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WATER SECURITY DIAGNOSTIC

# Argentina

## Valuing Water

Brief for Policy Makers

WORLD BANK GROUP

GWSP
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# Argentina

## Valuing Water

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WORLD BANK GROUP

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# Argentina Water Security: Valuing Water

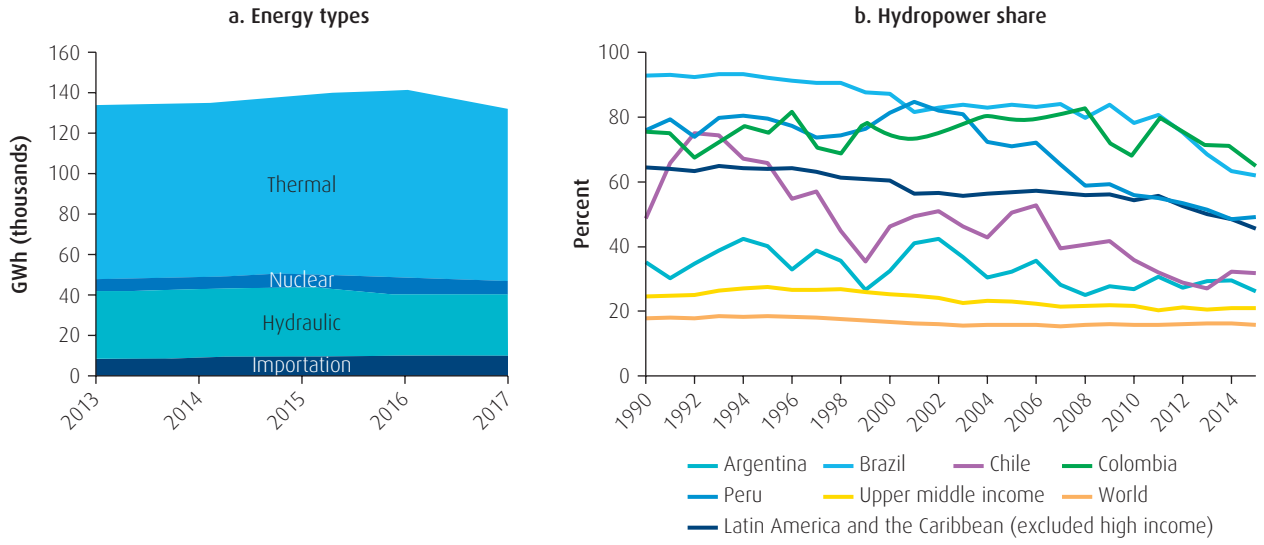
## 1. Benefits of Water Security for Argentina

**Water security is essential to Argentina's future, with implications for every economic sector and all aspects of life.** From domestic water use and sanitation, to industrial and agricultural use, to fluvial navigation, hydropower, and tourism, water security contributes both directly and indirectly to a strong economy and to high productivity. Consider just the largest direct benefit: piped water is essential for good health and saves people the high financial and labor costs of buying and transporting bottled water. Access to safely managed sanitation prevents the transmission of water-borne diseases and contributes to environmental quality. Indirect benefits include increased employment income through higher productivity. Argentina's predominant urbanization amplifies such benefits by concentrating populations.

**Because water will have several key roles to play in Argentina's future economic development, water security planning today is an urgent imperative:**

- **Industry has made the highest contribution to the country's gross domestic product (GDP): 31 percent of the total.** Although industry accounts only for 2 percent of the total demand for water in the country, more than 50 percent of industrial demand comes from the food, beverage, and chemical products sectors,[1] which depend heavily on a reliable supply of water. The country's dominant industrial sector will continue to depend on continuity of service in its water supply network, even as climate change potentially affects water availability in areas far from the main rivers.
- **While urban areas drive much of Argentina's economy, agriculture, is also key.** The country's strong agriculture sector is a main macroeconomic driver for Argentina (World Bank 2018), not so much for the share of GDP it represents, but mainly because Argentina is a net contributor to global food security. Agriculture is a major source of foreign reserves, because food exports represented 56 percent of merchandise exports[2]. And water again plays a key role here: while irrigated land constitutes only 5 percent of the total cropped land, irrigated crops' added value is about 13 percent of total agricultural output. Irrigation also contributes to local food security: nearly one-fourth of Argentina's irrigated crops are fruits, rice, and fodder grown mostly for local consumption (FAO and PROSAP 2015).
- **The Hidrovía (the Paraguay-Paraná waterway) will need upgrading as the economy grows.** It already supports 84 percent of Argentina's agricultural exports and by-products,[3] having linked important production areas to the market while reducing congestion and pollution from ground transport.

**Figure 1 Energy by Generation Type in Argentina, and Share of Hydropower in Electricity Generation in Selected Latin American Countries and the World**




*Sources:* Based on National Statistics and Censuses Institute data; World Development Indicators Database, World Bank.
*Note:* Panel a: energy by type of generation in Argentina. Panel b: hydropower as a share of total electricity generated in four countries, medium-high-income countries, and the world.

- **Hydropower is now Argentina's second largest electricity source and a contributor to at least 0.2 percent to the GDP.**[4] Although the share of hydropower is not so high as the LAC average, it will become an even more important energy source as the economy grows further (figure 1, panel a and b). In addition, multipurpose dams promise benefits to other sectors by guaranteeing supplies and increasing resilience to droughts, factoring in the environmental risks and costs associated.

## 2. Argentina´s Water Security Assessment

**Argentina now faces critical water security gaps—from its unmet need for water supply and sanitation water supply and sanitation services, a vulnerability now highlighted by the COVID-19 crisis, to risks from increased demand and exposure to climate variability.** Millions of Argentines lack safe water supply and sanitation, putting at risk not only their health but also their children's cognitive development and future labor productivity. The COVID-19 pandemic underlines the necessity of safe access to water supply, sanitation, and hygiene (WASH). Both as a first barrier against disease transmission and as a cornerstone of resilience, water security is vital for mitigating the secondary impacts of the crisis, especially on the most vulnerable communities. Other risks reflect the many effects of pollution, including climate impacts: from farmland erosion, pesticide, and herbicide contamination; to untreated wastewater; to modified glacial runoff, drought, and flood events; to rising seas. All of these risks are socioeconomic as well as ecological, jeopardizing both safe water provision and the reliable flows needed for agriculture, industry, and hydropower.

**In a complex macroeconomic context, now worsened by the pandemic, how should Argentina's decision-makers identify and prioritize water security initiatives?** The economic impacts of the COVID-19 crisis have come as a sharp shock to utilities, with income losses further eroding a financial position that was already precarious in many cases. Given the importance of a sustainable water sector—both financially and ecologically—which policies and investments make the best economic sense? Few previous studies of water security have tried to quantify its economic impacts in a holistic and systematic way. This report takes a novel approach: using a macroeconomic model, it estimates the total impact on national GDP of current water security gaps. It then uses the model to project the future impacts over 2020–30, both macroeconomic and socioeconomic, if Argentina simply keeps doing business as usual: that is, if it simply continues expanding water supply and sanitation coverage at its current slow pace, without stepping up efforts to address the impacts of floods and droughts or to prevent water quality from further deterioration. Finally, the report offers an alternative: looking at a broad range of additional water security interventions, it estimates their individual and aggregate impacts on GDP, along with their social development impacts, over the same period.

### Box 1 What's New in This Report?

**A holistic and comprehensive water assessment for Argentina, this report uses data compiled from institutions at all levels.** Its key analytic contributions are:

- A countrywide hydrological modeling of Argentina at the macro-basin level with climate change projections
- A holistic hydroeconomic modeling exercise, generating quantitative estimates of the overall economic impacts of Argentina's current water security gaps—and estimated cost-benefit ratios for future water security investments under two scenarios, the business as usual scenario and a water active scenario
- A Public Expenditure Review for the provision of water supply and sanitation services.
- An update of the Food and Agriculture Organization (FAO) and the Argentinian Provincial Agricultural Services Program (PROSAP) study on the viability of irrigation in Argentina, developed in 2015.
- A compilation of relevant water quality data, with proposed first steps toward an integral assessment of surface water quality across Argentina

**For decision-makers, the report's key contributions are its estimation of economic impacts from water security gaps (see the following section 3), analysis of underlying sector challenges and opportunities (see the following section 4), and recommendations for 2020–30 based on the projected impacts of future investments (see the following section 5).** The impacts and underlying issues point to the need for water sector governance reforms, together with targeted investments to develop opportunities and foster a more resilient and sustainable economy.

**By comparing the *business as usual scenario* for 2020–30 with a *water security active scenario*—a comprehensive set of new initiatives—the report finds that the action scenario would further boost Argentina's GDP by an annual average of 2.7 percent in 2030, while also attaining Sustainable Development Goal (SDG) targets.** In absolute terms, that would mean an added US$15 billion[5] per year in terms of aggregated value. The recommended initiatives in the water security action scenario are detailed in section 3 here (and more fully in chapter 7 of the report). Broadly, the main differences are:

- The *business as usual scenario* assumes that Argentina continues its present rate of investment in all water-related fronts (water resources management, water services, risk mitigation), without other substantial policy interventions or institutional reforms. In this scenario Argentina falls far short of its potential. In 2030, it will not have attained SDG 6 to achieve safely managed water and sanitation for all.
- The *water security action scenario* includes concerted initiatives in water resources management, water services, and water-related risk management. These initiatives not only propose to enhance infrastructure (expand water supply and sanitation services more rapidly, reduce flood and drought risks, and improve water quality) but also, even more vitally, to reform governance so that this enhancement will be efficient and sustainable. In this scenario, Argentina attains SDG 6 by 2030, enabling the realization of larger socioeconomic and environmental gains.

**The following three sections describe the stakes, outline challenges and opportunities, and trace a path toward greater water security.** Section 3 puts a price on today's water security gaps. It estimates the costs—economic, social, and environmental—of water-related infrastructure deficits, efficiency challenges, and regulatory and institutional weaknesses. Section 4 points to the main underlying issues in water resources management, water services, and water-related risk mitigation. Section 5 lists priority actions for water security. See box 1 for more details.

## 3. Present Costs of Water Security Gaps to Argentina and Its People

**What do water security gaps cost Argentina today—and how do they amplify the risks the country will face tomorrow?** First are the large *economic costs,* arising chiefly from gaps in Argentina's water supply and sanitation coverage from continued reliance on drought-sensitive rainfed crops, from recurrent floods or water quality issues. Second are the *social and distributional costs* derived from these gaps. Third, and connected to the rest, are consequent *environmental costs* on Argentina and its people.

### Economic Costs

**Argentina's water security deficits today inflict an annual economic cost of about 2.2 percent of GDP, or US$11.8 billion.**[6] More than half of this yearly

total reflects quality-of-life losses, including health and education effects, for people who lack access to safe drinking water and sanitation. Other substantial cost drivers include the water-related impacts of increasing exposure to climate change—mostly to droughts, but also floods. These reduce consumption power, destroy assets, and, in the case of droughts and agriculture, add to annual price inflation.

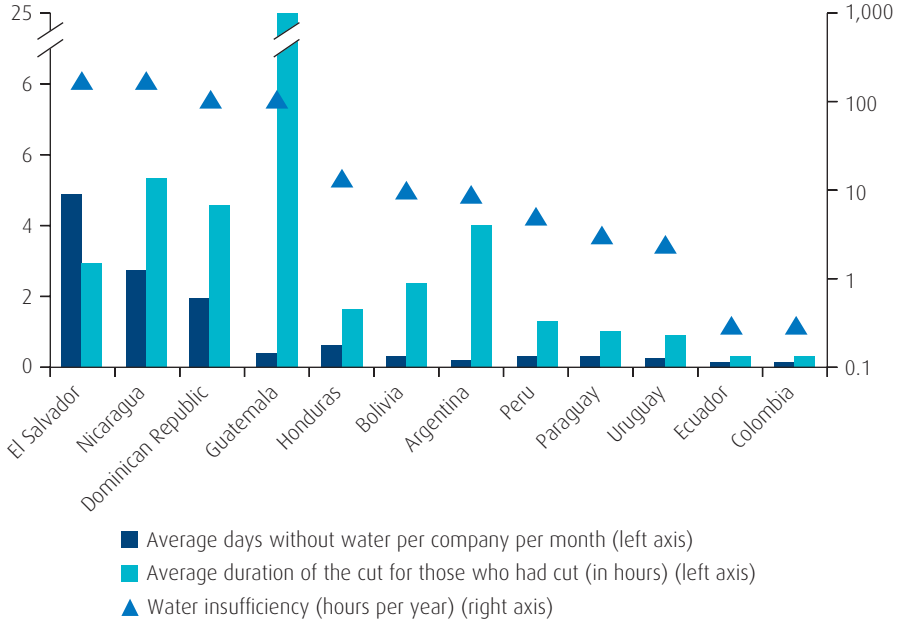
**The largest cost driver—accounting for more than half the yearly total—is the lack of secure, piped water supply services for 7.5 million people (about 17 percent of the population) together with the lack of sewerage for 21 million (about 48 percent).**[7] Argentines without sewerage perceive a loss in quality of life equivalent to US$4.4 billion annually, including health and education impacts. Those without piped water perceive a loss estimated at US$1.8 billion. The average combined annual economic impact of these water supply and sanitation access gaps is estimated at 1.3 percent of GDP.

**Smaller losses reflect industrial water supply disruptions.** The average Argentine company receives insufficient water for 8.8 hours per year (figure 2). Such discontinuities reduce annual industrial production by an average of 0.2 percent of GDP.[8]

**Another substantial cost driver is the impact of climate-related events.** Floods and droughts cost Argentina an estimated 0.8 percent of its annual average GDP. In the agriculture sector, about US$3.2 billion a year is lost on average (0.6 percent of GDP) due to climate variability—90 percent to droughts and 10 percent to floods. One reason for Argentina's special vulnerability to drought is the increasing reliance on rainfed agriculture (figure 3, panels a and b), which is highly exposed to climate variability. On top of these losses, climate impacts in rainfed agriculture increase inflation in Argentina by as much as 2.4 percentage points each year by reducing the supply of agricultural products and the availability of foreign exchange.[9] Floods in urban areas are estimated to cost Argentina 0.2 percent of GDP in asset losses and an associated loss in consumption of 0.3 percent each year, chiefly in urban areas along the Río de la Plata and its tributaries.

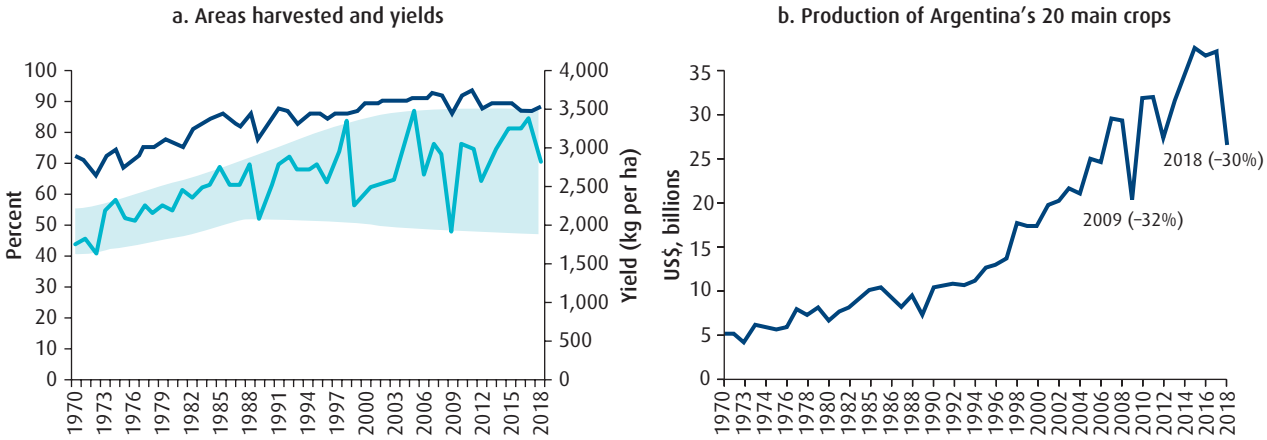
**Quantifiable economic costs arise from water pollution.** Polluted water in Argentina has an economic impact very conservatively estimated to exceed 0.1 percent of GDP. This figure includes reduced property values near polluted water bodies and increased recreational costs for travel to less polluted areas. Because many pollution impacts have not been assessed, the full cost of water pollution is likely to be considerably higher than the reported figure.

**Figure 2 Continuity of Water Network Service for Businesses, Selected Latin American Countries, 2016–17**




*Source:* Based on Enterprise Surveys database, World Bank, https://www.enterprisesurveys.org/en/enterprisesurveys.

**Figure 3 Planted and Harvested Area and Yield for Rainfed Farming, and Production of Argentina's 20 Main Crops, 1970–2018**




*Source:* Data from Ministry of Agriculture, Livestock, and Fishing. https://datos.magyp.gob.ar/dataset/estimaciones-agricolas.
*Note:* Panel a: the dark blue line is the percentage of area sown and harvested, and goes with left axis/light blue line goes with right axis and is the yield in kg per hectare. Panel b: Production of Argentina's 20 main crops in billions, 2017 prices.

**The economic risks from droughts and floods will continue to rise steeply with increased exposure to climate change.** Future climate-related impacts threaten to compromise 25 percent of areas now irrigated in Argentina (especially in the Cuyo region),[10] while making yields from rainfed crops and production even more unstable than they are today. According to this report's business as usual scenario, annual losses from droughts and floods by 2030 could increase by 40 percent from those at present, with a negative impact of 0.86 percent of today's GDP.

**Further coastal erosion—driven both by urban development and by sea level rise—poses large risks to the tourist economy south of Buenos Aires province and along the ocean cliffs of Patagonia** (SAyDS 2015). Rising seas are expected to affect up to 3,700 kilometers of the country's sandy coastline by the year 2100 (Vousdoukas et al. 2020), increasing flood risks and likely causing long-term economic impacts. Among the most affected areas are the southern region of Samborombón Bay to Mar Chiquita, Bahia Blanca, Viedma, and Rawson.[11]

## Social and Distributional Costs

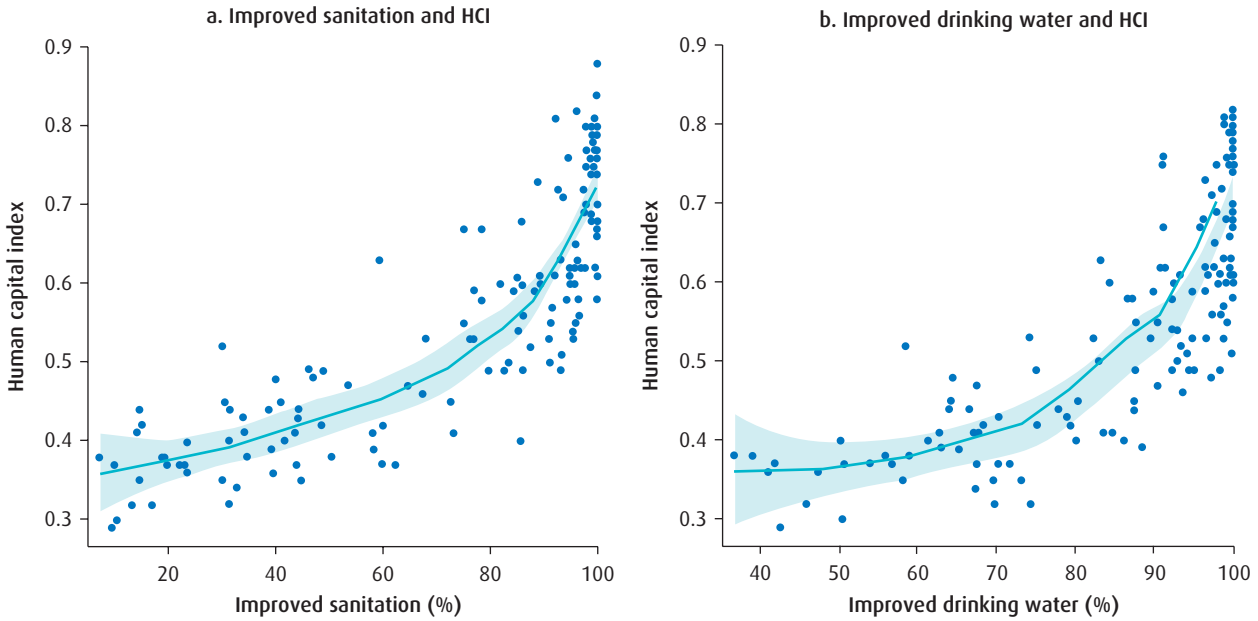
**Access to safe water and sanitation is inequitable, and this varies geographically across Argentina.** Of the roughly 7.5 million Argentines who lack secure access to piped water, most live in peri-urban Buenos Aires and other large cities, together with the provinces of the north (2018 data).[12] About 36 percent of such people are poor, and of the 21 million or so without sewerage services, 45 percent are poor.

**Water insecurity reduces a country's human capital.** water supply and sanitation data are closely tied to each indicator of the World Bank's Human Capital Index (HCI) (figure 4, panels a and b), considered a measure for a country's development potential.[13]

**Although losses of life and health from water supply and sanitation service gaps are relatively low by regional standards, such losses remain serious—and they appear to mostly reflect insufficient access to safe water.** Across Argentina, about 85 percent of all the disability-adjusted life years (DALYs) lost to water supply and sanitation service gaps can be related to a lack of piped water, with the remaining 15 percent resulting from a lack of sanitation services. Still, both gaps combine to put vulnerable Argentines at risk. The effects of under-five infant mortality and low birthweight—both on childhood development, including cognitive development, and on lifelong health—perpetuate inequities while constraining human capital (Andres et al. 2018).

**The geographic and economic inequities in Argentines' access to water supply and sanitation services also imply cultural and gender inequities.** The country's rural and indigenous populations remain economically and socially vulnerable, in part because of their continued exposure to unsafe water sources. And in parts of some Northern provinces, the burden of carrying water falls often and mainly on women and girls—disproportionately limiting their time for education and income-generating activities. In Argentina there are also gender gaps at the management level in water sector institutions, although this situation is gradually changing.

**Figure 4 Human Capital Index (2018) and Coverage of Improved Sanitation and Improved Drinking Water (2015), World**




*Sources:* Andres et al. 2018; HCI from Damania 2018; improved sanitation and improved drinking water from Joint Monitoring Programme for Water Supply and Sanitation, 2015, https://washdata.org/data, accessed March 2021.
*Note:* Panel a: $R^2$ value for the linear regression model is 0.6898. Panel b: $R^2$ value for the linear regression model is 0.6201. HCI = Human Capital Index.

**There is a clear link between water supply and sanitation access gaps and social inequities.** The people with the lowest incomes and the lowest ability to pay are the same people who value water services most highly (in relative terms). At the same time, the lack of access to water supply and sanitation services by this sector of the population perpetuates its socioeconomic condition. Furthermore, the report finds that potential tariff hikes would only worsen these inequities unless the increases are combined with targeted subsidies for those least able to pay.

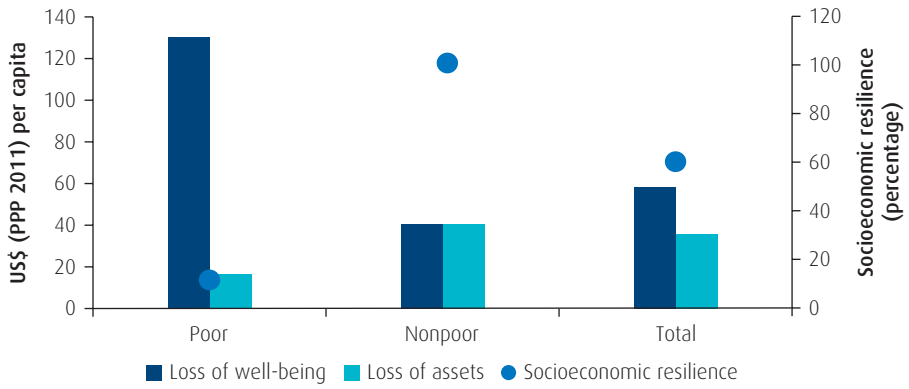
**Floods are a poverty trap for lower-income Argentines, especially in urban areas**. Even after social transfers, the poor often find it hard to fully recover before the next disaster. Although people with higher incomes (top 20 percent) experience asset losses 2.5 times higher than those with lower incomes (bottom 20 percent), the latter experience a loss in well-being (measured in terms of consumption power) that is 3.3 times higher than the former (figure 5).

**Unless water demand can be reduced through efficiency measures, productive areas can be expected to come under increasing stress from increased competition for water supplies—potentially sparking social tensions and conflicts.** These conflicts can be manifested in different ways, with the potential of leaving behind producers with lower capacity (that is, those who cannot pump water profitably from great depths), or creating tensions with downstream water users.

## Environmental Costs

**Economic growth has come at a high environmental price, creating a challenge for Argentina's efforts to attain SDGs 6.3 (improving water quality) and 6.6 (protecting water-related ecosystems).** Argentina lost 12 percent of its forests between 2001 and 2014, twice the global average,[14] accelerating soil erosion and land degradation (Bouza et al. 2016). Poor irrigation practices in low-productivity areas have increased groundwater salinity (FAO and INTA 2015). Climate change and human activities, such as nutrient and organic load enrichment, harm the composition, structure, and dynamics of marine and freshwater ecosystems. Increasing agrochemical use, conveyed by runoff and infiltration, contribute to the pollution of ground and surface water bodies. Yet, agrochemical use remains largely uncontrolled. Some rivers, particularly in the Buenos Aires Metropolitan Area, are also heavily polluted with domestic effluent, and at the national level

**Figure 5 Flood Impacts on Social Sectors by Income in Argentina, 2018**




*Source:* World Bank. Analysis derived from the Unbreakable Model. https://openknowledge.worldbank.org/handle/10986/25335.
*Note:* See appendix B of the main report (World Bank 2021) for methodology. Resilience is measured as ability to recover from a shock calculated as a fraction, in percentage, of asset losses over well-being losses.

only 20 percent of the collected sewage is treated in Argentina (DNAPyS 2017). Arsenic is the main natural contaminant in groundwater. It is estimated that one in 10 people in Argentina is exposed to arsenic (Nicolli, Meichtry, and Litter 2014).

**Climate change is affecting the glaciers and snow masses of the Central Andes, which then affect river flows and agricultural production in some areas.** Over the last half of the 20th century, 48 of the 50 main glaciers in the Southern Patagonian Ice Field experienced an accelerating loss of ice surface area (SAyDS 2015). Although studies are lacking, flow volumes in thermonival rivers (those subject to the glaciers' regulating role) appear likely to decline during seasons when water is vital. The resulting impacts would be felt from San Juan or Mendoza, which are key production areas, to Chubut.

## 4. Behind the Costs: Argentina's Underlying Water Security Challenges

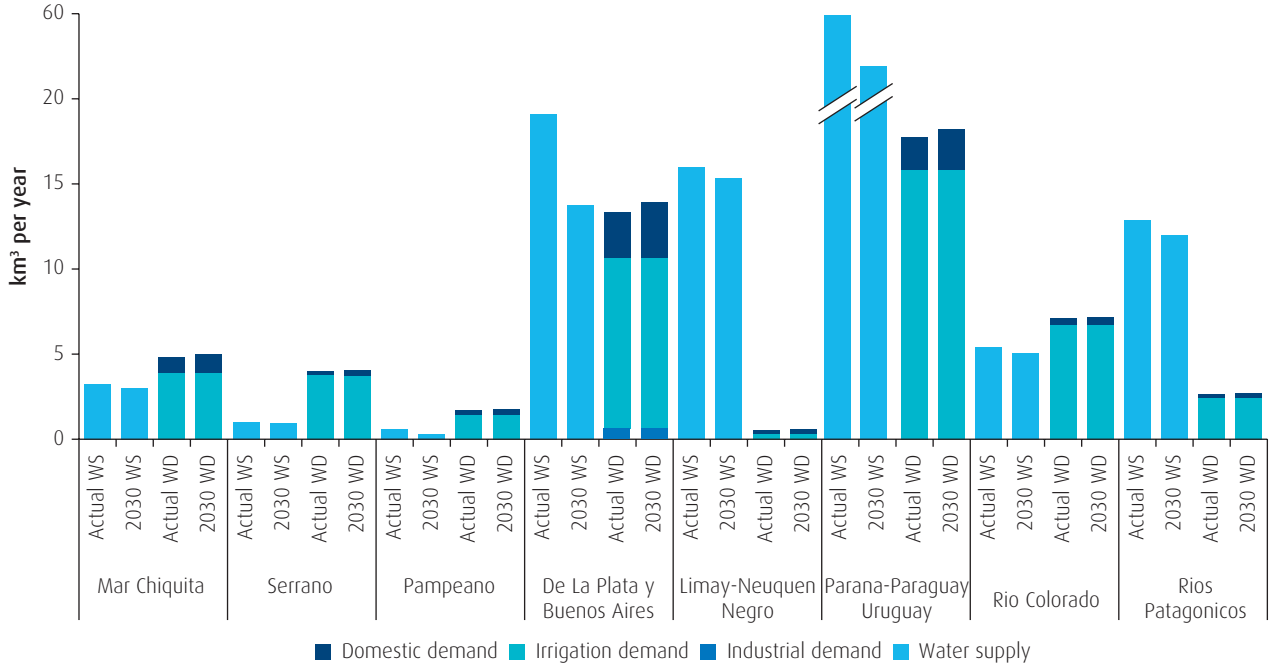
**The fundamental challenges to current and future water security in Argentina fall into three broad areas—all of which require concerted action if the country is to seize major new investment opportunities.** The main underlying challenges in water resources management, water services, and water-related risk management are summarized here. Many involve capacity and governance deficits that will have to be addressed before new infrastructure investments can be considered financially or environmentally sustainable. In brief:

- *Water resources management challenges* include data gaps and uneven (often low) institutional and regulatory capacity.
- *Water services challenges* include water services coverage and access gaps and widespread operational inefficiency.
- *Water-related risk management challenges* include knowledge gaps and related mitigation needs.

In addition, *water-related infrastructure investment needs and opportunities* exist in all three areas. These are not confined to expanding water supply and sanitation services, but also include enhanced irrigation—mostly through efficiency measures and complementary irrigation to rainfed crops—as well as promoting multipurpose storage and green infrastructure to mitigate extremes. Any such investments will require a tight link with capacity building efforts, coordination initiatives, and governance improvements throughout the sector. These efforts will help to ensure that scarce public funds are spent as efficiently as possible.

**Climate change tends to diminish long-term water availability across all macro-basins in Argentina (figure 6). This is caused by increasing temperatures and evapotranspiration, while rainfall trends are more uncertain.** While the northeast tends to be more humid, most of the rest of the country shows increasing aridity. In the central region of the humid pampas, dry anomalies are frequent. Although maximum rainfall does not appear to have increased across Argentina, increases in extreme summer precipitation have been detected in the northern and eastern regions. High temperatures and extreme precipitation will continue to increase in most parts of the country, although the precise quantification of this change presents considerable levels of uncertainty (SAyDS 2015).

**Figure 6 Water Demand and Surface Water Supply, Current and Business as Usual Scenario, Incorporating Climate Change, in Argentina**




*Source:* Analysis based on the water balance model, more details in appendix A of the main report (World Bank 2021).
*Note:* The water balance model estimates water availability and uses internationally recognized climate databases (CRU, GPCC, and TerraClimate) with more than 100 years of data and of actual evapotranspiration calculations. It analyzes the results of each of these databases separately, and this chapter summarizes the most notable results. The model has also been compared with others, such as direct balances (where potential evapotranspiration is deducted from precipitation) published by Argentina's National Institute of Agricultural Technology and the Secretariat of Infrastructure and Water Policy, and itemized models of different representative areas of the country, carried out with the HydroBID and CHAC models, usually obtaining adjustments and concordant trends. Water surplus means surface runoff only. Where demands exceed surface surplus, it means only that groundwater or snowmelt are being tapped to satisfy the demands. No information exists on what proportion of groundwater tapped is renewable. This analysis uses only climate change projections for 2030, which are similar for both RCP4.5 and RCP8.5 emissions. WD = water demand; WS = water supply.

## Water Resources Management Challenges

**A shortage of data widely shared among water institutions—and associated analytical tools—pose a first great challenge to analyze, understand, and manage Argentina's water.** Data are still scarce and uneven across the territory, impeding comprehensive knowledge about current and historical conditions. Provinces have their own monitoring networks, but often there are not yet fully developed mechanisms to share it widely among institutions or with the general public—a coordination deficit that outstrips the hydrometeorological infrastructure deficit. To enable efficient resource management in a context of increasing scarcity, more information is needed on the dynamics of groundwater resources, on snow cover and glaciers, and on the hydrology of the Pampa region.

The national government is upgrading the National Water Information System, trying to integrate information on ground, surface, and atmospheric water. This will be key to strengthen cooperation between provinces to promote regional understanding. This system could facilitate having systematic tools to plan, identify, and set priorities for water resources management infrastructure, including water risk mitigation.

**Argentina lacks a proper regulatory framework to promote integrated water resources management.** The national Guiding Principles of Water Policy, agreed in 2003 by the provinces and the federal government, establishes guidelines that allow the integration of technical, social, economic, legal, institutional, and environmental aspects of water, in the concept of water resources management. This has been an important step toward adopting more integrated water management approaches. However, these principles are not yet fully aligned with the national environmental regulatory framework and corresponding environmental management principles,

and its implementation has been uneven across the country.[15] In addition, Law No. 25.688 of 2002 on Environmental Water Management, which refers to various aspects of water management,[16] has not been regulated or operationalized, due to unconstitutionality objections related to invasion of provincial competences.

**No national guidelines exist for water quality or for allocating environmental flows, and wetlands remain underutilized.** No general guidelines have been defined yet for establishing water quality indicators, and provinces define their own methodologies and analyses. Environmental flows in Argentina are not yet defined using any nationally prescribed hydrological, hydrobiological, or holistic methodology. The potential of wetlands as green infrastructure assets is not yet being realized. However, the First National Inventory of Wetlands is underway, and some provinces have taken first steps toward conservation and integral management (the National Law on Minimum Standards for Environmental Protection of Wetlands is not approved).

**Institutional fragmentation and coordination pose challenges—despite clear efforts from institutions such as the Federal Water Council (COHIFE)—and provincial institutions are uneven in capacity.** These coordination challenges are both vertical (federal-provincial-municipal), and horizontal (within entities with different competencies over water in the same jurisdiction). COHIFE has the mandate to coordinate federal water policy and harmonize jurisdictions' water legislation, policies, and management,[17] but it is still in the process of developing its full potential. Its agreements are not binding, and its functions are not executive under the existing regulation. Some provinces have frameworks informed by decades of experience in managing scarcity, especially for irrigation. These provinces may have reliable cadasters and registers of public and private waters, groundwater and surface water rights, registered drilling companies, and discharge permits. But other provinces have limited regulatory development and institutional capacity—usually reflecting the low priority assigned to the sector by local governments—and thus cannot evaluate the resource, identify its users, monitor and oversee water uses in the field, or evaluate environmental impacts.[18]

**Integrated water resources management at the basin level—a key approach for water system resilience and water security—is still incipient in Argentina, and not yet applied consistently.** Interjurisdictional water basin committees have arisen in the past decades. Although there are a few solid examples, in most of them, basin planning functions are still under development. Because water resources management is legally a provincial responsibility, provinces delegated specific functions to these committees, which were created to respond to specific interjurisdictional issues within each basin. Thus, its internal structure also varies according to the different contexts. Yet, basin committees often face constraints in financing and in management instruments and capacity. Some good examples exist: basin committees with delegated management functions—such as the Interjurisdictional Committee of the Colorado River or the Interjurisdictional Basin Authority in the Limay, Neuquén, and Negro rivers—engage in planning and have clear roles and responsibilities, decision-making procedures, and conflict resolution mechanisms.

**Moving from planning to action in transboundary water management will require increased integration and improved coordination.** The transboundary water management agenda is especially important for Argentina as a downstream country in the Plata basin. More concerted efforts are still needed from Argentina and its neighbors to collect and systematize data for water resources management, with actions to increase resilience to extremes and to better know and tackle water pollution. The International Coordination Committee of the Countries of the La Plata Basin (Argentina, Bolivia, Brazil, Paraguay, Uruguay) has laid out its Program of Strategic Actions. The Guarani Aquifer agreement (Argentina, Brazil, Paraguay, Uruguay) needs better data to model the aquifer system, and needs to work on resolving concerns and tensions over the extent of compliance.

## Water-Related Risk Mitigation Challenges

**The increasing social and economic impacts of floods and droughts in Argentina are a consequence not so much of changes in these events' frequency or intensity but rather of increasing exposure and vulnerability levels.** A prime example is the rapid increase over recent decades in the production of high-value export grains, which are being cropped over a growing area where droughts naturally occur—on average—once every three years.[19]

**A major contributor to Argentina's exposure to droughts is the country's inefficient provision of water services.** In Argentina's fragile and drought-prone areas, utilities that produce water at extremely high rates jeopardize drought resilience. Excessive water production—in some more than 800 liters per person per day[20]—wastes a scarce and valuable resource in areas with high competition. Similarly wasteful are the many inefficient irrigation schemes,

combined with little monitoring and control of water flows, in which, on average, crops use only 34 percent of the water withdrawn (FAO and PROSAP 2015).

**Overcoming today's irrigation efficiency constraints is thus a critical challenge for Argentina, but integrated water management and transboundary water management also require attention.** Droughts are the main water-related risk for Argentina in terms of aggregated economic impacts, far exceeding those from floods, yet the latter have larger direct impacts on the poor. More effective integrated management of groundwater and surface water resources is required, together with an acceleration in the transboundary water management agenda in the La Plata Basin. The most recent droughts—which reduced the Paraná River to strikingly low levels—are a stark reminder of these priorities.

**The main drivers of Argentina's rising flood exposure are a lack of enforcing of flood risk zoning in uncontrolled urban expansions and the inadequate use of land in rural areas.** Of the more than 4 million Argentines exposed to five-year return period floods, half are poor, and many inhabit slums in greater metropolitan areas. The country has about 4,000 such slums, with one-third exposed to high flood risk.[21] With risk zoning regulations not well-implemented in some peri-urban areas, the urban population has become increasingly vulnerable to floods in the past two decades.[22] A lack of systematic data collection after flood events has hindered improved understanding of flood risks and targeting of mitigation actions. In rural areas, the absence of appropriate collective land use management (no tillage, crop rotation, or protection of slopes, and massive deforestation) increases the elevation of groundwater levels and runoff, and enhances flood risk, as illustrated in figure 7.

**Argentina has yet to exploit opportunities for nature-based flood risk mitigation.** Mitigation infrastructure is only rarely integrated into river basin planning processes, making it difficult to gather information on national flood mitigation infrastructure needs. Existing measures focus on traditional "grey" drainage infrastructure and riverbank protection, ignoring nature-based solutions to reduce flow peaks and store flood waters. Additionally, Argentina needs to integrate flood risk mitigation measures with improved hydrometeorological information.[23]

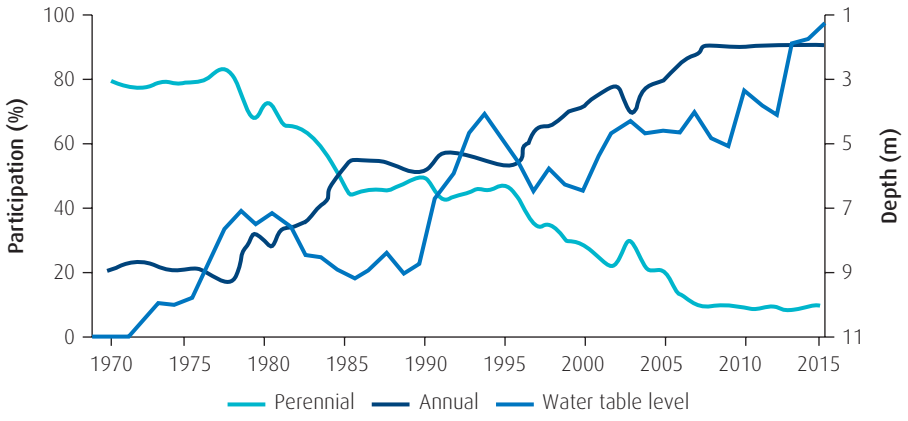
**Dam safety in Argentina needs to be strengthened, although there has been recent progress.** A recent study on dam safety in Argentina (Juncal 2019) shows shortcomings related, mainly, with its normative framework, regulatory design, imprecise delimitation of responsibilities among jurisdictions compared with the multiplicity of functions involved, and low capacities and limited resources. There is also an absence of a centralized, unified, and accessible registry of all this type of infrastructure. A new proposal for the dam safety law establishes a national policy on dam safety, inviting the provinces to adhere to it for the purposes of its application in their respective jurisdictions. It establishes the creation of the National Register of Dams and brings together various actors in relation to control actions, coordinated by the Dam Safety Regulatory Agency (ORSEP).

## Water Services Challenges

### Water Supply and Sanitation

**Argentina's water supply and sanitation sector continues to face governance challenges: meeting SDGs 6.1, 6.2 and 6.3 will require improved planning, capacity, and accountability.** Argentina has issued its first National Water Supply and Sanitation

**Figure 7 Evolution of the Participation of Annual and Perennial Crops and Water Table Level in Marcos Juárez, Córdoba, Argentina, 1970–2015**




*Sources:* Adaptation of Andreucci, Conde, and Bollatti 2015; Bollatti, Andreucci, and Escolá 2015.

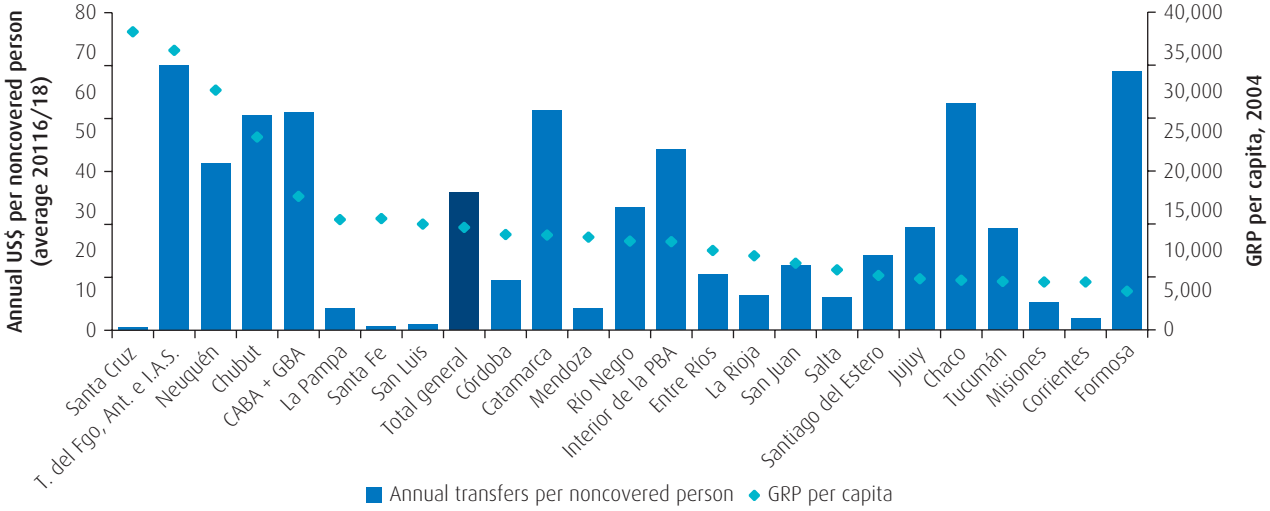
Plan (DNAPyS 2017), and established the National Directorate of Drinking Water and Sanitation (DNAPyS) for investment planning and sector coordination. New policy instruments include the Results Management Plans (PGRs), a planning and performance monitoring tool to make the main utilities efficient and sustainable, and a national information system for key performance indicators on main utilities. These are all partial steps, however, and additional work on sector governance is needed.

**Despite promising steps, the required enabling environment for a robust water supply and sanitation sector is not yet present.** No clear rules or criteria exist for how the federal government should financially support provincial expansion of water supply and sanitation services. As shown in figure 8, federal transfers to water supply and sanitation per noncovered person are very different per province, and with a current correlation to the provincial GDP (Seillant 2019). Nor do accountability mechanisms exist for the performance of provincial governments related to these nationally funded investments. For example, although some provincial operators have a series of business plans (PGRs) to define clear progress on performance, no mechanisms exist to ensure the plans' implementation (Acuña et al. 2019). The roles and functions of regulators are often diffuse, and some provincial regulatory frameworks are outdated. Capacity across the sector needs to be strengthened. The national information system still needs to be completed with data from more utilities. There is no centralized information on schools and health centers across the country with respect to access to safely managed water supply and sanitation services.

**A key challenge to water supply and sanitation sector performance is improving the efficiency of service provision at many utilities, including many that depend on operating subsidies that drain provincial and federal government resources.** The efficiency of drinking water provision in Argentina is low by Latin American and Caribbean regional standards. A lack of metered volumetric tariffs contributes to excessively high consumption rates and associated network losses. Operating costs are consequently on the high end, and on average, the 17 main provincial operators—serving 80 percent of Argentina's population—recover just 83 percent of these costs through tariff revenues. Government subsidies bridge the gap—but this is an inefficient way to use these transfers, which should be targeted to expand services instead. Subsidies can also influence tariffs more than operating costs or service requirements. Making water supply and sanitation utilities more efficient would free the money currently spent on operational subsidies for investment in water supply and sanitation infrastructure—moving Argentina closer to meeting targets under SDG 6.

**The performance of Argentina's water supply and sanitation sector is heavily influenced by insecure funding for the main operators, and is constrained by low capacity, preventing development of a planning culture.** Provinces are responsible for service provision, but the federal government is the main

**Figure 8 Average Annual Federal-Provincial Transfers for Water Supply and Sanitation Services per Noncovered Person in Argentina, 2016–18, and GRP per Capita, 2004**




*Sources:* Data as of Q1, 2018, based on National Institute of Statistics and Census data: National Census 2010; Annual Survey of Urban Households, EAHU 2010/14; Permanent Household Survey, EPH 2014/18.
*Note:* More details in the annex to appendix B of the main report (World Bank 2021). CABA = Autonomous City of Buenos Aires; GBA = Greater Buenos Aires; GRP = gross regional product; PBA = Province of Buenos Aires.

financier for the sector. This unresolved asymmetry often leads to misaligned incentives, and to a lack of planning culture at the utilities. Questionable investment choices may result. For example, in an environment of lack of rational or sequential planning, if funding were provided for new treatment plants, this investment may take priority over the more urgent need to reduce nonrevenue water. In addition, the performance of many provincial water supply and sanitation operators is limited by low capacity for key managerial and operational functions, such as human resources, billing, and reducing nonrevenue water. These low capacities are also often reflected in the poor quality and incoherence of engineering projects.

**Until these governance and efficiency challenges in the water supply and sanitation sector are addressed, substantial tariff increases—if not accompanied by subsidies targeted to the poor—would constitute questionable strategies for financial sustainability.** Although tariff increases may seem a tempting strategy to improve the financial performance of service providers, these increases alone are unlikely to realize efficiency gains or alleviate the need for subsidies. Tariffs sufficient to cover the current high operating and maintenance costs would be unaffordable for 27 percent of customers.

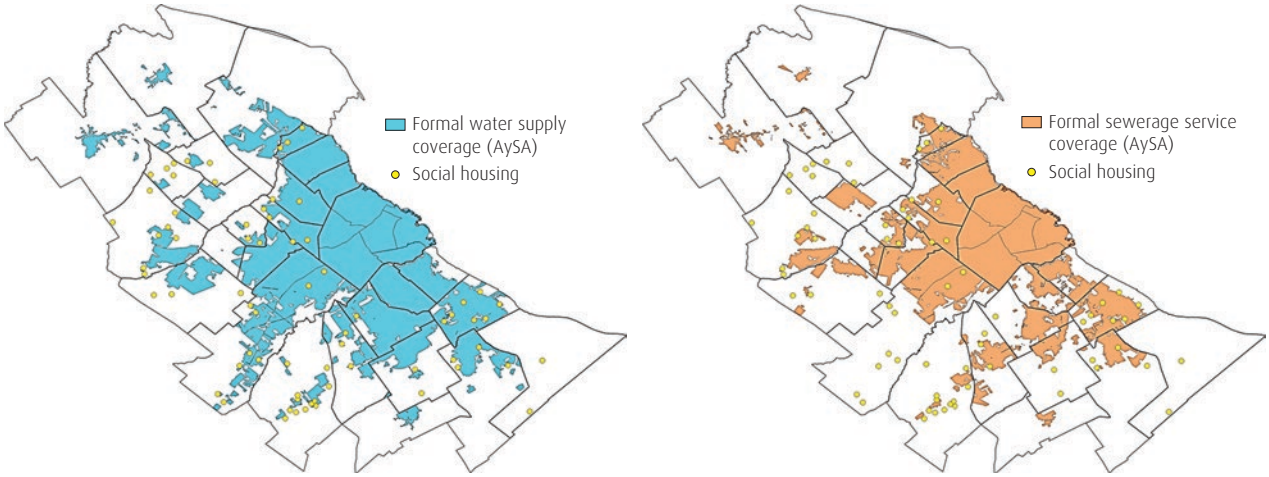
**Although sewerage coverage in Argentina is similar to the regional average, levels of wastewater treatment levels are below the regional average.** On-site sanitation (septage) management is not properly regulated and requires attention. Argentina places too great an emphasis on sewerage as the solution to expand access to achieve the SDG 6.2.1 target on access to safely managed sanitation. In the meantime, on-site sanitation—the existing solution for more than 20 million Argentines—still is not properly addressed since is no holistic regulation and supervision on the entire sanitation service chain (containment-emptying-transport-treatment and safe disposal). For wastewater treatment, Argentina ranks sixth lowest in the region: just 20 percent of its sewage effluents are treated, and only 11 percent of Argentines are connected to sewerage with treatment (SDG 6.2.1) (2018). In many urban areas, insufficient storm drainage and cross-connection cause sewer overflows, overloading treatment plants and enabling effluent discharge to waterways.

**The failure to coordinate large utility plans with urban planning instruments creates challenges in reducing service coverage gaps in an efficient manner**.[24] For instance, numerous social housing projects have been promoted in the locations of Greater Buenos Aires without formal[25] water supply and sanitation services (figure 9). Therefore, the cost of connecting those who most need service would be higher than if these projects were in locations with existing or planned formal coverage.[26] This could be rooted in the lack of coordination between institutions responsible for housing and water and sanitation services planning.

## Irrigation

**In irrigation as well as in water supply and sanitation services, improving efficiency is a key challenge—particularly given expected climate-driven declines**

**Figure 9 Coverage of Water Supply and Sanitation Services in Greater Buenos Aires, Argentina, and Location of Social Housing Projects**




*Sources:* Based on data of Muzzini et al. 2016; Secretary of Territorial Planning 2018, www.sig.planificacion.gob.ar, accessed March 2021.

**in water availability.** The average efficiency of irrigation water use across Argentina is just 34 percent (65 percent in collective networks and 52 percent in intra-plot systems).[27] Irrigation is not consistently governed throughout Argentina. And poor monitoring of the served flows to farmers is a common finding in some provinces. Different models exist for service delivery, regulatory control, institutional arrangements, and managing water use efficiency and sustainability. Best practices appear in some production models that emphasize high-value crops, generally for food processing industries and international markets, in which the water value is high. These areas also have a tradition of robust water governance and sound institutions.

**The key challenges to increasing irrigation system efficiency and sustainability are to adapt water supply to the dynamics of demand—both through technology and in relation to the rights system—and to increase cost recovery levels.** Most provincial water authorities could better manage water supply to meet the changing dynamics of demand. Argentina also has no clear policy or regulatory mechanisms to promote efficient irrigation technology. The existing system of fixed shifts for users is inefficient, because it does not allow adjusting water supply to different crop needs. Additionally, in most, though not all provinces, the price for delivered water and related services is too low to enable cost recovery. Argentina's high interest rates and challenging macroeconomic situation too often prevent producers from accessing financial markets for investments, either in new efficiency measures or in developing new schemes.

## 5. Closing the Gaps: Water Security Recommendations for Argentina

**Comparing the *business as usual scenario* for the next decade with a *water security active scenario*, this report finds that the action scenario will be far more demanding—but also far more rewarding for Argentina and its people.**[28] For example:

- **In the *business as usual scenario* for water supply and sanitation services,** Argentina will continue to expand coverage at a cost of US$1.5 billion annually between 2021 and 2030, increasing annual GDP by 0.5 percent, but the expansion will not be large enough to meet SDGs 6.1 and 6.2.
- **In the *water action scenario* for water supply and sanitation services,** Argentina can meet both SDGs 6.1 and 6.2 by spending US$3.4 billion annually to expand access over the next decade. As a result, annual GDP will rise by 1.21 percent—a 0.71 percentage-point gain over business as usual. And Argentina will realize a high benefit-to-cost ratio for each of these increased water supply and sanitation investments: 2.18 for piped water expansion, and 1.44 for sewerage and wastewater treatment expansion (urban population).
- **In the *business as usual scenario* for rainfed agriculture,** Argentina's annual average production of rainfed crops will fall by 10.7 percent over the coming decade—assuming that temperature rise and precipitation variability follow the third national communication on climate change SAyDS,2015) scenarios—causing an 0.86 percent drop in annual GDP. In addition, currently irrigated agricultural areas will experience a 15 percent decline in production and reduce annual GDP by a further 0.16 percent.
- **In the *water active scenario* for agriculture,** if Argentina invests an estimated US$16.5 billion in complementary irrigation for rainfed agriculture, it can realize a net annual increase of US$4.3 billion in profits from cereals and oilseed production by 2030 (while cutting the climate-driven drop in production of these crops from −10.7 percent to −1.8 percent). For irrigated areas, by investing up to about US$10.1 billion in efficiency and expansion, including the cost of drainage improvements and soil degradation recovery, Argentina can achieve as much as US$3 billion in annual gains. By implementing all the recommended actions on irrigation (detailed in chapter 6 of the main report [World Bank 2021]), Argentina would make its agriculture sector more resilient and make meaningful progress toward SDG 6.4.
- **Similarly, on urban flood mitigation, investments to reduce impacts are estimated to have benefit cost ratios of at least 1.4.** This means that following an "active scenario" would imply significant differences with a "business as usual" one. In the latter, existing negative impacts of 0.2 of GDP would, in the best case, perpetuate by 2030, if not increase.

**The water security action scenario comprises many related initiatives, which would sizably increase Argentina's annual GDP. However, making them sustainable will require large governance investments, including regulatory, institutional, and policy-making reforms.** In the water security action scenario, if fully implemented, the aggregate increase in annual GDP compared with business as usual is 2.7 percent, or about US$15 billion annually. A more detailed comparison of the two scenarios (partial impacts by sector) appears in box 2, table B2.1.[29] In order to realize such returns, Argentina must undertake also a series of institutional reforms to ensure sustainability.

**Reaching acceptable levels of water security linked to the achievement SDG 6 targets by 2030, plus seizing opportunities for further**

## Box 2 Effects of Closing Water Security Gaps

Comparing the *business as usual scenario* for the next decade with a *water security action scenario*, this report finds that the action scenario will be far more demanding—but far more rewarding. Estimates are that the action scenario can boost annual GDP by an additional 2.7 percent in 2030.

**Table B2.1 Estimated Impacts of Two Water Security Scenarios on Argentina's Annual GDP by 2030**

| Sector | Impact on Argentina's annual GDP (2030) | |
|---|---|---|
| | *Business as usual* | *Water security action* |
| **Water supply and sanitation services** | +0.5 percent | ➔ +1.21 percent |
| **Rainfed agriculture (complementary irrigation)** | −0.86 percent | ➔ −0.14 percent |
| **Irrigated agriculture (efficiency and expansion)** | −0.16 percent | ➔ +0.42 percent |
| **Water supply for businesses (ensuring continuity)** | −0.16 percent | ➔ 0.0 percent |
| **Water-related risk management (urban floods)** | −0.19 percent | ➔ −0.12 percent |
| **Addressing pollution impacts (surface water bodies)** | −0.09 percent | ➔ No change |
| **Multipurpose dams (uses beyond hydroelectric power)** | No change | ➔ +0.05 percent |
| **Hidrovía concession** | No change | ➔ Change has little significance |

*Source:* World Bank analysis.

**socioeconomic development from water, would require major investments in water infrastructure.** These costs are estimated at about US$97 billion. This implies increasing current investment levels by almost three times.

**Efficiency increases will be key to Argentina's success at financing infrastructure investments, especially in a challenging macroeconomic context.** For instance, in the water supply and sanitation sector alone, reducing utilities' operating and maintenance costs and increasing their tariff collection rates could save as much as US$0.8 billion annually. If Argentina could achieve those savings, the capital investment gap for the infrastructure expansion needed to achieve the SDGs would shrink to US$1.1 billion, with an additional US$1.3 billion needed to renew existing infrastructure. See figure 10.

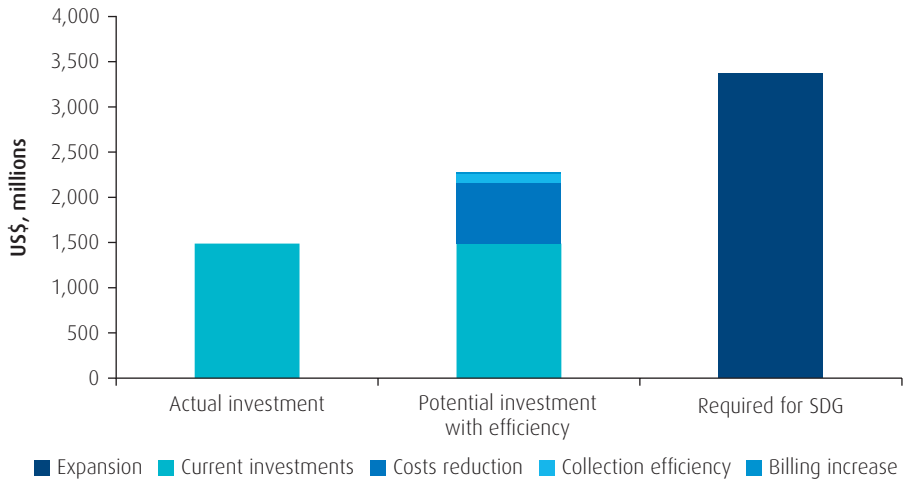
In addition to the overall aggregated impacts in the economy, decision-makers should also consider other dimensions associated to investments, namely: distributional impacts (social and geographic), but also, and especially during the COVID-19 crisis, short-term impacts related to generation of local employment, dependency on imported goods, and capacity for self-finance. Table 1 summarizes a semi-qualitative assessment of such variables at the macro level for Argentina.

## Infrastructure Investments to Close Water Security Gaps

**Increase storage infrastructure (hydropower and multipurpose).** The implementation of the strategy to increase the installed power capacity in hydroelectricity by 3 gigawatts by 2030 depends on the economic-financial and environmental viability of large projects. Although there is potential and specific projects are at an advanced stage of feasibility and design, the viability will depend on the local and national economic context. Because these projects are multipurpose, allowing the use of the resource for irrigation, drinking water, industrial use, or even recreational uses should increase their feasibility, provided that their environmental impacts can be managed.

**Efficiency investments in irrigated agriculture.** This intervention will have high positive impacts in priority areas with greater water stress (Catamarca, Córdoba, La Pampa, La Rioja, Mendoza, San Juan, Santa Fe, or Santiago del Estero). Because irrigation is by far the highest water consumer, investments to achieve greater efficiency in existing schemes should be a priority due to their great potential to save water. if coupled with the corresponding governance measures to better monitor and manage water supply. Also upgrading or developing new water resources management

**Figure 10 Possible Annual Utility Efficiencies and Investments in Argentina, 2017**




*Source:* Author analysis (see appendix C of the main report [World Bank 2021] for details).
*Note:* The efficiency improvements were calculated for 16 main providers, assuming that they at least reach the efficiency ratios corresponding to the fifth best provider in each of the three indicators (costs, collection efficiency, and average billing). SDG = Sustainable Development Goal.

**Table 1 Long- and Short-Term Socioeconomic and Fiscal Impacts of Water Infrastructure, Argentina**

| | Long-term impact (during infrastructure's lifespan) | | | Short-term impact (during construction) | | |
|---|---|---|---|---|---|---|
| | Net contribution to economic growth[a] (percent) | Distributional impact | | Local employment | More dependency on local goods (less demand for foreign currency) | Capacity to self-finance |
| | | Social (benefit the poor the most) | Geographic (reduce territorial asymmetries) | | | |
| **Complementary irrigation to rainfed agriculture** | 0.44 | | | | | |
| **Efficiency improvements in irrigated agriculture** | 0.57 | | | | | |
| **Expansion of water supply and sanitation to new areas** | 0.30 | | | | | |
| **Improvement of surface water quality through new wastewater treatment plants in areas with network in place** | 0.18 | | | | | |
| **Rehabilitation of water supply and sanitation networks to improve service quality** | 0.12 | | | | | |
| **Hydropower** | 0.07[b] | | | | | |
| **Deepening the Hidrovía** | 0.67 | | | | | |
| **Urban flood mitigation** | 0.27 | | | | | |
| **Hydrometeorological infrastructure** | 0.77 | | | | | |

*Source:* Based on economic analysis included in appendix B of the main report (World Bank 2021). Impacts are calculated based on GDP 2018.
*Note:* Dark color shows larger effect than light colors. Blank means no significant effect. The table is conceived as a prioritization tool that summarizes the analysis explained in the text. It compares the long-term and short-term variables to help select investments, depending on which criteria decision-makers emphasize.
a. Economic returns for a fixed capital investment of US$10 billion.
b. Not including additional benefits of multipurpose dams.

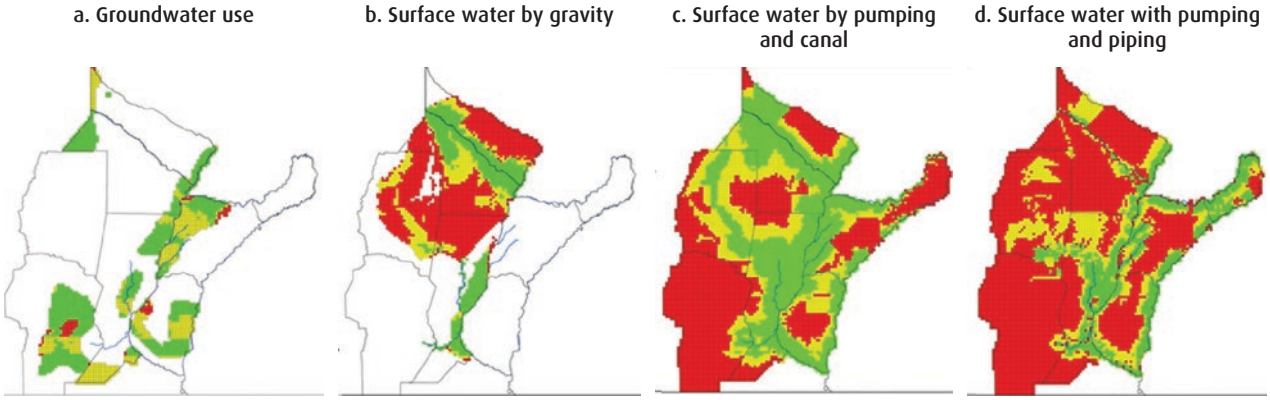
infrastructure and rehabilitating and improving drainage systems contribute to the same goals. This type of infrastructure needs to be conceived within the framework of robust drought resilience plans, given the imminent changes in climate diminishing the hydrologic buffer capacity of water resources.

**Complementary irrigation for rainfed crops.** In the short term, complementary irrigation may not have the same impacts in terms of distributional effects, employment generation, or territorial development. Yet, given the cascade effects of dry spells on agricultural production and, therefore, on the macro economy, this type of infrastructure is an essential buffer to mitigate such impacts in nonirrigated areas of high agricultural production. The viability of this expansion was analyzed by estimating the internal rate of return of the investment, considering different water sources (map 1).

**Green and grey flood mitigation infrastructure.** Infrastructure for flood mitigation, in areas of high recurrence and social impact such as the Metropolitan Area of Buenos Aires, Chaco, Corrientes, Formosa, Rosario, Santa Fe, or other flood-prone cities in the La Plata Basin, should be a priority because of the high social impacts that this type of infrastructure can have in alleviating chronic losses of well-being by the vulnerable population. This type of infrastructure does not just entail protection defenses against river overflows, like the ones built along the Parana River, or drainage networks and pumping stations. Interventions should place higher emphasis on retention and storage and consider combinations of green and grey infrastructure conceived in the framework of the river basin. This means working beyond municipal administrative boundaries and seeking optimal solutions at the basin level that link upstream and downstream phenomena (for example, retaining upstream and draining downstream). Strategies such as creating "sponge cities" can be promoted (in China, such cities in flat and humid areas are populated with natural or artificial water bodies in parks and gardens, whose function is to reduce peak flows). Urban regions such as the Buenos Aires Metropolitan Area, for example, would need to promote these types of strategies, seeking greater collaboration between municipalities at the basin level, where the retention infrastructure may not always be grey, but also green (through riverbanks, riverside parks, wetlands, and green roofs). These nature-based solutions are most effective when combined with early warning systems in densely populated and highly exposed areas. It is also necessary to revise engineering designs of gray infrastructure that are obsolete due to changes in land use, climate change, and variability, and it is necessary to advance in a process of updating the flood plans of the 100 main cities in the country.

**It is essential to understand the links between urban drainage and sewerage systems.** The first step is to diagnose the status of the networks. This analysis will help prevent fecal contamination in systems that theoretically drain into watercourses, or to avoid drains discharging into sewers, thus diluting fecal water in the sewage network and its negative impacts on treatment plant operations. This diagnosis is followed by interventions tailored to mitigate those problems, such as the separation of the networks, the enhancement of sewer capacity, or the adequate design of combined sewer overflows, in addition to the abovementioned storm or storage tanks to retain peak flows and minimize dumping of contaminated liquids to waterways. There must be enforceable regulations banning sewage connections to rainwater drainage.

**Map 1 Internal Rates of Return for Complementary Irrigation Expansion, Center-North Argentina**




*Source:* FAO and PROSAP 2015.
*Note:* Green: viable internal rates of return of more than 18 percent; yellow: medium viability zones with internal rates of return between 12 percent and 18 percent; red: no viability.

**Hydrometeorological infrastructure and early warning systems.** These interventions are low hanging fruits in terms of benefit-cost ratios. Early warning systems in urban areas of the La Plata River Basin or areas susceptible to flash floods are relatively small investments in relation to their benefits to exposed populations and assets. Warnings issued with sufficient anticipation and accuracy could save lives but also considerably reduce economic losses. As strategic resources, the density of groundwater and nivo-glacial measuring stations needs to be increased, especially in arid regions, due to the important regulatory function. It is also important to increase the density of water quality monitoring stations. This information will allow decision-makers to improve knowledge of impacts on water quantity and quality and to have greater control over the resource and a higher capacity to react to problems and enforce existing regulations.

**Investments in extending water supply and sanitation services.** In metropolitan areas, especially the Buenos Aires Metropolitan Area and the Northwest–Northeast region, expansion of water supply and sanitation infrastructure can have the highest social impacts and potential to reduce the vulnerability of the poor, especially in the face of phenomena such as COVID-19. This crisis represents an opportunity for the country to analyze the direction of its investments and assign greater importance to the drinking water and sanitation sector. Investing in the sector also has enormous potential for job creation and should figure prominently in policy discussions regarding short-term stimulus.

**On water supply and sanitation services, interventions should aim at increasing connectivity, with a focus on the most vulnerable neighborhoods.** This requires smart strategies to connect households in informal settlements, which could be pursued as part of more comprehensive urban upgrading interventions to tackle a series of other related challenges—land property, drainage, solid waste, health, education, and social services—in the context of integrated urban planning. Connectivity and expansion of branch networks planning should be synched with other main water supply and sanitation infrastructure to guarantee the quality of the service (water treatment plants, main trunks, secondary network, sewers, and wastewater treatment plants). Epidemiological evaluation studies related to the health impact of consuming water with low concentrations of arsenic or data on contamination of the source with high levels of nitrates will help to identify areas of urgent action.

**Investments in wastewater treatment plants.** Wastewater treatment plants should be prioritized in areas with existing sewers that discharge to nearby water bodies, because they create high environmental and social impacts downstream. Areas where the sewerage network discharges to receiving water bodies with high dilution capacity, or where there are no clearly identified environmental and social impacts downstream, could be considered in a second stage. In any case, treatment and discharge levels should adapt to the self-purification capacity of receiving water bodies.

**Rehabilitation of drinking water and sanitation networks, estimated at US$1.3 billion annually, may be relatively inexpensive interventions but they prevent systems from deteriorating in the near future, thus saving future resources to replace or rebuild key infrastructure.**

**Access to safely managed sanitation goes beyond sewers and wastewater treatment plants.** Sewerage is the preferred option to provide sanitation services to most of the citizens. However, its high cost implies that it will take much time to universalize this solution. This means that on-site solutions for domestic effluent management, a current option for those unconnected, deserves more attention than is currently being given. These on-site solutions, if well-implemented, can be counted toward the SDG goal of having "access to safely managed sanitation." These can be well-suited solutions for rural and urban areas with low population density. This subsector should be regulated and controlled from the design and construction of septic tanks to desludging, transportation, and treatment services to ensure safe disposal of treated sludge and to minimize contamination of soils, surface water, and aquifers in peri-urban settlements. The World Bank (2017) has developed guidelines on best practices that could be a first step to start regulating the management of on-site sanitation facilities.

This recommendation, together with the prioritization criteria provided for the construction of new wastewater treatment plants above, could significantly lower the investment amount needed to close the water security gaps under the "Active Scenario."

**Deepening the Paraná-Paraguay waterway.** The renewal of the Paraná-Paraguay waterway concession should consider a complete cost-benefit analysis to assess alternatives for increasing navigation depth and, therefore, transportation yields. Various depth and trace alternatives are considered for the waterway. Experience indicates that this infrastructure not only facilitates transportation but also promotes it and develops the areas of influence. The alternatives must be evaluated comprehensively, including the development of Santa Fe al Norte and regions not

directly along the basin, such as the Atlantic ports. It is essential that the cost-benefit evaluation considers the impact on the nation's economic development, and the experience of the last 25 years. Financial analysis will surely show that it is possible to self-finance investments, but an adequate structure in toll rates can contribute significantly.

## Governance Recommendations to Close Water Security Gaps

**The following are recommended actions to improve water sector governance in the short to medium term and represent necessary complements to needed investments.** Argentina's water security future will depend on governance improvements that will enhance the enabling environment for sustainable investments in infrastructure. In water resources management, realistic and coordinated planning is needed at the basin level, based on sufficient information and guided by a holistic approach to the sector. In water services, expansion must be accompanied by efforts to seize the existing large efficiency opportunities, in water supply and sanitation and irrigation. In water-related risk management, new infrastructure requires parallel enhancements in standards, regulations, and enforcement. Figures 11 and 12 summarize what it takes to boost water security in Argentina and represent the links between investments and governance reforms.

### Strengthen Water Resources Management

***1. Strengthen the national and provincial regulatory frameworks for water resources management as the legal foundation for increasing resilience to climate change at the national level in an efficient manner.***

| Complexity: High | Priority: Medium-high (Debate process should start now. Final adoption in the medium term) |
|---|---|

**A step forward from the 2003 Guiding Principles for Water Policy—and considering the objections formulated to Law 25.688—would be to establish a mandatory national legal framework of minimum contents and regulations on the environmental management of water, ensuring full participation of all provinces.** The effort to establish a legal framework on environmental water management should be relaunched, ensuring full participation from all provinces. The minimum contents of the law should be based on standards, criteria, methodologies, protocols, and best practices on the management of water resources, shared throughout the national territory, which each province can then adjust, adapt, and develop as needed. The new regulatory framework should also set forth a range of limits, indexes, or reference values for compliance with discharge and water quality regulations. An alternative would be a thorough revision and purification of Law 25.688, eliminating the controversial aspects mentioned in chapter 4 of the main report (World Bank 2021), and deepening the environmental aspects protected by the Constitution.

**In parallel, improvements are required in existing provincial regulations to strengthen water resources management strategies and systems' resilience to extreme events.** These improvements should aim to reinforce the prioritization of water uses and promote informed decisions. The adjustments in the provincial regulations could focus on:

- The adjustment of usage permits to the characteristics of each water source.
- In the case of interjurisdictional resources, periodically revisable agreements, quotas, and flow allocations should be established.
- Consideration of agreements on methodologies for setting up criteria for environmental flows defined in the corresponding basin plans, according to each geographical and ecological reality.
- Strengthened control mechanisms and an efficient sanction regime to prevent water contamination.

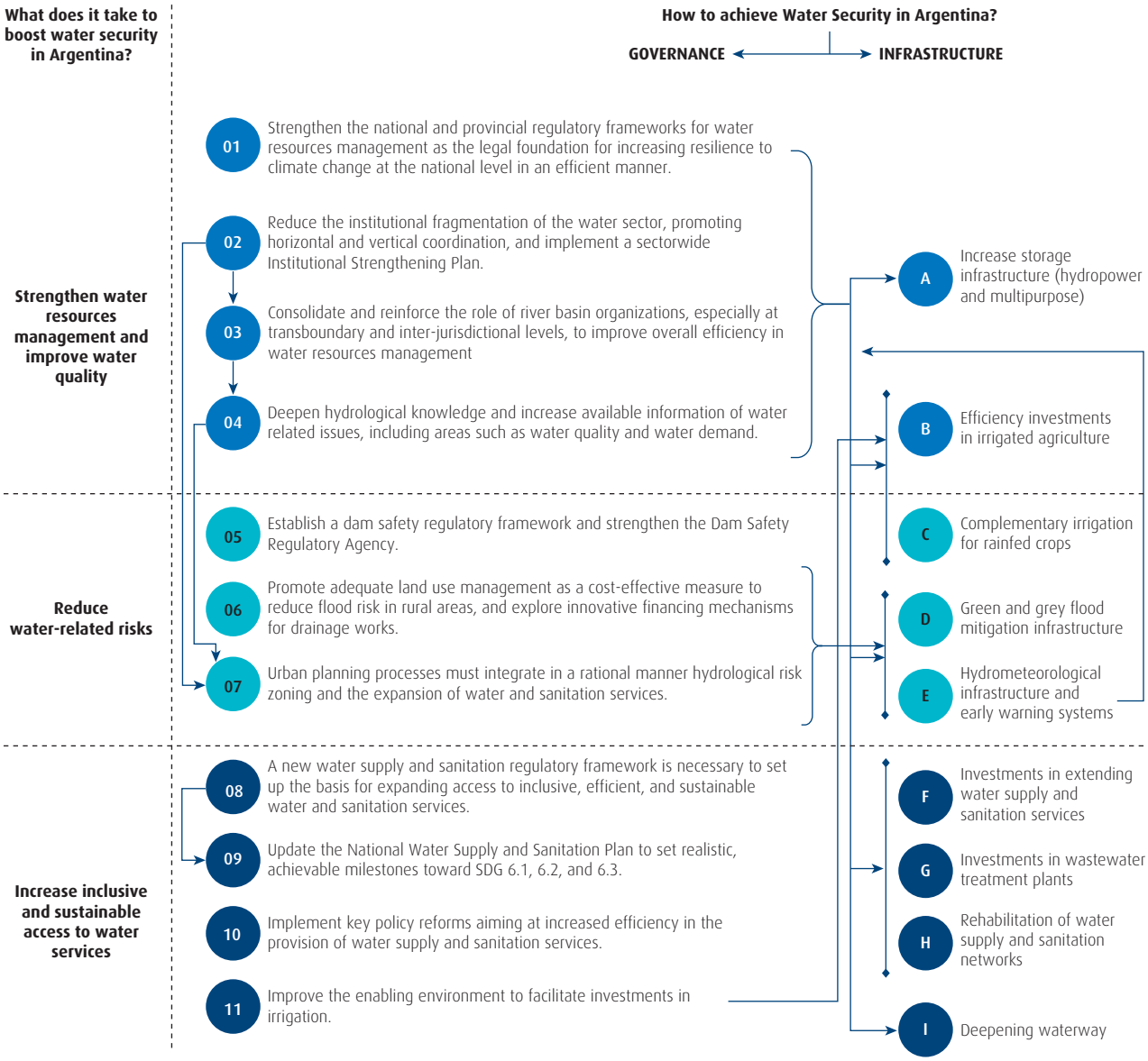
**The most important factor for success in the national regulatory framework upgrade is to guarantee a participatory process—that is, to ensure contributions from the provinces and key sector stakeholders.** For this purpose, it is fundamental to strengthen the role of COHIFE as the key body for provincial representation. This institution should have a clear role in the elaboration of the proposed legal framework.

***2. Reduce the institutional fragmentation of the water sector, promoting horizontal and vertical coordination, and implement a sectorwide Institutional Strengthening Plan.***

| Complexity: Medium | Priority: High with gradual implementation |
|---|---|

**National and provincial entities should work to reduce the existing levels of institutional fragmentation and the amount of overlapping responsibilities.** Whether it is under the umbrella of competencies of the same institution (ministry

## Figure 11 Recommendations and Associated Infrastructure Measures in Argentina



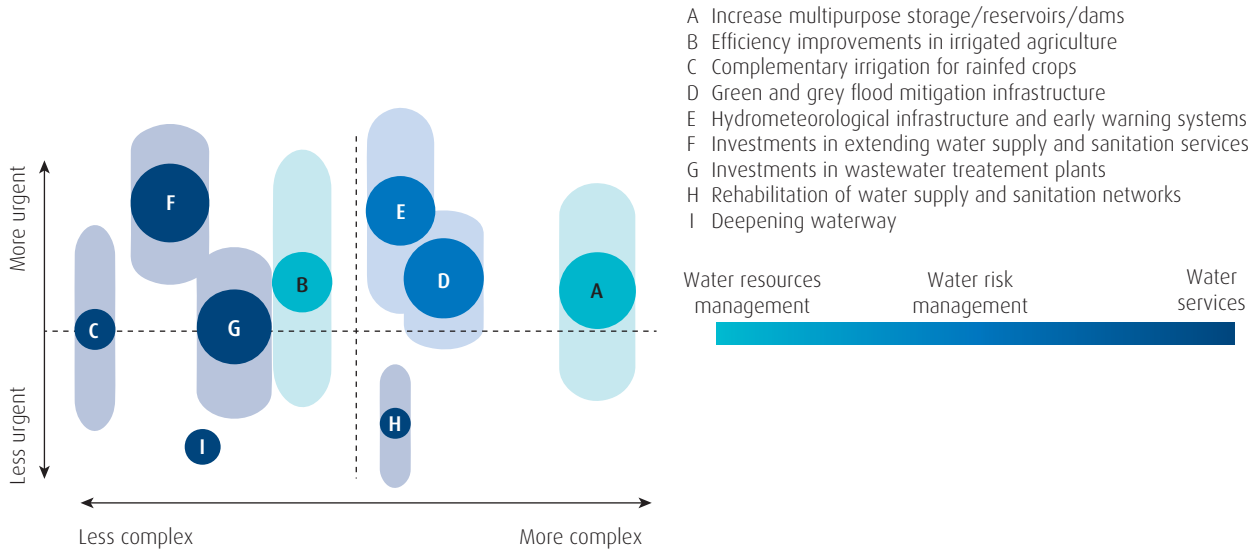

*Source:* Author analysis.

level) or by streamlining functions and establishing clear coordination mechanisms among entities, water resources management needs to be carried out organically, avoiding duplication of functions to maximize efficiency. This harmonization exercise would bring together resource control functions in terms of quantity and quality, integrating all aspects of water resources management.

A logical step in provinces with higher levels of fragmentation would be to consider a single water agency that has a mandate for bulk water resources management, and to consider different sectors of user demand, helping to minimize conflicts among sectors and achieve overall greater efficiencies in water use.

**Overcoming the significant disparities in water-related institutional capacities requires the development of a national plan for institutional strengthening, with concrete measures for different institutions at all levels.** It should encourage the horizontal transfer of capacities based on the successful experiences of provinces, as well as the transfer of the expertise and knowledge of specialized agencies. In particular, the following actors should have their capacity strengthened:

**Figure 12 Water Investments in Argentina**




*Source:* Author analysis.
*Note:* The spam/shadow for each measure relates to the variety of geographical priorities within such measure explained in the report and figure 11, according to the different priorities by province. The bubble size shows the net contribution to economic growth of the water infrastructure interventions (table 1). Each type of investment, A to I, should be linked to their corresponding governance recommendations included in figure 11.

- **Provincial water authorities.** They should improve their capacities for planning, managing water resources, and monitoring environmental sustainability, both in surface water and groundwater. Oversight should include reinforced inspection and verification in the field, control of compliance with regulations, and application of administrative sanctions in relation to the use and preservation of the resource.
- **COHIFE and Secretariat of Infrastructure and Water Policy (SIPH).** Both should share executive powers (as per the legal reforms discussed previously), be capable of developing binding agreements, and be endowed with sufficient resources to develop their activities.
- **Institutions and organizations that generate knowledge and develop information.** Such institutions[30] could promote a more active role in capacity building in provinces with fewer resources.

***3. Consolidate and reinforce the role of river basin organizations, especially at transboundary and interjurisdictional levels, to improve overall efficiency in water resources management.***

| Complexity: Medium | Priority: High |
|---|---|

**As a downstream country, Argentina must promote the acceleration of the transboundary water management agenda.** Strong Argentinian diplomatic work and political leadership are necessary to lead actions toward strengthening the organizational framework and the consolidation of concrete functions of international organizations, leading to a more effective and efficient implementation of existing basin-level strategic policies and programs.

**For La Plata, Bermejo, and Pilcomayo river basins, it is central to have an integrated information management platform.** This platform could benefit all the member countries by incorporating integrated measurement networks and management systems. In addition, member countries should coordinate to develop early warning systems.

**Interjurisdictional basin organizations have great potential to help improve the overall efficiency in water resources management.** This can happen once consensus is established with the provincial authorities on which functions could be delegated to them, with planning being the prevailing one. The next step is strengthening these organizations, matching their increased responsibilities with increased financial autonomy. For this purpose, attaining sustainable financing instruments that ensure the continuity of long-term policies is recommended.

The agenda should focus on matters including (i) the development of fully-fledged basin master plans; (ii) the elaboration of conflict resolution procedures;

and (iii) the identification of economic, social, and environmental prioritization principles of interventions proposed in the basin. Citizen engagement and overall active stakeholder participation processes should have important roles in the consolidation of the organizations. This means strengthening infrastructure users' associations and ensuring adequate representativeness of all users, among others.

**The importance of river basin planning as a main function of the river basin organizations.** Territorial planning must rely strongly on the basin as its management unit, considering land uses and ecosystems influencing the surface and groundwater balance. Hydrological plans should be further promoted and considered as a cross-sectional tool in spatial and sectoral planning. In this matter, it is worth looking at examples of countries like the ones in the European Union, where hydrological plans are environmental management instruments that all sectors should consult when developing their plans or projects, in order to minimize negative externalities and take advantage of synergies. This level of communication optimizes all sectors' use and impact of the resource, including urban development, energy, agriculture, and transport.

**Because of increasing uncertainty due to climate change and demand projections, hydrological planning should be robust and flexible.** Plans should pinpoint problems, establish progressive improvement targets and realistic measures, and identify financing options. Hydrological plans must go far beyond the mere assessment and costing of water works; these should be considered with other nonstructural measures to increase resilience and efficiency in how the resource is managed. Plans should include monitoring and evaluation mechanisms to correct and adjust to changing realities.

***4. Deepen hydrological knowledge and increase available information of water-related issues, including areas such as water quality and water demand.***

| Complexity: Medium | Priority: High |
|---|---|

Promoting data generation, mapping, modeling, and forecasting of ground and surface water resources in a systematized way, both at the provincial and national levels, is a low hanging fruit when the costs and benefits of such activities are compared. The ongoing initiatives to systematize data and information related to the status of the resource, in quality and quantity, should be boosted and expanded.

**Having large and standardized databases is not useful without a clear commitment to transparency in providing information.** Therefore, although Act 27,275 establishes the right of access to public information for all state authorities and agencies, mechanisms must be established to ensure transparency in information sharing between jurisdictions and institutions, and with the general public. Such sharing would greatly facilitate analysis, decision-making, and political action supported by citizen engagement, while improving the relationship between users and resource managers and reducing the likelihood of conflict.

**A two-step approach to hydrological knowledge is recommended.** Before further expanding hydrometeorological networks, it is advisable to coordinate and systematize existing datasets, improve network interconnectivity, and develop and share decision-making tools at the provincial and federal level. The second step would be investing in further development of hydrometeorological infrastructure and early warning systems.

For both steps, it is essential to guarantee operation and maintenance budgets to ensure sustainability. This would allow a continuation of the data series and the functionality of the decision-making tools and associated services (such as early warning systems). With expanded and more accurate data points, there will be more space to:

- Inform planning processes, starting with the basin plans, and including provincial water plans and an updated National Water Plan.[31]
- Improve forecasting services for the agricultural sector, enhancing its ability to predict and develop more resilient food production strategies.
- Anticipate and prevent climate change impacts associated with extreme events and erosion, of special interest for the river navigation and hydropower sectors.

**Progress must be made in assessing and quantifying demands for all water uses.** In coordination with other sectors, existing and projected water demands per basin are key pieces to develop solid water resources management plans that could contribute to the development of specific regions.

**Understanding the causes of water quality deterioration is necessary to prepare an updated and complete water quality map of the country's main water bodies, identify pollution causes, and propose remediation measures.** Indicators under SDG 6.3.2, whose guidance levels should be set for each basin or region, assess the status of water quality in relation to its reference condition.

**The next step should be to set the basis for a unified national dataset, built upon water**

**quality parameters and pollution sources.** The compilation should include biological, chemical, and morphological indicators that could serve to calculate environmental flows to protect riparian species and aquatic ecosystems.

**Information collection should be conducted in a systematized manner, through water quality and quantity monitoring programs.** Because of the laboratories' locations, and with most of the analytical capacity concentrated in the Autonomous City of Buenos Aires (CABA), Province of Buenos Aires, Córdoba, and Santa Fe, it would be necessary to increase the analytical capacity of water quality in the rest of the country.

## Reduce Water-Related Risks

***5. Establish a dam safety regulatory framework and strengthen the Dam Safety Regulatory Agency.***

| Complexity: Low | Priority: High |
|---|---|

**With regard to dam safety, and pending the passage of the act presented to Congress by the Organismo Regulador de Seguridad de Presas (ORSEP), this study recommends extending that agency's jurisdiction through agreements with all jurisdictions and basin organizations.** This would allow for economies of scale in terms of costs, and centralize dam safety control in a single entity. This would ensure a level of standardization of dam safety surveillance and control procedures across the national territory, taking advantage of the high skills and experience from this institution.

The National Register of Dams and Technical Archives, proposed in the draft law, would allow a diagnosis of infrastructure status. Then planning and systematizing a policy for the recovery and preventive maintenance of the existing infrastructure can occur, starting with those in the most critical state. It is important to ensure the implementation of agreements between competent authorities, operators, and the national authority, as well as to secure the necessary resources to implement them. Developing control, supervision, and monitoring systems of dams, dikes, and reservoirs increases the predictive capacity for emergencies, and fosters an active exchange between the operators and ORSEP. It is essential to ensure strong interinstitutional communication and coordination for this initiative, considering the participation of different sectors, authority levels, jurisdictions, and stakeholders with diverse responsibilities, resources, and competencies.

***6. Promote adequate land use management as a cost-effective measure to reduce flood risk in rural areas, and explore innovative financing mechanisms for drainage works.***

| Complexity: Low | Priority: Gradual implementation |
|---|---|

Expanding the practice of preparing and implementing land use management plans, with strong user participation in planning and management processes, could reduce the flood risk in rural areas. Yet, it is also possible to consider steps beyond the promotion of good practices. Some provinces are carrying out periodic remote sensing monitoring of land use changes.[32] This tool can be expanded to all areas and applied to ensure compliance with land use plans. All in all, more emphasis needs to be placed on consensual provincial planning for collective improvements in agricultural land use, promoting crop rotation for efficient use of water resources.

**Large drainage works in rural areas could be co-financed by direct beneficiaries.** This type of expensive infrastructure could be implemented through innovative financial instruments involving direct beneficiaries. As exemplified in the drainage works of the Salado River Basin in the Province of Buenos Aires, the high cost of the infrastructure, and the fact that the main group of direct beneficiaries is clearly defined, would allow the creation of a trust fund financed by future capital gains generated by expected increases in yields and production, as a result of the reduction in the impact of recurrent floods in such areas.

***7. Urban planning processes must integrate in a rational manner hydrological risk zoning and the expansion of water supply and sanitation services.***

| Complexity: Medium | Priority: Gradual implementation |
|---|---|

Multi-sectoral coordination between sector institutions at the municipal and provincial levels in metropolitan areas is essential for a more rational urban growth. The National System for Integrative Risk Management (SINAGIR) works as an example of interinstitutional coordination for disaster risk management of institutions down to the municipal level and citizen organizations. But this collaboration should be extended for infrastructure planning or for the development of early warning systems, starting with coordination among jurisdictions concerning data sharing and fostering joint decision-making processes.

**But the greatest challenge is compliance with flood zoning criteria, and planning for the associated costs.** This is a must to mitigate flood impacts, so administrations should work to minimize exceptions to the rule. Slum upgrading programs should consider flood risk mitigation as a central driver

for change in high risk areas, considering relocation alternatives, if necessary.

**Specifically, for floods originating from river overflow, clear criteria and operative procedures are needed to determine the natural flood plain or hydrologic public domain, already defined by law, to effectively control settlements in buffer areas.** Water authorities should define and implement these limits on the ground, considering associated flood return periods to prevent impacts associated to urban or agricultural areas. Again, these efforts should trespass administrative borders and be applied at the basin level.

## Increase Inclusive and Sustainable Access to Water Services

***8. A new water supply and sanitation regulatory framework is necessary to set up the basis for expanding access to inclusive, efficient and sustainable water supply and sanitation services***

| Complexity: High | Priority: High |
|---|---|

**The enabling environment for the delivery of adequate drinking water and sanitation services starts with building consensus among all stakeholders on water utilities as credible entities providing reliable services with efficiency, sustainability, and good financial performance.**[33] This common vision does not yet exist in Argentina. As discussed in chapter 5 of the report, efficiency improvements in operation would release enough funds for up to nearly 50 percent of the additional amount required to reach full coverage by 2030, above what is invested today. In Argentina's complex macroeconomic environment, worsened by the COVID-19 crisis, this way of obtaining funding is more justifiable than ever. It would imply that providers operate under commercial criteria and aspire not to depend on subsidies for operation, measuring the water that they produce and charge for what they supply, reduce significant losses in their systems, and satisfy customers with affordable and good service.

**This consensus should be reflected in a new regulatory instrument on water supply and sanitation that states the new vision and the overarching objectives for the sector.** This instrument sets equitable rules for the distribution of national public funds to the different jurisdictions, based on objective criteria of needs, the capacity of the provinces to finance and provide sustainable services, and the performance of the recipients. To achieve consensus in discussing this new law, it is necessary to establish a national advisory committee for water supply and sanitation, formed of provincial and national stakeholders.

**It would be advisable for the new law to establish a system of equivalent subsidies or matching grants, so that national contributions for infrastructure are distributed under well-defined and transparent criteria.** In the system of matching grants, earmarked federal funds would be matched by provincial funds. The advisory committee would revise criteria for investment eligibility. Criteria should be based on need, with funds distributed either equally (so each nonserved person receives the same) or progressively (in inverse relation to GDP per capita). Other criteria, such as population density and economies of scale, could play a role in defining the priorities. It would also be advisable that provider performance and achievement of objectives, measured by progress on key performance indicators, be incorporated into the criteria for allocating funds and determining the type of financing to be granted. In addition to efficiency indicators, an essential indicator to comply with is transparency. Operators should be incentivized to publish their financial statements, technical and financial reports, and progress in complying with key performance indicators related to quality of service provision and technical and financial sustainability.

**The new law should be accompanied by a fund for investments in drinking water and sanitation.** Given the need to achieve multiyear predictability to the future of public investments in drinking water and sanitation to ensure the efficiency of the funds committed, the national government should analyze options to incorporate an escrow fund that, during a specific time, ensures the financing of sector investments.

**At the provincial level, regulatory frameworks should be updated, the role of regulators reinforced.** Regulators should set and monitor performance standards and establish mechanisms to determine tariffs. They should also ensure that providers adopt defined paths to universal access and affordability with a special focus on the poor, incorporating a social tariff (or proposing subsidies to the government), and monitoring the overall performance of the service provider. Regulators should help to build capacity of the operator and report regularly to provincial government authorities, among others, on service delivery performance. Provincial regulators should maintain their financial independence by receiving a portion of tariff income to cover recurrent costs.

**Consequently, there is a need to build capacity in regulators of drinking water and sanitation—but also in the National Directorate of Drinking Water and Sanitation (DNAPyS) and in agencies that execute water projects.** Regulators should be equipped with skilled staff to perform the functions in the updated regulatory frameworks. The DNAPyS should expand its functions to coordinate with provinces in

implementing the updated National Water Supply and Sanitation Plan, provide stronger technical assistance in the design of drinking water and sanitation systems in the weaker jurisdictions and rural areas, keep expanding the national information systems in water supply and sanitation to cover a wider range of providers, and promote guidelines and courses on best practices in the sector (design, procurement, development of new technologies, and smart utilities).[34]

The progressive transfer of execution functions of infrastructure financed at the federal level to the provinces is recommended. The transfer could take place either at the utility level or at the corresponding provincial ministry responsible for water supply and sanitation services. This recommendation applies to nationally funded water infrastructure, if it will be managed and operated by the provinces. This transfer will increase the level of ownership and avoid mismatches in the execution of priorities, among others.

### *9. Update the National Water Supply and Sanitation Plan to set realistic, achievable milestones toward SDGs 6.1, 6.2, and 6.3.*

| Complexity: Low | Priority: Medium |
|---|---|

Realistic planning should consider the financing possibilities of the sector and that, at present, the easiest source of funding relies on efficiency gains within the sector. Also, the plan should prioritize investments, using such criteria as economic, environmental, and social aspects. The updated National Water Supply and Sanitation Plan would benefit from focusing on the following areas:

- **Establish guidelines to expand services in the *barrios populares*, or vulnerable neighborhoods**. This strategy should evaluate how to enable access to areas more difficult to reach and to promote connectivity.
- **Expand the water supply and sanitation national information system by including smaller operators in towns and rural areas, as well as health care centers and schools across the country.** A national information system, such as the one for main utilities in urban areas, could be expanded to the rural areas. The Information System for Water and Sanitation in Rural Areas (SIASAR), promoted by the World Bank and the Inter-American Development Bank, has been implemented successfully across the Latin America and the Caribbean region, but not yet in Argentina.
- **Address the atomization of low-performance service providers.** Strategies could include having larger utilities provide technical assistance services to the smallest ones, or agglomeration strategies could achieve either economies of scale in service provision, or most important, higher quality in the level of service. Sometimes it may be feasible to expand the jurisdiction area of well-performing utilities in urban areas, as with Argentine Water and Sanitation (AySA). Successful experiences of regionalization in Latin America and the Caribbean can be used as examples, such as those in Colombia or Brazil (World Bank 2017).
- **More data are needed to understand gender inequalities related to water and their causes, and to propose actions to promote women´s participation both in utilities and in water sector organizations.** Increasing women's participation in water utilities benefits women, the community, and the organizations. Expanding existing initiatives to other utilities, such as the ones pursued by AySA to promote women in managerial positions, is also recommended.

### *10. Implement key policy reforms aiming at increased efficiency in the provision of water supply and sanitation services.*

| Complexity: Medium | Priority: High |
|---|---|

These reforms are presented here, established by order of priority:

- **Expand and promote the implementation of Results Management Plans (PGRs).** National and provincial governments should continue to promote the preparation of PGRs across provinces as a solid, enforceable planning tool at the utility level. Goals include reaching universal access, operational efficiency, and financial sustainability. The signing of a binding agreement involving all stakeholders, with the understanding that all parties will follow the milestones defined in the PGR, could serve to ensure compliance. The new legal framework, and more particularly the system of matching grants proposed, could be a powerful incentive for the implementation of these plans.
- **Reducing physical and commercial losses and energy consumption are among the most relevant actions providers must take.** Water utilities must drastically increase the efficiency of resource provision by reducing physical losses, measuring consumption, and applying a tariff structure that promotes rational consumption. This is even more urgent in water scarce areas as an essential measure to increase drought resilience.
- **Revise tariff update policies, as well as operation subsidies, if any, to ensure that the financing flow maintains its real value in case of inflation.** This policy should accompany greater efficiency in revenue collection and operations. Adequate tariff policies that promote rational use are progressive volumetric tariffs based on actual metered consumption. The regulatory frameworks should provide for adequate mechanisms to adjust tariffs to changes in costs, and establish a social tariff

system for the population with insufficient capacity to pay, before rate increases exceed such capacity.

- **Promote a path toward smart utilities and circular economy.** Digital solutions are essential tools to streamline processes, save transaction costs, and increase resilience by responding faster to shocks. Circular economy strategies should take advantage of the great opportunities the sector offers in terms of climate change adaptation and mitigation. Low-cost operating treatment plants (without aeration) can recover up to 100 percent of operating costs by generating electricity from biogas produced in anaerobic digestion tanks (World Bank 2015). The combination of this process with the digestion of urban organic waste (co-digestion) further increases energy production and reduces total plant emissions. These opportunities, or others, such as the production of nitrogen fertilizers from sewage sludge, are still untapped in Argentina. Promoting wastewater reuse can be an essential climate change adaptation measure by saving large amounts of water in zones with water stress.

***11. Improve the enabling environment to facilitate investments in irrigation.***

| Complexity: High | Priority: Medium |
|---|---|

**In addition to efficiency measures and consequent savings, creativity is needed while searching for financing instruments in complex macroeconomic contexts.** Innovative forms of financing to mobilize private resources have been planned, for example, in the Meseta Intermedia project in Chubut. The proposed financing would be through a trust that draws on future capital gains generated by the irrigation infrastructure and associated services.

**Formulas for access to financing by producers should be expanded, for either individuals or associations in the form of consortia.** Access can aim at producers' institutional strengthening, at the expansion of irrigated areas, or at efficiency improvement investments. These formulas may lead to new reciprocal guarantee companies that grant guarantees to improve their financing conditions through banks, capital markets, and suppliers, or other public financial institutions. In addition, these initiatives could support land titling and regulation programs, making concession granting more flexible. They should be based on knowing resource availability, especially in provinces that have numerous occupied or leased farms (FAO and PROSAP 2015).

**Controlling external factors and establishing incentives to achieve greater efficiency are essential ingredients for the viability and sustainability of new irrigation schemes.** Factors external to the irrigation sector must be controlled to ensure the viability of new irrigation schemes, such as guaranteeing adequate communication and logistic infrastructure for the swift delivery of products, thus improving market accessibility. Provincial administrations should propose measures that generate incentives for greater efficiency in water use. The water rights system could be reinforced by, for instance, establishing taxes that cover negative externalities (pollution and overexploitation) or creating payments for water use (such as for the volume delivered) that would allow recovering the costs of administering the resource. Promoting more active exchange of experiences and good practices in the irrigation sector with more advanced provinces also recommended.

## Notes

1. Data from National Institute of Statistics and Census, 2020.
2. Average in the 2010–19 period.
3. Ministry of Agriculture, Livestock and Fisheries, 2017, https://www.magyp.gob.ar/datosabiertos/(accessed March 2021).
4. The estimate is based on hydropower representing 26 percent of total generation and electricity generation and distribution contributing 2.2 percent of added value (33 percent for generation and 66 percent for transmission). see the website at https://www.minem.gob.ar/servicios/archivos/6886/AS_14817236511.pdf, accessed March 2021.
5. 2018 values.
6. See World Bank (2021) for data and detail on the methodologies used, with its respective appendixes and references.
7. Coverage estimates correspond to 2018, based on data from the 2010 census and projections by department of National Institute of Statistics and Census (incorporating its latest adjustments—see Demographic Analysis Series No. 38), the Permanent Household Survey, and the Annual Survey of Urban Homes, also prepared by those agencies. At the time of publishing this report, sources from the Ministry of Public Works reported figures for 2021 of 4.3 and 14.6 million people without coverage for water and sanitation in urban areas (compared with the 5.5 and 17.3 in urban areas from this report).
8. The inadequate quality of service causes a 0.224 percent drop in aggregate sales of the sector. Total factor productivity is estimated to experience a similar impact in the productive sectors, excluding the primary sectors (agriculture and mining). This shock is used in the computable general equilibrium simulation.
9. According to results from the World Bank's applied structural macroeconometric model and the Faculty of Engineering of the Universidad Nacional de La Plata (UNLP)'s Cointegration Vector Model. Details in appendix B of the main report (World Bank 2021).
10. Update of the FAO and PROSAP (2015) study, with climate change scenarios analyzed in chapter 2 and appendix F of the main report (World Bank 2021).

11. See Coastal Risk Screening Tool database, Climate Central, 2019, at https://coastal.climatecentral.org/map, accessed March 2021.
12. Data as of 2018 based on the National Institute of Statistics and Census data: 2010 Census, Permanent Household Survey (EPH 2014/18) and Annual Survey of Urban Households (EAHU 2010/14).
13. HCI is a measure of a country's development potential. It combines five measures of human capital into a single index to quantify the contribution of health and education to the productivity of the next generation. The five measures are the percentage of stunting of children under age five, percentage of children surviving past age five, expected years of schooling by age 18, harmonized test scores, and percentage of 15 year olds who survive until age 60. See the HCI website at https://datacatalog.worldbank.org /dataset/human-capital-index, accessed March 2021.
14. World Bank data based on Global Forest Watch website, 2016, at https://www.globalforestwatch.org/, accessed March 2021 (World Bank 2016).
15. As indicated by the General Auditor of the Nation (AGN) and by assessments conducted under the PROSAP initiative in 2015.
16. Refers to interjurisdictional basin committees; guidelines for protecting and replenishing aquifers; standards for environmental and water quality; and development of the National Plan for preserving, developing, and using water judiciously. The entity of environmental policy coordination defined for this law is the Federal Environmental Council (COFEMA).
17. Foundational Letter of COHIFE ratified by Law 26,438/2008.
18. COHIFE is evaluating all water tariff policies across all provincial jurisdictions in order to assess the differences and support those that are less advanced.
19. World Bank estimation and analysis based on Center for Survey and Evaluation of Agricultural and Natural Resources (CREAN) data at www.crean.unc.edu.ar /monitoreo-de-sequias/.
20. See detailed data in World Bank (2021). Data informed by service providers in 2019.
21. Based on estimations of Fathom flooded area, at https://www.fathom.global/, and vulnerable neighborhoods based on the National Registry of Popular Neighborhoods (RENABAP) data, at www.argentina.gob.ar /desarrollosocial/renabap/mapa.
22. Water surpluses due to land use change systematically began to increase the water table (Andreucci, Conde, and Bollatti 2015; Bollatti, Andreucci, and Escolá 2015).
23. Radars are important elements to provide reliability to the forecast services. Argentina has today 11 weather radars and is about to incorporate 10 more.
24. Such important gaps in access to infrastructure and services within agglomerations are indicative of the unsustainability and high costs of the current urban expansion patterns, and they negatively affect livability (Muzzini et al. 2016).
25. Referred to the official service provider in a specific jurisdiction. In the case of GBA, this provider is AySA.
26. In addition, ERAS Resolution (10/2019) shows the magnitude of the problems of the "disengaged" neighborhoods (in terms of lack of direct link with the water networks of the operator; population included in these areas and issues related to maintenance of water quality; and efforts that the control entity and AySA must make to ensure the quality of the service).
27. Field scale hydraulic delivery efficiency.
28. See chapter 6 of the main report (World Bank 2021), with its respective appendixes and references.
29. The 2.7 percent results from effects of changes in factors of production calculated with the general equilibrium model and derived from the different impacts. Details in appendix B of the main report (World Bank 2021).
30. For instance, the National Meteorology Service (SMN), the National Water Institute (INA), the National Institute of Agricultural Technology (INTA), the Argentine Institute of Nivology, Glaciology and Environmental Sciences (IANIGLIA), research centers, and universities.
31. The National Water Plan is under revision by the current government to incorporate a federal approach.
32. Mostly by the private sector in agricultural areas. In addition, the National Commission for Space Activities (CONAE) has developed a new tool that provides essential information for planning and decision-making on agricultural land use. See the website at https://www.argentina.gob.ar/noticias/mapas-de -estatus-hidrico-elaborados-con-informacion-satelital.
33. More details in the annex to appendix B of the main report (World Bank 2021).
34. At the time of publishing this report the Ministry of Public Works prepared a new Federal Water and Sanitation Plan, including information on rural areas and schools, and also introducing formulas for prioritizing investments according to different levels of vulnerability.

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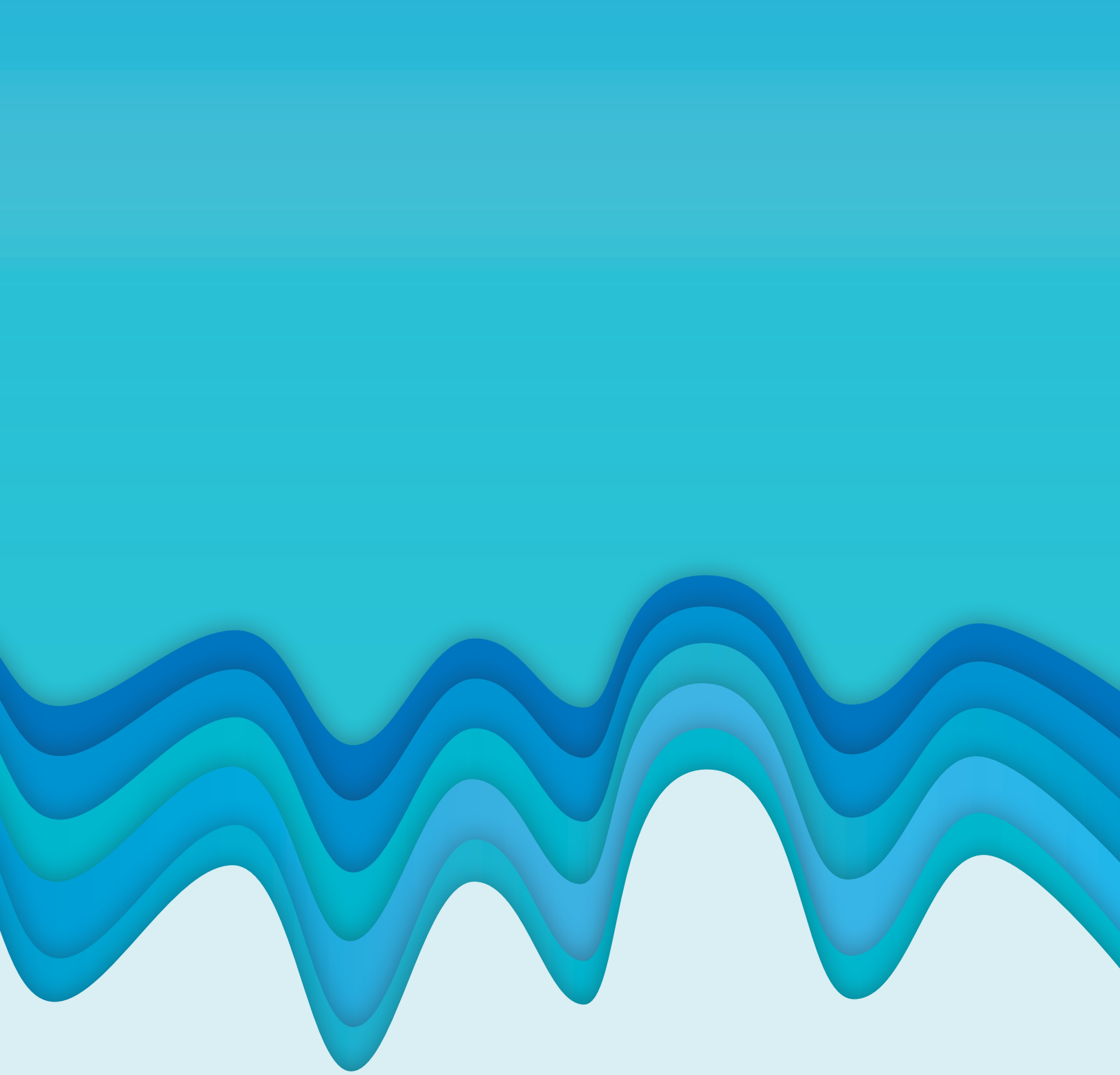

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