffer most).

7. **Be ready to learn and adapt**. Even permanent reallocation requires adaptation to changing circumstances and unintended consequences, both in the donor and the recipient regions. Adjustments to reallocation agreements may be necessary due to population and economic growth in the donor region, changing legal and institutional conditions, and the emergence of new needs. To the extent possible, periodic reviews should be built into the process to avoid crisis-driven responses. Sound accounting, monitoring, and evaluation are needed to make adjustments to the original agreement.

Water Reallocation in an Urban World

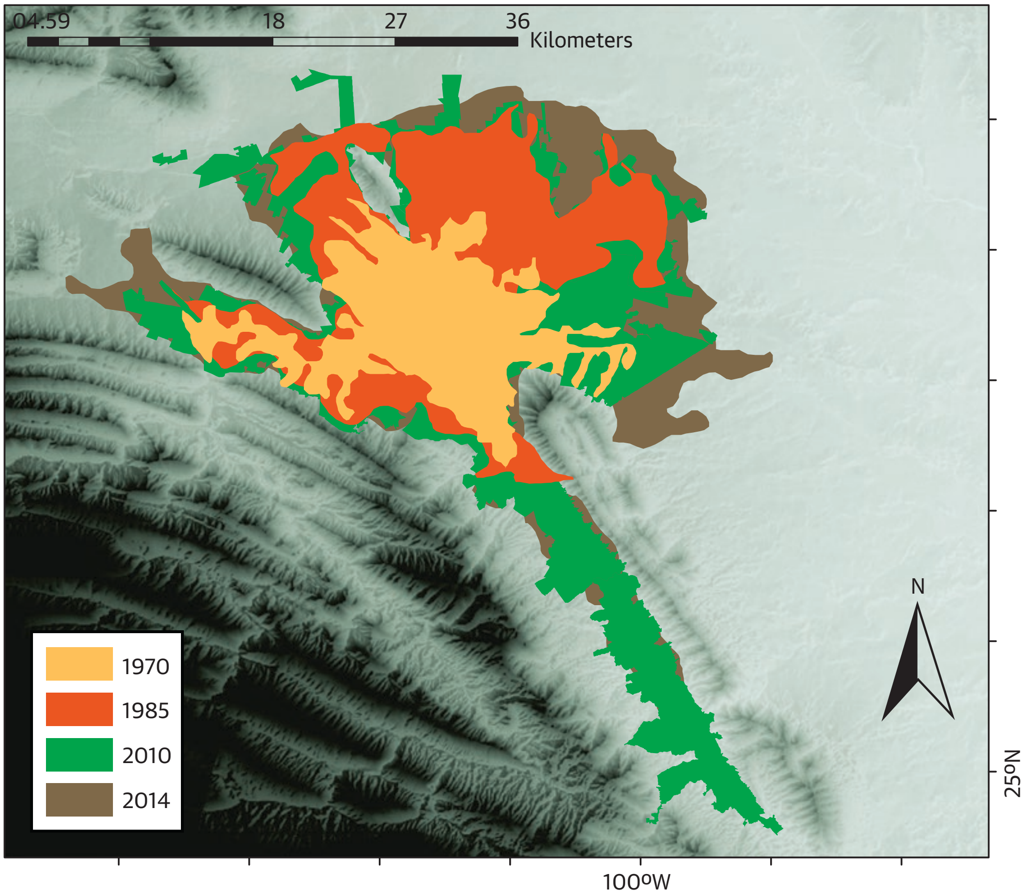
Urbanization, population growth, and rising incomes are intensifying competition for water. Approximately 2.5 billion additional people are expected to live in cities by 2050, with 90 percent in Africa and Asia. Urban demand is projected to increase by up to 80 percent by 2050, and many cities already face supply-demand imbalances and shortages during drought (Flörke, Schneider, and McDonald 2018). These trends create a pressing need for policies, incentives, and infrastructure to share water between cities and surrounding rural communities (Civitelli and Gruère 2017). There is a growing recognition that doing so will require a "fundamental re-thinking of water rights and appropriate governance mechanisms" (World Bank 2016, 20).

For rapidly urbanizing regions experiencing water scarcity, water resource reallocation—a change to the volume, timing, location, or quality of water delivered under formal or informal water rights—is becoming increasingly important (Hommes et al. 2019). River basin closure—when downstream water needs are unmet—and groundwater overdraft are signs of an imbalance between supply and demand (Wester et al. 2008). In the context of growing water stress, reallocation presents a management option to change patterns of water supply in response to shifting demands. Reallocation occurs and is enabled by water supply augmentation and demand management, and is often pursued with them (Molle 2006). As lower cost options for dealing with water scarcity are exhausted, cities and countries may explore large interbasin transfers (as with Monterrey, Mexico; maps 1 and 2) or pursue reallocation using existing infrastructure. For example, the city of Monterrey (maps 1 and 2) depicts a common trajectory of water development. The metropolitan area has expanded rapidly in response to the city's emergence as a hub for economic development and international trade. The sprawling urban area has relied on water reallocation from surrounding regions, expanding the regional water supply network far beyond the metropolitan borders. Water reallocation is therefore central to the emerging paradigm for sharing water resources and the benefits they generate.

The era of reallocation is likely to involve increasing linkages between cities and agriculture. Water has always moved from rural regions to cities. In places and eras ranging from ancient Rome and Los Angeles in the early 20th century to contemporary initiatives from Mexico City to Kathmandu, Nepal, imported water supplies have offered a path to urban water security. Yet the scale, intensity, and dynamics of the water imports are rapidly changing. Urban water infrastructure now moves approximately 500 billion liters per day over a distance of 27,000 kilometers; 12 percent of cities over 750,000 people rely on interbasin transfers, many drawing water from rural regions (McDonald et al. 2014). A systematic review of the global experience identified 103 reallocation projects reallocating approximately 16 billion m^3 of water per year from rural to urban regions, serving 69 cities with a 2015 population of almost 400 million (Garrick et al. 2019).

Competition between cities and agriculture is projected to increase. Almost half the world's surface water dependent cities with a population over 750,000 are expected to compete with agricultural regions for water by 2050. Even where water is abundant, the failure of local utilities to deliver safe drinking water prompts informal water vendors to fill the gap

MAP 1. Urban Extent of the Monterrey Metropolitan Region

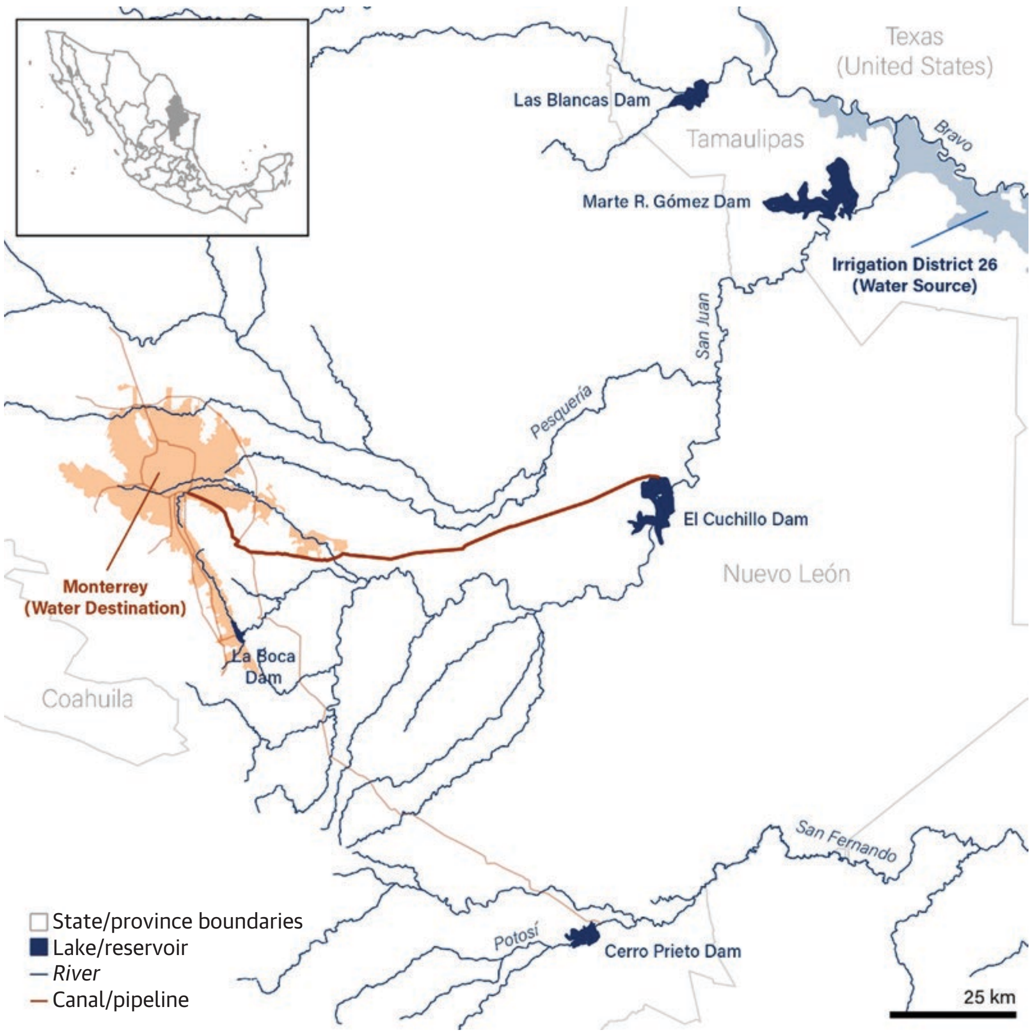


Source: Adapted from Sisto et al. 2016.

by pumping water from agricultural tube wells for growing slums and cities (Venkatachalam 2015). Water reallocation from agriculture to urban uses can also occur implicitly as land use changes. The conversion of prime cropland is expected to cause a 3.2 percent reduction in cropland by 2030; local hotspots are much higher than the global average, such as in Vietnam (10 percent) and the Arab Republic of Egypt (over 30 percent). In addition, urban food systems are embedding agricultural water use within the city and its supply systems, creating novel allocation and management challenges (d'Amour 2017).

The standard justification for reallocation is economic. First, the economic productivity of water varies across competing uses, and there is potential to increase social welfare by moving water from relatively lower valued uses to higher valued uses. The marginal benefit of supplying water to a city often far exceeds the value of that water in agriculture. Second, agriculture uses the most water in arid and semi-arid regions often with low water use efficiency. Recent modeling projects that a 10 percent increase in irrigation water use efficiency over 50 years would reduce anticipated urban water deficits by over 2,600 cubic megameters and support more than 230 million people (Flörke, Schneider, and McDonald

MAP 2. Expansion of the Regional Water Supply System, Including El Cuchillo Reservoir



Source: Adapted from Sisto et al. 2016.

Note: The population of the metropolitan area of Monterrey increased from approximately 270,000 in 1950 to almost 3 million in 1990, when El Cuchillo Dam was approved, expanding the spatial extent of the metropolitan area (map 1). The regional water supply system expanded as a result to draw water from greater distances, including the El Cuchillo project, which diverts water historically used by downstream irrigators.

2018). However, the potential for water savings needs to be considered carefully given the paradox of irrigation efficiency, whereby farm-level efficiency gains translate into increased consumption at the basin scale (Grafton et al. 2018). Increasing irrigation efficiency involves technical, financial, and political challenges to ensure water accounting, reduce water extractions, generate sufficient capital, and address the distributional impacts of reallocation.

The practical and political difficulties of reallocation have meant that the economic rationale has not been sufficient due to the distance, cost, and contentious politics involved with reallocation. The differences in marginal productivity may miss the system-level value of water in agriculture and equity impacts on the most marginal and vulnerable.

Further, realizing gains in water use efficiency creates profound technical, political, and economic challenges. As a consequence, water planners follow the path of least resistance, in which political, social, and economic costs are considered together, rather than assessing only financial criteria and cost-benefit analysis (Molle and Berkoff 2009). These political costs of reallocation can be formidable and have stymied or delayed projects that are justified on economic grounds alone.

The growing global experience with reallocation highlights the importance of political economy issues: the distribution of benefits and costs and the winners and losers associated with allocation decisions. Reallocation from rural regions to cities is *expected* to reduce agricultural production as water availability declines. This creates a potential zero-sum game: cities benefit from the additional water supplies, while reduced water supplies for the agricultural region threatens agricultural production and jobs. In this scenario, water security for the city comes at the expense of water security for agriculture. Owens Valley of California is frequently cited as an example of this approach. Land and water rights purchases in the early 20th century led to the retirement of agricultural lands to supply water for Los Angeles and Southern California. Owens Valley benefited from rising land values, which increased by a factor of 11 compared with a doubling of land values in a comparable rural county during the same period. However, the lion's share of benefits were captured by Los Angeles, creating the perception of an unfair deal and lingering resentment that has constrained reallocation from agricultural to urban uses today (Libecap 2008).

As pressure for reallocation from rural to urban areas grows, so have fears about the consequences for poor rural households (Birkenholtz 2016). Prior reviews note the potentially adverse consequences for equity, environmental sustainability, and the livelihoods of poor rural populations. Coimbatore, India, offers an illustration of this threat: administrative reallocation projects since 1960, coupled with informal groundwater markets, have steadily reallocated water from agricultural to urban and industrial uses. Reallocation has reduced farm income by 50 percent at the tail end of irrigation systems in the Bhavani River basin and has increased poverty in farm households by 12 percent; groundwater depletion to meet urban and industrial needs has reduced water levels (Meinzen-Dick and Ringler 2008). Reallocation in Coimbatore has contributed to economic diversification and urban water security, but it has raised the specter of deepening inequalities across the rural-urban divide that could leave the poorest households behind.

More recent experiences with reallocation have strived to share the benefits of reallocation as equitably as possible, including a negotiation process seen as legitimate and fair by the donor region. In these circumstances, compensation and benefit sharing measures are increasingly used to offset the negative impacts of reallocation, and often leave the donor region better off (Dai et al. 2017). For example, financial payments to farmers or irrigation districts can offset lost production or facilitate farm-level efficiency improvements to maintain or increase productivity. Other forms of compensation are proliferating: investments in irrigation modernization, alternative water supplies, and other benefit sharing programs in the donor region are means of maintaining or enhancing agricultural production in the donor region. These opportunities for win-win outcomes depend on the type and level of compensation and negotiation.

Despite these concerns, experience with water reallocation is growing, leading to new thinking about the drivers, types, and effectiveness of reallocation, as well as lessons learned about how to design and implement reallocation projects. It has been 20 years since World Bank research framed opportunities and surveyed innovations in water reallocation and conservation (Bhatia, Cestti, and Winpenny 1995), and 10 years since Molle and Berkoff (2009) conducted a broad review of reallocation as a means of sharing water between agriculture and cities. Garrick et al. (2019) contributes to this research with a systematic review of the global experience with reallocation from rural to urban regions. We explore whether reallocation can be an effective and equitable response to resource scarcity and shocks.

Reallocation Defined

Water reallocation changes the prevailing pattern of water use and can be defined as **change to the volume, timing, and location or quality of water delivery, intended to deliver specific goals** (Grafton, Garrick, and Horne 2017). Reallocation occurs within a legal and institutional framework of formal or informal water rights governing who gets water, how much, when, and where, as well as who is involved in decisions about water allocation and reallocation.

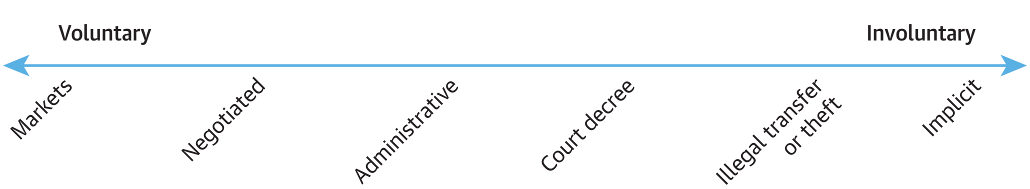
Economic theory distinguishes an initial allocation from reallocation because the two processes may involve different modes of governance. An 'initial' allocation establishes water rights, while subsequent changes are governed by rules that determine when and how water can be redistributed. An initial allocation implies a formal process by the state or community to define rights or licences to access, withdraw, use, manage and trade water, and is often accompanied by an assessment of the renewable supplies under different infrastructure systems. Rarely is there a blank slate. Informal water claims almost always predate efforts by governments and communities to allocate water formally. Therefore we argue that allocation almost always involves reallocation, either from informal users, the environment, or both.

Reallocation from rural regions to cities involves changes in the type and/or place of water use from rural to urban purposes when the existing allocation is deemed physically impossible, economically inefficient or socially unacceptable (Marston and Cai 2016). This occurs when urbanizing regions approach or exceed full development of local water supplies, requiring additional, higher cost water from surrounding regions. The nature of water use varies between urban and rural types, particularly agriculture. A substantial portion of water is consumed by crops in agriculture in contrast to drinking water and industrial uses, which produce wastewater and changes in water quality.

Water reallocation takes many forms: administrative agreements, negotiated settlements, market-based transactions, court decrees, and implicit processes of water reallocation through land use change (Hooper and Lankford 2018). In practice these different approaches are often combined or occur in sequence, and they are contingent upon the institutional framework for water planning, water rights, and conflict resolution.

Two interrelated characteristics shape the political economy of reallocation from rural regions to cities: (i) to what degree the reallocation decision is *voluntary* (figure 1), and (ii) whether and how existing users are *compensated* for the loss of water.

FIGURE 1. Types of Water Reallocation



Voluntary reallocation is associated with market-based transfers or collective negotiation. Voluntary approaches require participation by existing users in the reallocation decision, and, typically, a compensation scheme deemed fair by the existing water users and other affected stakeholders. By contrast, some court decisions or administrative decrees involve involuntary reallocation by suspending or terminating existing water rights based on legal prerogatives of the granting authority, such as to serve the public trust. Involuntary reallocation processes may trigger negotiation to resolve the grievances raised by those excluded from the initial decision. Water reallocation can occur implicitly, such as land use conversion, a gradual shift in the operating rules for a reservoir storage, or informal water vendors moving water from rural regions to supply urban and peri-urban dwellers. Hermosillo, Sonora, in Mexico, illustrates how multiple forms of reallocation can occur in the same place as cities grow and the institutional arrangements governing water sharing shift with time: market-oriented transfers from agricultural groundwater wells in 2004 were followed by negotiated transfers in 2005 and construction of an aqueduct (involving an administrative decision) in 2009 (Scott and Pablos 2011).

Political and technical challenges associated with water reallocation increase with duration, distance, or involvement of multiple sectors. First, reallocation can be temporary or permanent, ranging from part of an irrigation season to perpetuity. Permanent reallocation typically involves more conflict than a temporary agreement due to the distributional issues involved and the perception that the change in water use is irreversible. In Southern California, permanent acquisitions from Owens Valley created significant disputes over valuation, negotiation, and enforcement compared with the contemporary dry-year agreements used to reduce agricultural water use temporarily to buffer shortages during sustained droughts.

Second, reallocation can occur locally or span political and basin boundaries. Reallocation over longer distances creates greater potential for conflict due to the cascading impacts in the donor region and the impacts on the local water balance as water departs the system. Rural-to-urban reallocation projects range from a few kilometers for tanker trucks operating at the peri-urban fringe to interbasin transfers moving water over great distances, such as China's 4,000-kilometer South-to-North Water Diversion Project. Costs, infrastructure, and disparities in costs and benefits are expected to increase as water moves longer distances.

Finally, reallocation can occur within or between uses. Reallocation across water uses—such as from rural to urban—involves more substantial risk of distributional conflicts than within a given use. The reduction of water in the area of origin involves indirect economic and social impacts, which are less prevalent when water stays within the same group of users. The capacity to address the increasing complexity and conflict associated with longer duration and distances and the involvement of multiple uses is a function of the infrastructure, water accounting, water rights, and wider institutional arrangements involved.

A political economy perspective provides criteria for examining reallocation based on effectiveness, equity, and efficiency. Water reallocation involves questions of justice, fairness, and the distribution of resources and benefits generated. It also affects current and long-term economic efficiency. Economic efficiency implies the allocation of scarce resources to their highest valued economic uses, defined as a situation that maximizes the marginal productivity of water across its competing uses. *Equity* and *fairness* are difficult to define and measure by comparison; these terms are aspirational, contextual, and contingent. Further, there are trade-offs between efficiency and equity, as when efficiency dictates the reallocation of water from agriculture to cities, but equity merits consideration of the amount and pace of reallocation, and the compensation and benefit sharing arrangements in place.

We focus on the drivers, process, and outcomes of reallocation from rural to urban regions according to these criteria, exploring whether the goals of the reallocation are met as well as the winners and losers involved. This requires an understanding of costs and benefits of reallocation, as well as their distribution between and within rural regions and cities.

Methodology

This report synthesizes the global evidence on reallocation from rural regions to cities. The methodological approach includes two steps. The first step involves a systematic review of the global experience with rural-to-urban water reallocation (map 3) (Garrick et al. 2019).[1,2] The review examines the supply and demand drivers of reallocation, the reallocation process, and impacts. Here we emphasize three of the key findings that shaped this report's methodology. First, reallocation is driven by the interaction of supply and demand drivers. Urban population growth and economic development leads to increases in water demand in a context of limited water supplies, climate variability, or water quality problems. Second, collective negotiation and administrative decisions are the most prevalent form of reallocation decision making. The administrative agreements that govern the negotiation and implementation of reallocation projects often involve the construction of new infrastructure and include provisions for compensation. Finally, the evidence on the costs and benefits of these projects and their distribution is sparse, and virtually uncharted for informal reallocation processes (e.g., via informal markets or theft). In this context, there is increasing need to assess the evolution of water reallocation projects and their political economy.

The second step involved the development of in-depth case studies, employing a political economy framework to assess the drivers, processes, and outcomes of water reallocation

MAP 3. Rural-to-Urban Water Reallocation, following Garrick et al. (2019)

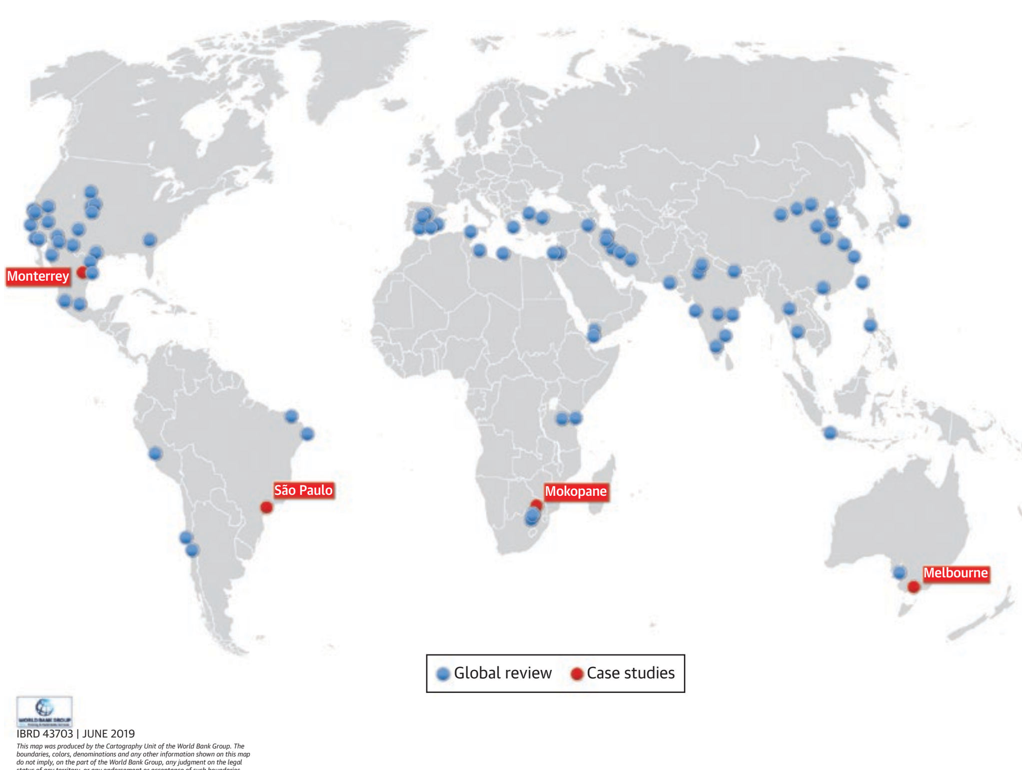


TABLE 1. Selected Attributes of the Water Reallocation Case Studies

	Melbourne, Australia	Mokopane, South Africa	Monterrey, Mexico	São Paulo, Brazil
Year (agreements)	2007, 2010	1993	1989, 1995, 1996	1974, 2004, 2017
Primary Goals	• Irrigation modernization • Municipal water supplies • Environmental water recovery	• Municipal water supplies • Farmer debt relief	• Municipal water supplies • Flood control	• Municipal water supplies
Distance (km)	70	~25	108	80
Volume (m³/y)	Up to 75 million	Up to 2.4 million	Up to 157 million	Up to 900 million
Capital cost[a] (millions, US$ 2019)	$784 Pipeline only[b]	n.a.	$893–$1,236	$516 Phase 1 only
Financing	Melbourne Water (state-owned water utility)	National government	Nuevo Leon state government, Monterrey Water Authority, national government; IDB	Various sources
Donor region	Goulburn Valley, Murray River (Goulburn-Murray Irrigation District)	Sterk River Irrigation Scheme	Irrigation District 026, Lower San Juan	PCJ rivers
Donor characteristics	258,000 ha of irrigation	1,600 ha of irrigation	70,000–100,000 ha of irrigation (~5,000 farms)	PCJ headwaters

Sources: Aguilar-Barajas and Garrick 2019; de Souza Leão and De Stefano in press; O'Donnell, Garrick, and Horne 2019.
Note: IDB = Inter-American Development Bank; n.a. = not applicable; PCJ = Piracicaba, Capivari, and Jundiaí.
a All dollar figures in this report are in 2019 US dollars (US$). Foreign currency values were first converted to contemporary US$ based on the annual average currency exchange rate during the year in which the costs were incurred and were then adjusted for inflation using the US Consumer Price Index to obtain the 2019 US$.
b Capital investments in irrigation efficiency to generate the water "savings" cost an additional US$972.5 million and were funded by the Victoria state government.

projects from a political economy perspective. four *administrative* reallocation projects from rural regions to cities (table 1): Melbourne, Australia; Mokopane, South Africa; Monterrey, Mexico; and São Paulo, Brazil. The case studies are examples in which the national or state governments have reallocated large volumes of water from one place to another (e.g., inter-basin or interregion transfers). Case study selection criteria include the following:

- A focus on administrative reallocation projects, rather than market-based transactions.
- Cases that have not received extensive coverage in academic literature to date, or have only received coverage when first negotiated and completed.
- Data availability for in-depth analysis, including primary data on political, social, environmental, and economic drivers and impacts of the project; technical information regarding the change in water balance; and information on the costs and benefits of the project and their distribution.
- Participation of local partners and experts, including personnel with institutional memory of the project, such as government officials and key informants from the donor and recipient regions.

Three of the four case studies are from countries with reallocation at key stages in the development path of growing cities. Whereas the Monterrey and São Paolo cases involve large cities, the case of Mokopane provides insights from a rapidly urbanizing township that exemplifies the growing challenges faced by towns and small to intermediate-sized cities. The fourth case study from Australia involves the reallocation of water "saved" through irrigation efficiency; it offers an important example given the growing push to use irrigation efficiency to quench the growing water demands of cities.

Drawing on multiple sources of data, the case studies assess the evolution and effectiveness of reallocation projects across multiple criteria. Data include archival information (agreements, meeting minutes), interviews with decision makers and stakeholders, and available financial and socioeconomic data. A set of assessment questions explore the political economy of reallocation, examining the history, negotiation, and impacts of the project (box 1).

An international team conducted 60 interviews during a two-month period (February and March 2017). Interviewees included key actors from the rural communities (donor or source region), city representatives (recipient region), water resource agencies, and other relevant stakeholders. They included three former state governors, a deputy state government premier, four heads of national water agencies (past and present), directors of major urban water utilities (past and present), as well as irrigation managers and farmers, city water managers, members of civil society, and political leaders. However, the distributional impacts on water reallocation require high resolution and localized socioeconomic analysis, which was limited.

BOX 1. Assessment Questions

- **Drivers and goals.** What drove the reallocation, and what were the goals of the project?
- **Mechanisms.** What processes were used for the reallocation? What alternatives were considered?
- **Efficacy.** Did the reallocation achieve its intended goals? What were the unintended consequences?
- **Efficiency and equity.** What were social, economic, and environmental costs and benefits of reallocation, and how were they distributed within and between the donor and recipient region? How did this change over the short term and long term?
- **Compensation.** How were existing users (donor region) and third parties impacted by the project? How was the donor region compensated?
- **Dynamics.** How has the reallocation project affected the future prospects for reallocation in the region?
- **Lessons.** What lessons can be learned about the design, implementation, and renegotiation of the project? What are the perceptions of the project across different actors?

Understanding Reallocation

This section summarizes the responses to these questions. We distil key ideas and lessons for decision makers facing the challenge of scoping, designing, or implementing a water reallocation agreement to quench the thirst of fast developing urban areas. Both the literature review and the in-depth case studies were guided by five primary questions:

- **Drivers**: What drives reallocation?
- **Process**: How is water reallocated in practice?
- **Politics**: What are the political controversies associated with reallocation?
- **Outcomes**: How can water reallocation deliver more efficient and equitable outcomes?
- **Lessons**: What lessons can be learned?

What Drives Reallocation?

Reallocation from agriculture to cities is the product of two fundamental drivers: growing demand and inadequate supply (Marston and Cai 2016). However, supply-demand imbalances are not sufficient on their own to overcome the political, financial, and technical barriers, which require additional enabling conditions or triggers. We provide an overview of the different demand and supply drivers and triggers based on the broader literature (table 2) and for the four case studies (table 3).

Demand drivers. Population growth; the rising economic value of water for urban water uses; and the technical, political, and economic feasibility of increasing urban water use efficiency represent the key variables driving reallocation from rural to urban regions. Demand increases with population growth until urban water use efficiency

TABLE 2. Trends and Drivers for Rural-to-Urban Water Reallocation

Trends	Drivers
Changing demand patterns	• Exhaustion of local surface and groundwater supplies • Increasing competition between agriculture, peri-urban and urban uses • Changes in the timing, location, and quality of water
Changing supply patterns	• Impacts of drought on cities and agricultural water availability • Inadequate water supply infrastructure for storage and piped connections • Improved wastewater collection, treatment, and reuse for agriculture • Climate variability and change affecting water reliability
Declining water quality	• Impacts of agricultural and industrial pollution on urban water supplies • Local contamination due to inadequate wastewater treatment
Increasing water use efficiency	• Increased irrigation efficiency generates water savings subject to proper accounting of return flows

Source: Adapted from OECD 2015.

TABLE 3. Factors Driving Administrative Reallocation from Agriculture to Urban Water Uses

	Population growth and economic development	Intensive use of local water resources	Pollution of local resources	Prolonged drought	Wastewater reuse	Improved irrigation efficiency
Melbourne, Australia	Y	Y	n.a.	Y	n.a.	Y
Mokopane, South Africa	Y	n.a.	n.a.	n.a.	n.a.	n.a.
Monterrey, Mexico	Y	Y	n.a.	n.a.	Y	n.a.
São Paulo, Brazil	Y	Y	Y	n.a.	n.a.	n.a.

Source: Author elaboration.
Note: Y= yes; n.a. = not applicable.

enables decoupling. The marginal economic value of water in cities is often higher than agriculture. Finally, urban water use efficiency provides a potential substitute for reallocation, but can prove costly or encounter political and cultural resistance.

A conventional trajectory involves population growth leading to the exhaustion and degradation of local water supplies (Richter et al. 2013). The economic importance of cities and industry creates political will and financial capital for reallocation when local supplies prove inadequate. For example, Monterrey grew from 270,000 in 1950 to almost 3 million by 1990, becoming one of the largest cities in Mexico and a hub of international trade and economic growth. This growth led to an increase of its water consumption, which outstripped water available from local aquifers and nearby reservoirs. Similar trajectories are occurring across the global south, from Hyderabad, India, to Nairobi, Kenya.

Water quality problems in the city may also lead to reallocation. In São Paulo, pollution due to heavy industrial development and poor wastewater collection and treatment has degraded local surface and groundwater resources. In some regions where water stress is already high, population growth has decoupled from water demand through increasing urban water use efficiency, but this may not be enough to meet urban water needs. In Albuquerque, New Mexico, severe water imbalances and plummeting groundwater levels have led to major water efficiency efforts since 1995. The city has achieved a reduction of half of the daily per capita water consumption in 20 years: from 251 to 127 gallons per capita per day. Despite these efforts, Albuquerque has needed to pursue new surface water resources, both from agricultural farmers in the surrounding counties and through an interbasin water transfer.

Supply drivers. Legal restrictions on new supplies, infrastructure development, and droughts are key supply variables driving reallocation from rural to urban regions. Legal and technical constraints on new infrastructure development have provided a primary driver for reallocation, when new demands depend on reallocation from existing water supplies rather than the importation of new sources. However, infrastructure development or modernization can enable large-scale reallocation projects to move water from historic to contemporary uses.

Droughts are critical factors driving reallocation. Even in cities with sufficient water supplies to meet demands in average years, temporary deficits associated with droughts can spur reallocation to meet chronic and acute shortages alike. In Australia, the reallocation to Melbourne was accelerated by the growing threats of water shortages due to drought. In Taiwan, rainfall deficits from 2002 to 2006 led to reductions in paddy growing, following provisions for emergency transfers to support urban demand under the 1942 Taiwan Water Law. In Spain, prolonged drought has led to administrative decisions to temporary reallocate irrigation water to urban areas. Other regions in the Western United States have entered into interruptible contracts, or dry-year options, in which irrigation districts fallow lands during droughts to buffer water supplies for cities.

Reallocation is linked with irrigation efficiency improvements. Investments in irrigation efficiency can create opportunities for reallocation when agricultural regions reduce water consumption. Although improved irrigation efficiency offers a potential source of water supply for growing cities, it also raises challenges for water accounting to document and verify water savings and understand the implications for downstream water users and the environment (Wester et al. 2008). If designed and monitored carefully, irrigation districts and urban areas can establish a win-win situation, by which cities can benefit from water savings due irrigation modernization and farmers can obtain financing from cities to contribute to the modernization of their irrigation systems. In this regard, irrigation efficiency can act as both a response to reallocation and a driver. In the first instance, irrigation efficiency increase can be a strategy by the donor region to manage reductions in water availability associated with reallocation. In the second instance, the need for capital investment in irrigation modernization schemes may drive reallocation when agricultural regions release water in exchange for financing. In northern Victoria, Melbourne and the state government invested in a US$972.5 million irrigation modernization program to address shortage risks associated with the Millennium drought and expand the supply portfolio for the city's long-term growth. Similar programs have been developed in Southern California and Japan. For example, in Japan, the Saitama Prefecture paid for the rehabilitation of irrigation infrastructure and reallocated over 7 cubic meters per second of saved water for domestic use over a series of incremental projects from 1968 to 2003 (Matsuno et al. 2007). Such approaches involve irrigation modernization as a form of compensation.

Finally, the collection, treatment, and reuse of urban wastewater present another growing opportunity for reallocation. Improved sanitation infrastructure provides cities with large volumes of water that can be offered to irrigators in exchange for water from conventional water sources. This involves reallocation of high-quality water from agricultural uses to cities in exchange for treated wastewater that meets quality requirements for irrigated agriculture. In Monterrey, for example, the development of the El Cuchillo agreement came with a subsequent water sharing agreement committing the city to deliver 6 cubic meters per second of treated wastewater to the downstream irrigation district.

External Triggers. Many water stressed cities struggle to reallocate water from surrounding agricultural regions. For instance, in Cape Town, South Africa, reallocation from agriculture has been politically infeasible despite being routinely identified as an important management option for the city's urban water security. This illustrates that the economic and technical drivers are not sufficient on their own. Reallocation depends on factors or levers coming together to overcome political resistance, economic crises, financing challenges, and technical problems.

Even when water demand for cities outstrips available supplies, reallocation may not occur until triggers create a window for action. These triggers can take multiple forms and operate at a range of spatial and temporal scales. Political windows may arise during changes in government and the emergence of new leadership from the affected region. For example, approval and implementation of the Telugu project to deliver water from the Krishna River Basin to Chennai, India, became possible because of a temporary political alignment between the Union government (national government) and state governments enabled by the electoral gains brought about by the project. Across the case studies, political transitions created opportunities and constraints for reallocation. In Monterrey, the national election of President Carlos Salinas de Gortari brought new impetus to the El Cuchillo project nearly 70 years after the first planning studies. The president made modernization a plank of his presidency and had family from the region, which made the El Cuchillo project an attractive target due to its wider economic and strategic significance.

Financing represents another important trigger or constraint on reallocation, particularly when capital investments in infrastructure are required for interbasin transfers or irrigation modernisation. Australia presents a clear example of financing enabling rural to urban reallocation from Northern Victoria to Melbourne (box 2). The existence of a budget surplus and willingness of the state government to invest in irrigation water savings helped to tip the balance for the project; moreover, the need for external investment to modernize irrigation made the agricultural community and leaders initially more amenable to reallocation in exchange for financing. Conversely, the lack of finance can hinder projects even when the benefits far exceed the costs and political and technical challenges have been addressed. In Kathmandu, the US$689 million Melamchi Water Supply project can be traced to the 1973 Water Master Plan (Gurung et al. 2017). An infusion of funding from the Asian Development Bank (ADB) in 2000 spurred development of the project. As a condition for the funding, the ADB mandated institutional reforms to include private operations and other measures; these proved challenging and led to restructuring.

How Is Water Reallocated in Practice?

The case studies illustrate that reallocation is a process that can span multiple decades. Although reallocation is shaped by local history and hydrology, administrative approaches to reallocation involve broad similarities across diverse contexts. The global experiences

BOX 2. Reallocation through North to South Pipeline in Melbourne

The North-South (or Sugarloaf) Pipeline was completed in 2010 to deliver up to 75 cubic megameters per year to Melbourne through a interbasin transfer from the Goulburn River, a tributary of the Murray River. The US$729 million, 70-kilometer pipeline was announced in June 2007 during the depths of the 13-year Millennium drought (1997–2009). Reservoir storage for Melbourne's 4 million residents dipped below 30 percent in May 2007, prompting a US$4.8 billion plan to address Victoria's water security. Even though Northern Victoria and the Murray-Darling Basin were also experiencing severe drought, the Sugarloaf Pipeline was considered the lowest-cost source of new water for Melbourne and the most rapid of the options available, to be further supplemented in the longer term by a proposed desalination plant. The water from the Goulburn River would be generated through water savings from a US$972.5 million irrigation infrastructure upgrade (the Food Bowl Modernization scheme) championed by a prominent group of agricultural and business leaders from the donor region.

More than 40 years after former Victorian premier Sir Henry Bolte proclaimed that not a single drop of water would leave the Murray-Darling Basin for Melbourne, a once in a 100-year opportunity opened. A unique convergence of four factors drove the project: (i) the threat drought posed to Melbourne's water security; (ii) the longer term needs of a growing city; (iii) the push for irrigation modernization—and the associated need for financing—to drive economic growth in Northern Victoria; and (iv) growing commitments to secure water for the environment. The drought "insurance" offered by the project for Melbourne's water supply was a critical justification and helped to tip the scales for its rapid approval, despite the legacy of resistance.

The Sugarloaf Pipeline was complete, and delivering small volumes of water to Melbourne, in late 2010. However, in November 2010, a new coalition government was elected in Victoria, bringing a new water minister, Peter Walsh, who opposed the project and was elected in part due to his vocal opposition. The incoming government immediately halted deliveries of water to Melbourne from the Sugarloaf Pipeline. Since late 2011, new rules of operation prevent the use of the Sugarloaf Pipeline to deliver water to Melbourne unless the city's water reservoirs drop below 30 percent by November 30. This is an unprecedented threshold for Melbourne (even during the Millennium drought, storages remained above 30 percent by November 30), and means that the Sugarloaf Pipeline will rarely (if ever) be used under current rules.

The Sugarloaf Pipeline is an example of rural-to-urban reallocation in the context of irrigation modernization, in which the savings generated by irrigation efficiency provided the water supply for urban, additional agriculture, and environmental restoration purposes. The reallocation experience in Melbourne and the Goulburn

box continues next page

BOX 2. continued

region illustrates the political and technical challenges of reallocation using water generated through irrigation efficiency projects due to the water accounting needed to document and validate savings. Other important lessons include drought's status as a double-edged sword: it can facilitate investments in infrastructure projects that would be difficult under normal circumstances, but it can also accelerate projects with limited time for the technical study, engagement, and political negotiation needed to sustain the reform.

Source: O'Donnell, Garrick, and Horne 2019

with administrative approaches to rural-to-urban reallocation illustrate the existence of four phases—drivers, diagnosis, design, and delivery—although these are often hard to distinguish in practice and rarely part of a linear process. The supply and demand drivers create pressure for reallocation as cities grow, and can be triggered by the political and financial factors noted previously. When cities pursue more water, reallocation from rural regions constitutes only one option among a range of other infrastructure (e.g., groundwater development, desalination) and demand management approaches, and is assessed in relation to these alternatives as a complement or substitute. Even when reallocation presents the most efficient option, design and delivery challenges often arise due to technical and political economy issues noted previously. Changes in patterns of water allocation and use involve unintended consequences that create the need for adjustment, and, sometimes, renegotiation. Reallocation projects involve an assessment (diagnosis) to evaluate reallocation against other alternatives and to design the project based on technical, economic efficiency, and equity considerations.

Diagnosis involves technical studies and stakeholder consultations, which can vary tremendously in their rigor, depending on capacity for water accounting and budgeting, stakeholder mapping, communication and engagement efforts, and feasibility studies. A water balance and water accounting can track the supply and demand from a system, and the boundaries of the system become a crucial determination, as illustrated by the expansion of São Paulo Metropolitan Region water system to include the (Piracicaba, Capivari, and Jundiaí) PCJ basins. The system boundaries can guide mapping of the relevant stakeholders from the source and destination regions, offering a baseline and benchmark for assessing the impacts of reallocation. In Mokopane, farm owners were included in the mapping of stakeholders, but farm workers were not. Effective communication and engagement with affected stakeholders become important at this phase, requiring strategies to reduce or preempt backlash later in the process.

Design determines whether new or modernized infrastructure is needed for reallocation. Design is institutional and involves the development of agreements regarding financing arrangements, water sharing, and compensation. The design phase of administrative reallocation often involves extensive negotiation in all these areas, which builds on the stakeholder mapping and engagement addressed during diagnosis and scoping. These processes will involve different agencies or stakeholders based on the institutional framework governing allocation and reallocation, ranging from highly centralized and formal processes to informal arrangements. The design of administrative agreements—water permits, operational rules and related instruments—proves critical for effective and equitable reallocation. In this regard, reallocation agreements bear striking resemblance to international transboundary water agreements, which establish rules, rights, and responsibilities and ensure provisions for adjustment and conflict resolution. For example, the Monterrey project involved three agreements, including an operational agreement in 1996 with detailed criteria and conditions for water sharing, compensation, and coordination by a river basin council. The political feasibility and socioeconomic impacts of the project are heavily influenced by compensation agreements, which take diverse forms, sources, amounts, and recipients based on the nature of the impacts and focus on poor households.

The experience in Hyderabad, illustrates the importance of agreement design. The city draws water from the Krishna and Manjira rivers with a sequence of government orders used to enact administrative reallocation in each. Although politically contentious in both instances, reallocation from the Krishna occurred without compensation and has met with sustained resistance. Conversely, an intersectoral water sharing agreement for the Manjira transfer defined water volumes to support irrigation projects when sufficient water is reserved to meet Hyderabad's allocation, mitigating impacts on the agricultural region (Celio, Scott, and Giordano 2010).

Delivery involves the construction and operation of the agreement, as well as the monitoring and evaluation of impacts. The unintended consequences of reallocation and the lessons from operating experience provide the basis for adjustment and may lead to renegotiation. Periodic renewal processes can build predictable openings for adjustment, as experienced with São Paulo in which the initial water permit in 1974 involved a 30-year term, followed by 10-year agreements in 2004 and 2017. These renegotiation opportunities allow adjustments to shifting drivers and the diagnosis and response to new risks and opportunities, particularly as the donor region grows. Although the temporary nature of such agreements affords several advantages and may make the parties more likely to agree to a reallocation, droughts or other social, economic, and environmental changes can make renegotiation more difficult, or delayed, as occurred in 2014 due to the severe drought affecting São Paulo (box 3). Delivery requires appropriate tools for evaluating and tracking impacts, including capacity to disaggregate the impacts to understand the distributional impacts of reallocation. For example, socioeconomic indicators, agricultural productivity, water use efficiency, and water accounting all prove critical for understanding and addressing the negative impacts of reallocation.

BOX 3. Cycles of Reallocation Amid Change in São Paulo

In 1974 the Cantareira system, a network of reservoirs located in the inland region of the State of São Paulo, started operations to reallocate water from the rural headwaters of the PCJ basins to the São Paulo Metropolitan Region (SPMR). Currently, up to 900 million cubic meters per year of water travel over 80 kilometers to provide drinking water to about 8 million people in the SPMR, the most important financial and economic center in Brazil and home to over 21 million people. Since 1974, the operating rules of the Cantareira system have been revised and renegotiated twice, once in 2004 and once in 2017, leading to the revision of the water allocation shares between the donor and the recipient regions, as well as the conditions regulating the reallocation.

The case study demonstrates that reallocation is dynamic and needs to be revisited over time. The project was originally designed and developed over 50 years ago under a military regime to bring water from a sparsely populated, rural region to a densely inhabited, fast-growing region. Sustained urban and industrial growth in the donor region, the democratization of Brazil, and the implementation of a new water management model have created a radically new context that required stakeholders to revisit the original goals and rules of the reallocation.

Since the start of operations, the Cantareira project has been effective in achieving its main goal of meeting the water needs of an important share of the SPMR population. Over time, however, it became evident that the reallocation could not be managed unilaterally by the SPMR utility company (Sabesp), but had to consider the needs of the donor region. Recurrent floods and droughts showed the weaknesses of the reallocation agreement and the need for more flexible solutions to increase water security in both regions. The expiration of the water reallocation permit in 2004 and in 2014 allowed the government to revise the reallocation rules to increase its ability to deal with extreme events and to slightly increase the share of benefits of the Cantareira system with the donor region. In both renewals, droughts catalyzed change and adaptation, as they revealed the weaknesses of the reallocation design. The 2003-04 and 2014 droughts pushed decision makers to look for more sophisticated and flexible solutions in the revision of the reallocation design.

During negotiations, strong technical advice is key, but politics and perceptions also matter. The evolution of the water permit over time shows that the rules for the allocation have become increasingly more technical and complex to improve the resilience of the water supply system. In the design of both permits, in 2004 and 2017, negotiators were sophisticated in defining operating rules, terms, and conditions (e.g., risk aversion curves, water banks, and new location of the allocation control points). Reallocation design was rooted in sound technical studies, but the negotiation was also inevitably a very political issue. In particular, the political constellation at federal, state, and municipal levels highly influenced the negotiations, as did the electoral calendar.

Source: de Souza Leão and De Stefano, in press.

Navigating the Controversies of Reallocation

Administrative reallocation occurs across a range of contexts and institutional arrangements. Regardless of the differences, some common issues contribute to misperceptions and tensions. The literature and case studies reveal challenges associated with diverging perspectives about the ownership of water, informal water users, water use efficiency, monitoring, and compensation.

Controversies over water rights affect water reallocation by creating uncertainty about *who owns and should control water*. Uncertainty can stem from legal disputes associated with water licencing and the rules and priorities governing water allocation between cities and agriculture. Both cities and agricultural regions cite such controversies to promote reallocation or resist it, respectively. Cities may claim water that "never really belonged" to agricultural regions, while agricultural regions often claim the priority of their rights and claims. In Monterrey, for example, downstream farmers asserted strong claims regarding their ownership over water, invoking a 1952 Presidential Accord that had been superseded by national water laws leading to the regularization of water licences. The Accord remains a basis for complaints by irrigators, regardless of its legal validity. In São Paulo's case, PCJ stakeholders stress that water transferred to the capital originates in their headwaters, and, therefore, they should have a say about how it is shared and used.

Informal water use is prevalent in many agricultural regions, and it can hinder efforts to reallocate water or implement agreed benefit sharing mechanisms. Agricultural regions may lobby against reallocation projects that threaten informal water users or bring added scrutiny and metering that could lead to tighter regulation enforcement. Informal, unlicensed, or illegal water uses can complicate the implementation of agreements when informal water users intercept water intended for a recipient region, or capture the return flows from the city meant for downstream agriculture. This was the case in Monterrey, in which treated wastewater was intercepted by informal water users before reaching the downstream irrigation district, requiring compensation.

Water use efficiency has emerged as a common source of disputes in reallocation projects, as both sides—rural and urban—claim the other can increase water use efficiency. This can cause "finger pointing" regarding how efficiently the donor and the recipient regions manage their water. In São Paulo, Monterrey, and Mokopane, rural stakeholders have complained about low water use efficiency in the recipient region and have argued that water conservation could delay or even preempt the need for reallocation. In São Paulo Metropolitan Region, water losses from distribution networks are high. As the donor region developed and stakeholders asserted claims on the water that been transferred to São Paulo, new commitments were negotiated to improve water use efficiency in São Paulo. The 2004 water permit required Sabesp to maintain permanent programs for leakage control, rational water use, water waste reduction, and incentives for water reuse. Conversely, cities increasingly see irrigation water use efficiency as a source of new water, illustrated by experiences across Australia, the Western United States, Japan, and China. The Melbourne case study illustrates how the perception of water savings can be a powerful stimulus for urban investment in irrigation modernization, particularly in the context of droughts.

Disputes related to water use efficiency are linked to *challenges with monitoring*, which can breed mistrust regarding water use, deliveries, and impacts of reallocation. The lack of measurements and monitoring of changing water availability and use across the donor and recipient region can lead to claims from both sides that the reallocation project is either unfair or poorly implemented. In Monterrey and Melbourne, disputes regarding monitoring have led to doubts about the validity of the compensation mechanisms (Monterrey) and the water savings (Melbourne). Monterrey lacked an effective mechanism for detecting the quantities of treated wastewater arriving at the downstream irrigation district and separating these flows from other water sources conveyed by the tributary. In Melbourne, irrigation modernization has raised technical accounting challenges associated with verifying water savings and addressing the negative impacts on those farmers who lost their connections to irrigation systems.

The perceptions of fairness hinge not only on the issues of ownership, water use efficiency, and measurement but also on the *source of the compensation*. In Monterrey, it was not sufficient for the farmers to receive compensation: they also believed that the city, rather than the national government, should pay for it. Melbourne experienced a different challenge: the city paid for irrigation modernization but the irrigation community split its support when some irrigation regions benefited more than others. Some irrigators also rejected outright the idea of an exchange, arguing that the state government should fund irrigation modernization without requiring any water transfer to Melbourne in return.

The diverging perceptions and lingering political tensions have underscored the need for creative approaches to benefit sharing, supported by transparent and inclusive processes. They also support the need to reconcile perceptions of reallocation with the actual outcomes. Doing so requires measuring and understanding the impacts on the donor and recipient regions over the short and long term.

Can Water Reallocation Deliver Efficient and Equitable Outcomes?

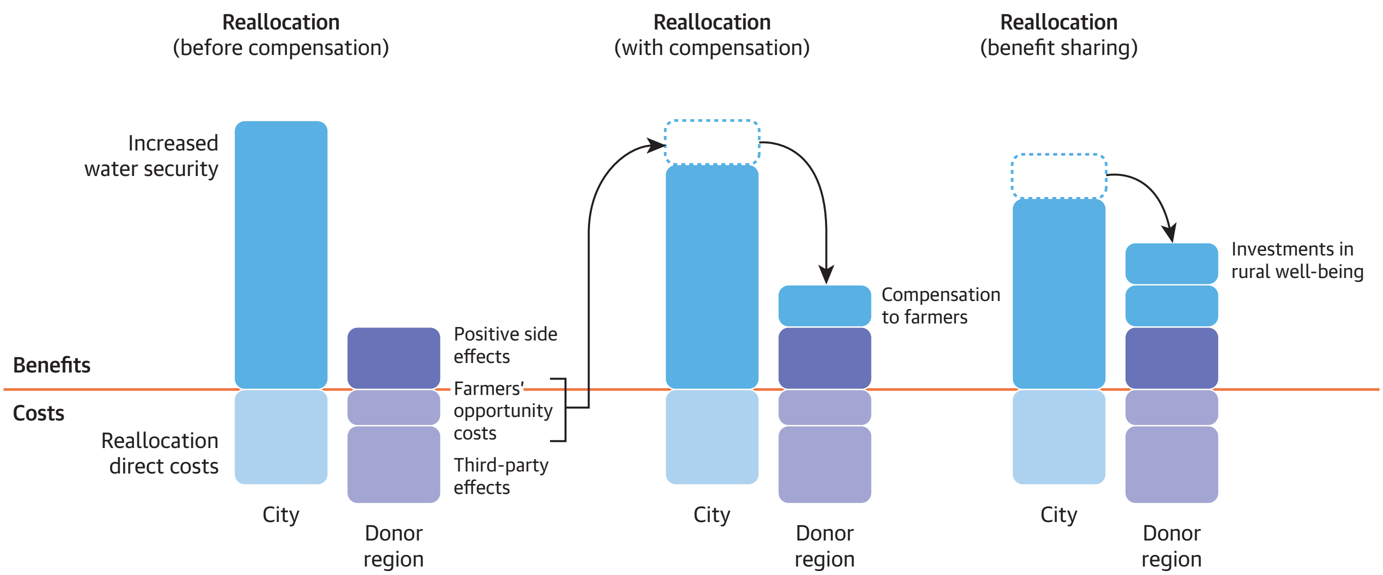
The concept of *benefit sharing* offers a useful way to think about and evaluate reallocation projects. Although the term has typically been used in the context of transboundary rivers, it also applies to water sharing between rural and urban regions. Benefit sharing requires accounting for the full range of benefits and costs associated with reallocation of water, not only the changing patterns of water use. This creates opportunities to improve outcomes for both the donor and recipient region, or at least minimize the costs borne by the donor region.

Reallocation generates a stream of multiple types of benefits and costs, which are distributed between and within the city and the donor region. The outcomes of reallocation processes can be assessed according to the benefits, costs, and their distribution. First, an efficient reallocation project requires that benefits exceed the costs. The project's benefits will enhance the economic productivity of the water for the city, which can generate positive spillovers because urban water security fosters economic development, trade, and additional investment by industry. However, benefits may also accrue to the donor region despite the loss of water. For example, when reallocation requires increased river flow regulation, the reallocation project may provide flood control and regulation benefits, as occurred in both Monterrey and São Paulo. The city or financiers will have financial construction costs and opportunity costs of the capital investment, which could have been dedicated to alternative water supply and demand management options or investments outside the water sector altogether. The alternative water supplies for the city may involve lower costs (e.g., water use efficiency) but carry other risks or political or technical concerns.

For rural regions, the project costs often exceed the benefits. They include the opportunity costs of the water and lost economic opportunities, such as the reduction in irrigated agriculture, which may be partially offset by the productivity improvements associated with upstream regulation and more reliable water deliveries. The global review and the in-depth cases illustrate opportunity costs associated with lost agriculture, as well as the countervailing productivity improvements as farmers attempt to adjust to limited water supplies. These productivity gains were achieved in Monterrey and north of Melbourne, but the improvements were uneven, illustrating the distributional impacts and implications, over time and space. The social and economic costs also extend beyond the direct negative impacts on water users through "third-party effects," which are indirect negative impacts, or ripple effects, of lost agricultural and rural economic activity felt by associated industries and labour. Third-party effects are often ignored or underestimated in the design and delivery of projects. They led to concerns about the viability and stability of agricultural production in the donor regions in Mokopane and Monterrey.

Benefit sharing can make reallocation fairer by accounting for the direct and indirect costs borne by rural regions (figure 2). The equity impacts of reallocation depend on the type, amount, and form of compensation to offset the costs concentrated in the rural regions. Conventional approaches to compensation consider the opportunity costs faced by the farmers and design monetary payments based on the lost acreage, productivity, and commodity values. These approaches address the direct costs borne by individuals but ignore the wider, indirect costs associated with the third-party effects noted previously, such as lost employment and industries or other longer term consequences on society and the environment. Conventional approaches encounter several practical and political difficulties associated with monitoring changes in acreage and water application, estimation of productivity rates, and assumptions about crop choices and commodity values. A shift from narrow compensation to benefit sharing establishes a premium over the opportunity costs and considers the system-level costs—not only the impacts felt by the individuals—to ensure a broader portfolio of benefits that may include regional infrastructure development, alternative water supplies, and investment in community development. Benefit sharing may allow

FIGURE 2. **Moving from Compensation to Benefit Sharing**



both urban and rural regions to gain from the project, or at least sustain rural well-being by offsetting the wider costs of the project. The outlook of a reallocation project changes with time, because the costs are localized and immediate, while benefits are delayed and more diffuse. Thus, benefit sharing also takes into account mid- and long-term effects of reallocation.

This shift from compensation to benefit sharing involves three main implications: the need to (i) **account for the full range of costs and benefits over space and time**; (ii) understand the **distributional issues**, particularly the consequences for poor populations (see example in box 4), and (iii) **compensate the region, not the individual**. The full range of costs and benefits includes the direct and short-term costs and benefits, including the opportunity costs for the donor region—the forgone agricultural production and future economic development—and the benefits accruing to the city. The indirect and longer term costs and benefits should also be considered, accounting for the regional impact of the reallocation for the donor region and the ancillary benefits generated by the project for the regional economy that can ripple out and reach the rural region over the longer term. Designing and implementing benefit sharing strategies requires the following four main considerations.

Forms or types of benefit sharing. The global experience suggests three primary forms of compensation for the donor region: (i) monetary payments based on opportunity costs (compensation in its narrow sense); (ii) infrastructure modernization and other material investments; and (iii) the provision of alternative water supplies. Table 4 summarizes benefit sharing in the case studies, illustrating the wide range of options and the movement from narrow compensation based on opportunity costs of agriculture in Mokopane to the broader portfolio of measures adopted in Monterrey.

BOX 4. Narrow Compensation Approach in Mokopane

In the latter part of the 20th century, the town of Potgietersrus and its black township Mahwelereng, in the Limpopo province of South Africa, grew rapidly. The 1991 Census indicated a growth rate of 4.5 percent, and the 1996 Census indicated a population of 281,285. Increasing water demands from the urban area resulted in various options being considered for meeting the new demand, including the transfer of water from the Vaal River. In 1993, however, in the face of a severe drought, the state bought water rights from the adjacent irrigation scheme to provide water for the town. The reallocation of water occurred from the Sterk River Irrigation Scheme (SRIS), served by the Doorndraai Dam to Potgietersrus (now Mokopane). This was not, however, a market-based purchase of water rights, but an administrative process, driven by the state, in which struggling farmers were offered a set price (US$3,752 per hectare, 2019) for their water rights, in a context in which they had few other options to get out of deep debt. It was a process with a dual aim: farmer relief and water transfer from agriculture to urban use. Many farmers on the irrigation scheme, established in the 1950s, were struggling due to lack of water and poor soils, and saw the buyout as a possible solution, although in many cases the payout was not sufficient to rescue them financially.

This occurred in the final days of apartheid, just prior to the first democratic elections of April 1994. It also took place in the context of a severe drought in 1992–93. The project provided water to the municipality to meet growing water needs, and served as a relatively quick solution in the face of a major drought. However, the project was part of a context in which poor water use regulation had already impacted the downstream irrigation farmers, with significant negative financial and economic impacts in the area. The approach did not resolve the issues in the catchment arising from poor water regulation, and interviews with affected farmers revealed an ongoing bitterness about the handling of the project.

The experience in Mokopane suggests lessons relevant for rapidly growing towns in which a narrow, unilateral approach to compensation can engender lingering resentment by overlooking the broader needs of the community. First, in areas of high climatic variability, longer term scenarios of water availability for the sectors must be considered. This approach is particularly important to prevent expedient decision making that may have unintended long-term implications and leave limited time for engagement and negotiation. Second, the broader impacts on the remaining farmers need to be considered if only a portion of the water is taken from an irrigation scheme to avoid placing the full burden of operations and maintenance on a smaller group, leading to the steady degradation of irrigation infrastructure. Finally, the narrow and rushed approach to compensation meant that farm owners did not have

box continues next page

BOX 4. continued

an opportunity to negotiate or even to examine or question the methodology used by the government to calculate the price. Although farmers were compensated for the loss of their water rights, many were not satisfied with the amount offered. The wider community was also largely ignored. Farm workers do not appear to have been factored into the compensation. As a result of these steps, reallocation is seen as a politically infeasible in the South African context, with a chilling influence across Sub-Saharan Africa.

TABLE 4. Benefit Sharing: Form, Amount, Recipients, and Financing

Case	Types	Benefits for donor region	Recipient	Financing
Mokopane, South Africa	Financial	*Transfer payments to farmers US$3,752 per ha, 2019*	*29 irrigation farmers on 30 portions of land*	*Department of Water Affairs*
São Paulo, Brazil	River flow regulation	*Flood control downstream* *Share of regulated flow*	*PCJ Basins*	*Sabesp*
Monterrey, Mexico	Financial Alternative water supplies Infrastructure (irrigation modernisation and compensation dam)	*Transfer payments to farmers* *6 m^3/s of treated wastewater* *Share of regulated flow and flood protection*	*Farmers in Irrigation Districts 026 and 031*	*Monterrey Water Authority, Nuevo Leon state government, and federal government*
Melbourne, Australia	Infrastructure (irrigation modernization)	*US$972.5 million irrigation infrastructure upgrade for Stage 1*	*Irrigators in Goulburn River Valley*	*Victoria government and Melbourne Water (state-owned water utility)*

Note: PCJ = Piracicaba, Capivari, and Jundiaí.

Recipients. Recipients range from water users in the donor region to the associated districts and wider region through infrastructure systems. The São Paulo experience suggests that benefit sharing must account for future urban growth and the associated water users. The Monterrey case shows that compensations only to farmers ignore the damages to the economy associated with the production (e.g., irrigation material suppliers, seed providers, fuel suppliers, and seasonal harvest labor) and the postproduction (e.g., produce distribution, canning industry) processes. As a result, there is increasing focus on regional development and rural livelihoods in benefit sharing arrangements in which water districts and rural communities receive infrastructure, training, and other means of transitioning agricultural and rural economies.

Financing. This is inextricably linked with the amount of compensation: the question of how much to pay in the absence of a market is bound up with the question of who pays. The options range from the direct beneficiary—the city and its ratepayers—or the wider national governments, international donors, or private financing. The case studies bring evidence of blended sources, as illustrated by the experience of Monterrey (box 5).

Amount. This represents one of the most contentious issues, because it requires sharing the benefits in a manner deemed fair by the donor region and acceptable by the recipient region and the associated financial and government entities. The starting point for determining the amount of compensation has been the opportunity costs of current water use: that is, the forgone agricultural and economic productivity associated with the loss or reduction of water availability in the donor region. This is not always a straightforward matter in its own right. It involves contestable assumptions about the levels of historic water use, the cropping patterns and productivity of farmlands, and the commodity prices. This can also miss the labor-intensive agricultural economy in many low-income contexts and the economic activity associated with the distribution and processing of agricultural products.

BOX 5. Portfolio Approach to Compensate Region, not Individual, in Monterrey

Monterrey is a rapidly growing semi-arid city in Northern Mexico with a territory over 6,000 square kilometers and the third largest metropolitan area in Mexico after the Mexico Valley and Guadalajara. Population has increased from 300,000 in 1950 to over 4 million today. The city is strategically important due to its economic significance and role as a hub of international trade, with per capita gross domestic product 176 percent of the national average (2012). In 1994, former president of Mexico, Carlos Salinas de Gortari, inaugurated El Cuchillo reservoir to transfer water from the Lower San Juan River to Monterrey. A 108-kilometer aqueduct delivers up to 5 cubic meters per second from El Cuchillo to the Monterrey (MMA), contributing approximately 20 percent of the water supply for the metropolis. The US$969 million project (2019) was financed by the Inter-American Development Bank (IDB) and Mexican government, including both state and federal sources. Since 1989, three agreements have been developed to finance, construct, and operate the El Cuchillo project to benefit Monterrey and compensate the farmers in the downstream irrigation district.

El Cuchillo Dam has enhanced urban water security, contributing to an increase of daily water supply from 15 hours per day in 1993 to continuous coverage by 1997, despite a period of intense drought that coincided with its filling. Irrigation development predated the dam, however, requiring a set of agreements to reallocate water from downstream agriculture to the city and to devise compensation mechanisms to offset the initial decrease in water supply reliability experienced by agricultural communities. Irrigation in District 026 (ID026) has supported as many

BOX 5. continued

as 100,000 hectares of maize and sorghum with 4,800 farms and just under 70,000 hectares in the 2013–14 Census.

Benefits from treated wastewater, monetary payments, and a new dam have addressed some of the regional needs, although there are technical and political challenges associated with monitoring and enforcement. Contrary to expectations that the reallocation of water from the San Juan River to Monterrey would threaten the viability of the downstream farmers, the project is now seen as integral to the regional water supply for both the MMA and the farmers. The project involved, for the first time in Mexico, an agreement between two states and included commitments of treated wastewater for delivery to downstream storage. The project illustrates the multiple flows of water and benefits associated with water reallocation from agriculture to urban uses, and the need for a regional and systems perspective.

In 1996, an operational and benefit sharing agreement formalized requirements for Monterrey to deliver treated wastewater to the ID026 at the Marte R. Gómez (MRG) dam as a primary form of compensation. These commitments included provisions for the following:

- Construction of an aqueduct to convey treated water from Monterrey to the irrigation region through the Pesquería River funded by Nuevo León and the federal government (not constructed to date).
- Downstream delivery capacity of 8 cubic meters per second to the MRG so a minimum of 6 cubic meters per second (or 189 million cubic meters per year) would reach the reservoir, which was considered essential for the Tamaulipas government and ID026 to sign the accord.
- Inclusion of legal water rights in the Pesquería River (used to convey the wastewater from Monterrey to the agricultural region) in a registrar for the users of the San Juan Basin to prevent interception by informal users.

The agreement specified compensation if the preceding commitments were not fulfilled. Every November, a determination of deficits in treated wastewater deliveries is calculated based on data as of October 31. Compensation is based on the opportunity costs for farmers by estimating the acreage fallowed due to the deficit in treated wastewater. The compensation is based on the price of 1 ton of white maize per hectare lost. The amount is paid in two equal instalments, one in February and the other in May. Comisión Nacional del Agua (CONAGUA), the national water agency, determines, based upon the specific conditions of each case, the source of compensation with the farmers preferring that the city, the beneficiary, pay.

box continues next page

BOX 5. continued

The main lesson from El Cuchillo is that water reallocation needs to be designed and assessed in a regional context using a systems perspective on the costs, benefits, and mechanisms for sharing them. Doing so requires well-designed agreements, including processes for including affected stakeholders; compensation schemes that focus on the region, not only the individual losses; robust and transparent water accounting to inform implementation; and appropriate coordination bodies to resolve conflicts.

Key Lessons Learned

The cases of reallocation considered in these studies are just a small fraction of a larger international phenomenon that suggests a set of lessons and practical implications for decision makers considering reallocation as part of the water resource management tool kit. We argue that cities should be reconceptualized as part of urban-rural systems when we talk about water allocation (lesson 1). This has implications for reallocating water in terms of water accounting (what needs to be measured and where) (lesson 2); governance, including who needs to be included and how (lesson 3); institutional mechanisms to facilitate coordination and conflict resolution (lesson 4); and, finally, to shift from thinking about compensation to thinking about benefit sharing (lesson 5) in a dynamic context (lessons 6 and 7).

1. **Benefit sharing requires a systems perspective**. Cities are part of urban-rural systems. Reallocation, therefore, involves multiple economic, social, and physical linkages between rural and urban regions, requiring a systems perspective to understand the changing patterns of water use and the associated redistribution of benefits and costs over multiple time scales. A systems perspective can improve reallocation processes in all phases, including the design of compensation mechanisms to share benefits with the donor region.
2. **Get the numbers—and the water balance—right**. Reallocation is an inherently political decision, but should be informed by reliable data, robust accounting, and sound modeling. This includes tracking changes in water supply, water use, and water use efficiency; designing alternatives for allocation rules; and understanding and measuring costs and benefits of reallocation and their distribution. A sound understanding of the water balance underpins effective and equitable reallocation, which in turn depends on robust accounting that prioritizes the data, monitoring systems and evaluation processes needed for designing and delivering reallocation projects.
3. **Water sharing agreements should be backed by sound governance.** Reallocation from rural to urban regions involves a form of water sharing agreement across sectors and sometimes political borders. Like other transboundary agreements, rules should guide the content, and also the governance processes. Clear rules should define the volume of water transferred, the timing and location of deliveries, monitoring and compliance, compensations, and the processes and parties involved in both planning and decision making. Moreover, effective agreements require conflict resolution mechanisms and well-functioning water governance. Coordination will ensure that agreements are compatible and complementary with national laws, regulatory frameworks, and other local and regional institutional arrangements. Regional authorities and river basin organizations can offer the platform for effective negotiation, conflict resolution, and agreements.
4. **Inclusion and transparency preempt future troubles**. Any durable reallocation requires effective engagement with the donor region and ensuring inclusion of key actors. This may require

taking into account informal or illegal water users. Failing to do so during the initial planning stage can breed resentment, distrust, and even technical problems that will likely affect later stages of negotiation and implementation. For this, communication and transparency are essential at the outset and throughout the process. This can require having a good communication strategy in place and well-defined venues to ensure engagement. The process and manner for sharing the benefits and spreading the costs of reallocation should be deemed fair by the key actors to get buy in and broad support. Misinformation, distrust, rumors, and false myths can cost time and resources in the long run.

5. **Droughts and crises can tip the balance, but rushing carries risks**. Urbanization and economic development are the ultimate drivers for reallocation from rural to urban areas, but reallocation rarely happens until there is alignment of enabling conditions (physical, financial, institutional, social) and key triggers. For example, droughts often present windows of opportunity but raise the risk of rushed decisions. In other circumstances, the catalyst comes from political changes or financing. Seizing the opportunities, and limiting the risks, requires preparation of the technical analysis and engagement before these windows open.
6. **Benefit sharing can transform conflict into cooperation**. Broader approaches to compensation can help reduce conflicts and support regional development opportunities for cities and rural livelihoods. The scope and scale of compensation—who receives it, who pays, and how much—should account for the needs of the donor region as a whole, not only the individuals, to capture regional economic impacts of reallocation. Forms of compensation include financial payments, investment in infrastructure, and alternative water supplies. These should be guided by efficiency, fairness, and inclusiveness. It is also critical to measure and understand the socioeconomic impacts and implications of water reallocation (avoiding or minimizing preventable negative impacts on poor households, which often suffer most).
7. **Be ready to learn and adapt**. Even permanent reallocation requires adaptation to changing circumstances and unintended consequences, both in the donor and the recipient regions. Adjustments to reallocation agreements may be necessary due to population and economic growth in the donor region, changing legal and institutional conditions, and the emergence of new needs. To the extent possible, periodic reviews should be built into the process to avoid crisis-driven responses. Sound accounting, monitoring, and evaluation are needed to make adjustments to the original agreement.

Notes

1. A dissertation project (Hooper 2015) includes a literature review of agricultural to urban reallocation.
2. All case studies in this report were covered by the systematic review focusing on urban agglomerations with populations exceeding 300,000 (Garrick et al. 2019), with the exception of Mokopane.

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SKU W18011