WATER GLOBAL PRACTICE

WASTEWATER?

Shifting Paradigms: From Waste to Resource

Preliminary Insights for the Latin America and Caribbean Region for the World Water Forum 2018

MARCH 2018

Public Disclosure Authorized

Innovation, Significant Financial Investments, and Paradigm Shifts Are Necessary to Achieve the Sustainable Development Goal for Water in the Latin America and Caribbean Region

Historically, countries in Latin America and the Caribbean have prioritized investments in water supply, achieving good coverage in the past years. Around 96 percent of households have access to an improved source of drinking water, although this average hides the gap between rural (86 percent) and urban (99 percent) coverage (WHO and UNICEF 2017) and the provision of a suitable level of service. Around 86 percent of the region's population has access to some form of basic sanitation, with an important difference between rural (68 percent) and urban (90 percent) areas (WHO and UNICEF 2017). However, it is estimated that only about 60 percent of the population is connected to a sewage system (14 percent in rural and 72 percent in urban areas) (WHO and UNICEF 2017), and only about 40 percent of the region's wastewater is treated (FAO 2017)—a low percentage for the region's levels of income and urbanization—with significant implications for public health and environmental sustainability.[1] Figure 1 and figure 2 show sewage connections and wastewater treatment for several countries in the region compared to OECD averages. Wastewater management and treatment levels vary significantly through countries in Latin America and the Caribbean and the regional averages mask this significant variation. In some countries, such as Chile, virtually all wastewater in urban areas is collected and treated, but in others, such as Costa Rica, wastewater treatment is almost nonexistent. Now the region is implementing massive programs to collect and treat its wastewater.

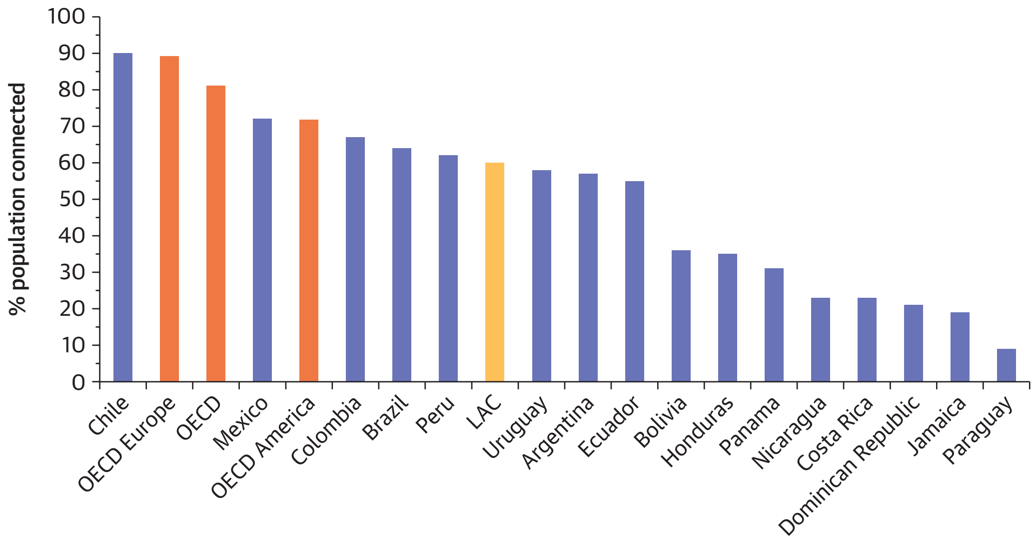
The Development Bank of Latin America (CAF) estimates that over the period 2010-30, US$80 billion

MAIN MESSAGES

- **Innovation, significant financial investments, and paradigm shifts are necessary to achieve the Sustainable Development Goal for water in the Latin America and the Caribbean region.**
- **A paradigm shift is needed in the region regarding wastewater planning, management, and financing at the regional and project levels toward a circular economy in which wastewater is considered a valuable resource rather than a liability.**
- **A complete life cycle analysis that covers financial, environmental (including climate), and social aspects must be used to assess and evaluate wastewater treatment plants.**
- **Wastewater initiatives should be developed as part of a basin planning framework to maximize benefits, resources allocation, and stakeholder engagement.**
- **For this paradigm shift to happen the region needs to focus on adequate legislation, intersectoral regulation, policies, and incentives to promote resource recovery.**

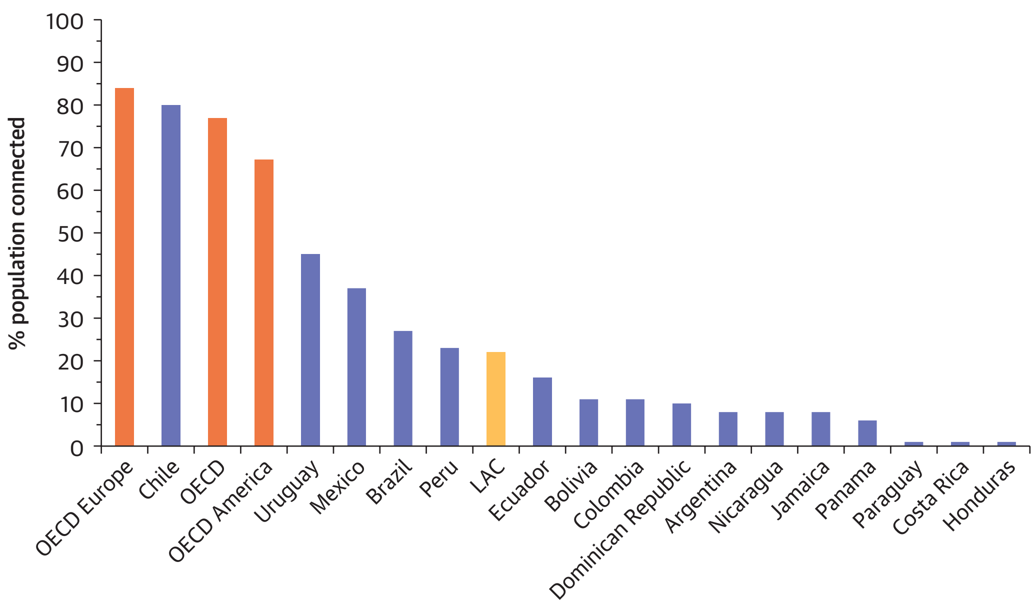
WORLD BANK GROUP

FIGURE 1. **Sewerage Network for Selected Countries, 2015**



Sources: OECD data 2015; WHO and UNICEF 2017.
Note: OECD = Organisation for Economic Co-operation and Development; LAC = Latin America and the Caribbean.

FIGURE 2. **Wastewater Treatment for Selected Countries, 2015**



Sources: OECD data 2015; WHO and UNICEF 2017.
Note: OECD = Organisation for Economic Co-operation and Development; LAC = Latin America and the Caribbean.

should be spent on sewerage infrastructure and US$33 billion on wastewater treatment in the region. In addition to the substantial investment costs, operation and maintenance costs are very high and often neglected in many countries in the region.

Given these infrastructure financing needs, the public sector alone cannot provide enough funding to satisfy the increasing demand for services. Private capital must be involved to close the gap. Private investors are, however, usually reluctant to invest in water infrastructure projects because of the risks involved such as a long pay-off period, low tariffs, lumpy investments, and the sunken nature of the investment. There is a need for an environment that enables private investment in infrastructure in tandem with improved efficiency of public financing to promote sustainable service delivery, especially in the poorest countries. To create this environment, countries need to strengthen their institutional capacity to translate investments into service assets and promote a favorable regulatory environment to streamline project development processes and attract investment in the sector.

A Paradigm Shift Is Needed in the Region Regarding Wastewater Planning, Management, and Financing at Different Levels

Regional or Country Level

Moving from ad-hoc and isolated wastewater solutions, such as one treatment plant per municipality, to integrated river basin planning approaches that incorporate climate variables and yield sustainable and resilient systems

Basin planning is a coordinating framework for water resources management that focuses public and private sector efforts to address the highest priority problems within hydrologically-defined geographic areas, taking into consideration all sources of water. By planning and analyzing water quality and quantity at the basin level, integrated solutions that are more financially, socially, economically, and environmentally sustainable are possible. Basin planning allows the identification of the optimal deployment of facilities and sanitation programs including the location, timing, and phasing of treatment infrastructure. It also enables decision makers to set priorities for investment planning and action. This planning approach moves away from uniform or arbitrary water pollution control standards to one in which investments are better matched to both local environmental needs and resources. Basin planning involves a strategic mapping of a water body, the identification of critical areas and their respective water quality objectives (set based on desirable use of such areas: recreational, non-contact sports, drinking water source, etc.), the identification of cost-effective priorities for water pollution control interventions to improve environmental quality, as well as the definition of a process for prioritizing investment opportunities and trade-offs of the different options considered. This analysis is important for both environmental effectiveness and management efficiency to ensure the best use of limited resources. It also shifts the evaluation of projects from primarily cost focused to a benefit-cost analysis that compares the cost with economic benefits from a wide range of environmental and social improvements. Basin planning is, therefore, an iterative process that allows decision makers to move from the traditional approach of being reactive to a serious environmental problem to a proactive approach to manage available resources in any given basin through a structured progressive approach.

In contrast, wastewater infrastructure projects driven by political, social, and other non-scientific albeit powerful factors do not lead to the best use of funds and resources. The basin should be the starting planning unit for wastewater treatment because it steers away from ad hoc and isolated wastewater solutions, moving toward integrated regional planning. There must be a proper incorporation of urban development, solid waste and sanitation plans, hygiene education, climate change awareness, pollution control efforts, and other productive uses of water as part of the planning efforts. This means that environmental ministries or organizations in charge of environmental standards, basin management organizations, municipalities, city councils, and water utilities need to coordinate their plans and actions to ensure that all regulations can be met while the most cost-effective and sustainable outcome can be achieved. A current challenge in the region is an excessive emphasis on new infrastructure without considering the sustainability of the system (e.g., operational and maintenance costs coverage) or evaluating the existing infrastructure capacity. This could be minimized by an ex-ante evaluation of current infrastructure's actual capacity, with system optimization as a key objective. To achieve these goals, current basin planning efforts in the region need to be strengthened: governments need to support basin organizations so they can improve their technical expertise and exert oversight powers to enforce the implementation of basin plans. Additionally, interventions prioritized in basin plans should be aligned to municipal and regional priorities.

Moving from stringent imported environmental standards to locally contextualized regulations and legislation that are based on river basin analysis and promote resource recovery

Many Latin American and Caribbean countries have adopted legislation and environmental standards developed in high-income countries that have strong institutional and technical capacity and high financial support from both government and users and adequate tariff structures. Often such legislation is designed without considering the economic implications of their implementation (needed institutional capacity, capital expenditures [CapEx], or operation and maintenance costs [OpEx]) and imposes standards that are unrealistic and unaffordable. For example, in Cordoba, Argentina, legislation implemented in 2015 requires wastewater being discharged into a lake to never exceed specific concentrations of pollutants, which leads to an average design effluent value that few wastewater treatment plants (WWTPs) in the world even meet today. The CapEx and OpEx implications of meeting this legislation at a new WWTP for the city of Cordoba far exceed the municipality's financing and institutional capacity. Appropriate limits must be decided based on the basin characteristics, water uses, and options for reuse. Ideally, limits at the point of source should be set on seasonal averages of concentrations (as opposed to a "never to be exceeded" limit). There must also be coordination between separate legislation, and the wastewater effluent quality standards must match the legislation for water quality in receiving water bodies. This can be achieved using the above-mentioned basin planning approach. As exemplified in numerous cases in the Region, when setting WWTP effluent limits, it is important to do a cost-benefit analysis. If the cost (CapEx and OpEx) to meet those standards is too high compared to the benefits to be achieved, then the limits must be reconsidered and adapted accordingly.

The vast majority of the existing legislation in Latin America and the Caribbean was created with the sole purpose of meeting environmental standards. However, the changes in the sector call for new legislation and regulation that embrace and promote gradual resource recovery. Resource recovery (i.e., water reuse, bioenergy generation, beneficial use of biosolids[2]) is key to the sustainability of WWT systems. Latin America and the Caribbean has numerous examples of legislation limiting or forbidding resource recovery. For instance, in some countries WWTP sludge is considered a hazardous waste, which has to be disposed in a confined cell, within a sanitary landfill. Not only does this regulation eliminate the opportunity to take advantage of nutrient-rich biosolids for agricultural and forestry use, or for soil recovery, but it also imposes an additional financial burden on the water utility. There are numerous examples of governments who want to promote wastewater reuse for agriculture but impose very stringent regulations that force the WWTP to remove most of the phosphorous content, which is beneficial for agriculture uses. In the case of electricity generation from biogas from WWTPs, selling the electricity generated at the plant to the grid, or transporting this electricity to another point to be used by the water utility is not always permitted by regulations and seldom promoted. This is the case of SAGUAPAC, the water utility of Santa Cruz de la Sierra, Bolivia, which has anaerobic lagoons for wastewater treatment. These lagoons generate enough biogas that when converted into electricity would cover a large percentage of the utility's power demand. However, the transportation of this electricity to the points of use outside the WWTP is not permitted by current regulations. This results in biogas being burned at the WWTP without any other beneficial use except the significant reduction in greenhouse gas emissions (CO_2 resulting from biogas combustion has 21 times less greenhouse gas potential than the CH_4 contained in the biogas).

Changing from stable and rigid assumptions related to wastewater treatment planning to instead consider potential future environmental and system changes, while allowing for incremental growth of wastewater treatment facilities

There is a lack of policy and regulatory mechanisms that promote the gradual improvement in the wastewater treatment sector. In most countries in the region, regulation is binding from the day of its passage, with no intermediate and incremental steps to enable its compliance. Without these gradual improvements, CapEx and OpEx can become prohibitive, thereby technically preventing any type of change. Instead, regulations could offer a progressive path that would allow utilities to gradually implement lower-cost solutions for wastewater treatment followed by upgrades to more advanced technologies as and when financial resources allow. As a first step, affordable treatment systems can positively impact the environment (e.g., receiving water body quality) and public health (e.g., food safety), and, progressively, utilities can move toward expanded sewerage systems and more robust treatment technologies as financial and operational capacity grows.

Traditional planning and project design use unchanging assumptions that lead to rigid designs with no room to cope with uncertainty and dynamic changes in the future. Traditional design is based on well-known load forecasting procedures; however, the underlying assumption is that the conditions surrounding the facilities will be steady, stable and predictable. This assumption is rarely the reality due to dynamic conditions of the service area, available technology, climate change, and the institutional framework, among other factors—all of which affect the operation of facilities.

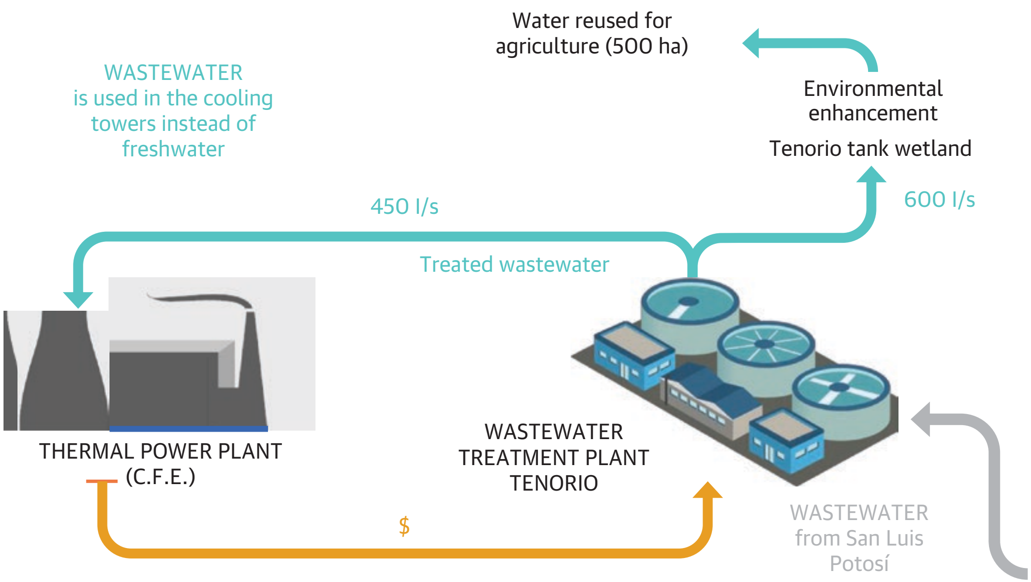
Project Level

Changing the region's perspective of 'wastewater treatment plants' to 'water resource recovery facilities,'[3] *recognizing the inherit value of water to be treated*

The practice of wastewater treatment continues to evolve, not only technologically but functionally as well. Traditionally, treatment focused on removing contaminants and pathogens to recover water and safely discharge it to the environment. Today's view is that WWTPs are instead water resource recovery facilities (WRRFs). This comes with the realization that many components in wastewater can be recovered for beneficial purposes, starting with the water itself (for agriculture, industry, and even human consumption), followed by nutrients (nitrogen and phosphorus) and energy generation. The region needs to acknowledge wastewater's potential and value. In fact, the expected demographic growth and the urbanization of the region make wastewater one of the only water resources whose availability will increase in the next years. Given the opportunity, recovered water can be fully incorporated in the water balance already inside the urban areas (less transportation of water, which incur major CapEx and OpEx).

Improved wastewater management offers a double value proposition if, in addition to the environmental and health benefits of wastewater treatment, financial returns are also possible that cover partially or all operations and maintenance (O&M) costs. Resource recovery from these facilities in the form of energy, nutrients, reusable water, and biosolids represent an economic and financial benefit that contributes to the sustainability of these systems and the water utilities

FIGURE 3. Tenorio Project: Wastewater Reuse in San Luis Potosí



Source: World Bank design using data from Rojas, Equihua, and Gonzalez 2012.
Note: Treatment plant image is by Tracey Saxby, Integration and Application Network, University of Maryland Center for Environmental Science (ian.umces.edu/imagelibrary/). CFE = Comisión Federal de Electricidad (Federal Electricity Commission).

operating them. For example, in Mexico, new water reuse regulations and a creative project contract incentivized wastewater reuse in San Luis Potosí. Instead of using fresh water, a power plant uses treated effluent from a nearby WWTP in its cooling towers (see figure 3). This wastewater is 33% cheaper for the power plant than groundwater, and this has resulted in savings of US$18 million for the power utility in 6 years. For the water utility, this extra revenue covers almost all operation and maintenance costs of the WWTP. The remaining wastewater is used for agricultural purposes. In addition, the reuse scheme of San Luis Potosí has reduced groundwater extractions by 48 million cubic meters in 6 years (equivalent to the water consumed by 110,000 people in the same period). Wastewater resource recovery is being implemented in many countries around the world, but this is usually done in an ad-hoc basis and is not part of a long-term national strategy or policy. The region needs to focus on the institutional, regulatory, and policy frameworks that incentivize these schemes and approaches. There is a need to move from linear to circular thinking in the sector.

Moving from traditional to innovative financing and business models that consider the long-term operation and management of assets, in addition to taking advantage of the potential for resource recovery in WWTPs

Financing (including efficient public spending) and cost recovery for sanitation infrastructure is a challenge throughout the region. Many utilities do not have adequate tariffs for sanitation, and where such charges exist they are usually insufficient to finance operation and maintenance costs, not to mention capital nor future expansion costs. This problem is particularly acute in countries that embark on ambitious investment programs to increase the coverage of wastewater treatment, like the ones needed in Latin America and the Caribbean to meet the SDGs. Hence, there is considerable agreement that more efficient subsidies are needed for sanitation, at least during a transition period. The challenge is to devise programs to channel these subsidies, while promoting efficiency and operational and environmental sustainability.

The existence of subsidies, however, does not mean that the sector has to rely on conventional financing without taking advantage of market conditions and incentives to enhance sustainability. Given the potential for resource recovery in WWTPs, the sector should pursue innovative financial and business models that leverage those potential extra revenue streams. One option is the development of financial incentives for operators to perform along the same philosophical lines as results-based financing. A good example of this is PRODES in Brazil, a federal program which did not directly invest in the capital costs of wastewater treatment infrastructure. PRODES, instead, paid the operator for the delivery of specified volumes of treated wastewater at specified levels of quality after the investment was operational. Such an approach has many advantages, not least of which is the incentive for effective operation and maintenance and improved public subsidies. There are also examples of blended financing, successful public-private partnerships (PPPs), and innovative contract and partnership models that ensure a stable revenue stream for the WWTP and therefore enable access to finance. Examples of innovative projects that build stable revenue streams include selling treated wastewater (as in the case of San Luis Potosí, Mexico or Durban, South Africa), selling energy (as in the case of biogas sales by Aguas Andinas to Metrogas, in Santiago de Chile), using bioenergy in the WWTPs (as in the case of Ridgewood, USA), and the beneficial use of biosolids, among others. Another option could be to capitalize on the potential land value capture increase that wastewater treatment can provide to nearby and downstream areas given the improvements in water quality and the environment.

Focus Areas For This Paradigm Shift to Happen in the Region

Adequate Legislation

Minimum standards for effluent quality can be set for an entire country, as is the case of blanket-type legislation in several countries in Latin America and the Caribbean. However, such legislation must be evaluated considering the costs of implementation. Establishing tough effluent standards just to match or copy those used in developed countries negatively impacts the environment by forcing countries to spend too much in a small number of plants, leaving other sources of contamination untreated.

Legislation must be consistent: whenever possible, WWTP effluent requirements must be adapted based on current and future water user's needs and objectives and improvement considerations for the receiving water body. In such cases, effluent limits should be based on total maximum daily loads (TMDLs) acceptable by the water body in question in a defined timeframe feasible for implementation (average mass of pollutant discharged per day, kg/d). For cases where maximum loads to a specific water body cannot be established, legislation for both plant effluent and water bodies must be consistent. Gradual application of WWTP effluent quality standards (whether maximum concentrations or loads) should be permitted so that targets are realistic. Switching from no treatment to state of the art technologies to meet stringent limits can have costs that well exceed the capacity of the responsible utilities and might never be met. Therefore, the implementation of gradually increasing levels of treatment (preliminary, primary, secondary, etc.) must be regulated. Legislation and regulations should also allow for flexible and innovative financing (efficient public spending with incentives, results-based financing, innovative contracts, private sector involvement, etc.). It is important to note that adequate legislation alone is not sufficient—strong enforcement agencies and clear enforcement mechanisms are also required.

Intersectoral Regulation, Policies, and Incentives to Promote Resource Recovery

Legislation, regulatory measures, policies, and incentives must be adjusted, developed, and implemented to promote resource recovery at WWTPs in coordination with other sectors. Water-sector-only initiatives may not permit water reuse or the use of biosolids as fertilizer if health and agricultural policies are not properly aligned. Revenue from bioenergy generation may not be possible if the electricity sector or regulator does not have any incentive to foster the use, purchase, and/or transport of electricity generated from biogas at WWTPs. The water-energy-food nexus must be studied and understood at the basin level. Only such an understanding will adequately provide the positive reinforcement needed for combined policies and regulatory actions.

Basin Planning Framework

Wastewater initiatives should be developed as part of a basin planning framework to maximize benefits, resources allocation, and stakeholder engagement.

Basin planning is an effective tool to understand water quantity and quality requirements from different water users. Basin planning allows the integration of benefits and impacts of the proposed interventions in multiple sectors, enabling the incorporation of climate change risks and socio-environmental considerations. Most recent basin planning methodologies are based on strong participatory mechanisms that contribute to multi-level stakeholder engagement, resulting in a reduction of water-related conflicts and the improvement project sustainability. Projects developed using this approach promote resource optimization and efficiency gains and maximize economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems. As such, projects with an integrated basin approach should be given a higher priority.

Financial, Environmental, and Social Considerations in Wastewater Treatment Plant Evaluations

A complete life cycle analysis that covers financial, environmental (including climate), and social aspects must be used to assess and evaluate wastewater treatment plants. Sources of funding for O&M of WWTPs must be considered and guaranteed prior to initiating new plants, expansions, and/or upgrades. When funding for O&M is insufficient, lower-cost technologies must be evaluated, at least as an initial stage in the program. The contribution of the plant to the environment should be seen not only as an improvement of the water quality in the receiving water body, but also as an environmental benefit associated with water reuse (e.g., substitution of alternative water sources), energy generation from biogas (e.g., climate change mitigation and adaptation), and beneficial use of biosolids as fertilizers (e.g., substitution of synthetic fertilizers, which contribute to pollution). Also, positive social implications of the facility should be considered for the whole cycle—for example, jobs generated by the construction and O&M of the plant; an increase in the value of properties through improvement of the receiving water body; adequate alternative water source to farmers when reuse is implemented; low-cost, valuable fertilizers to farmers when a biosolids program is in place; improved health in the population from better quality in nearby water bodies. Tariffs for wastewater can then be approved and justified based on such a life-cycle analysis. OpEx can be covered through those tariffs and through the extra revenue from the sale of recovered resources (treated wastewater, energy, biosolids, etc.).

To rise to the wastewater challenge in the region and promote a paradigm shift, the World Bank, together with CAF and other partners, is embarking on a new initiative: "Wastewater: From Waste to Resource." The initiative promotes a paradigm shift in Latin America and the Caribbean toward circular economy investments in the sector in which wastewater is considered an asset and a resource rather than a liability. The activity will provide guidance on improved strategies for the planning and financing of wastewater treatment and resources recovery by exploring, analyzing, and exemplifying all the above-mentioned issues and will seek to improve current practice in terms of environmental effectiveness, economic efficiency, and financial and institutional practicality and sustainability.

Basic Guidelines for Financing Wastewater Treatment Plants

When financing wastewater treatment plants (WWTPs), priority must be given to projects that meet all or most of the following criteria:

1. Are part of a basin approach or Integrated Water Resources Management (IWRM) program and adequately prioritized within such program.
2. Have adequately analyzed life-cycle costs, including life-cycle evaluations of environmental, social, and financial aspects.
3. Can cover OpEx with approved tariffs and/or from innovative business models, such as income from sale of water for reuse, biosolids and/or energy generated by the facility (through biogas or hydropower).
4. Use clear effluent limits based on either receiving water body loading criteria (best option) or regulatory requirements based on scientifically/economically sound legislation. Projects may meet effluent criteria gradually (i.e., in stages).
5. Propose technologies adequate for the specific application and have unit costs (US$/p.e.) within a range observed in the country or region.
6. Promote resource recovery (e.g., water reuse, biosolids beneficial use, and/or energy generation from biogas or through hydropower) in a sustainable way.
7. Use industrial discharges identified through adequate monitoring and control systems. Either industries will pay for their treatment (e.g., $/kg of COD treated), or industries will reduce their discharges to previously agreed-upon concentrations by in-house treatment.
8. Incorporate private sector participation, while separating functions of regulation and control (in hands of the government) and O&M (in hands of the private operator). The project must clearly indicate how the private sector will contribute to the sustainability of the project.
9. Contribute to the development of the sector by assisting in the training of government employees, local university students, operators from government-run utilities, and other professionals in the region who can gain from the experience.
10. Have climate resilience considerations built in and/or contribute to climate change mitigation.
11. Have a measurable contribution to the Sustainable Development Goals.

A weighted system to give higher or lower priority to some of these criteria could be proposed. However, such a system should have weights assigned based on local conditions rather than a blanket-type approach for all projects. A considerable level of complexity could be added the proposed criteria. However, as in most evaluations, the simpler the rules (or the criteria), the more applicable they are.

Notes

1. "...whilst substantial benefits can be realized from providing access to water, sanitation and hygiene, there may also be some 'disbenefits' along the way, depending on the sequencing of investments (for example, if access to water is provided without simultaneous access to sanitation) ... In many countries, there is an initial focus on investing in providing access to drinking water. However, even if such investments have benefits, they can also have disbenefits as the volume of untreated wastewater discharged in the local environment increases, thereby increasing the amount of dirty water lying around (with increased risks of spreading diseases such as malaria via insects breeding in pools of dirty water), spreading the risk of epidemics and contaminating groundwater" (OECD 2011).
2. Biosolid is sludge from WWTPs treated to a level such that it can have beneficial uses and/or safe disposal.
3. *Water resource recovery facility* is a term promoted by the Water Environment Federation, among several other professional associations and academic institutions, in lieu of *wastewater treatment plant*. The change reflects the paradigm shift that recognizes the inherit value of water to be treated.

Bibliography

CAF (Development Bank of Latin America). 2012. *Agua Potable y Saneamiento en América Latina y el Caribe: Metas Realistas y Soluciones Sostenibles* [Drinking Water and Sanitation in Latin America and the Caribbean: Realistic Goals and Sustainable Solutions]. Caracas, Venezuela: CAF.

Corbin, C. 2014. "Value Added. Public-Private Partnership Brings Cost Savings, Energy Efficiency to New Jersey Plant." *Water and Wastes Digest*, February 13. https://www.wwdmag.com/energy-efficiency/value-added.

FAO (Food and Agriculture Organization). 2017. *Reutilización de aguas para agricultura en América Latina y el Caribe: Estado, Principios y Necesidades*. FAO, Washington, DC.

Gisclon, A., S. McCarley, and K. McNally. 2002. "The Durban Water Recycling Project—The Vision Becomes Reality." Paper presented at the Biennial conference of the Water Institute of Southern Africa (WISA), Durban, South Africa, May 19-23.

Lackey, Katy, and Lauren Fillmore. 2017. "Energy Management for Water Utilities in Latin America and the Caribbean: Exploring Energy Efficiency and Energy Recovery Potential in Wastewater Treatment Plants." World Bank, Washington, DC.

Nazareth, P. 2014. "PRODES (Programa Despolución de Cuencas Hidrograficas de la Agencia Nacional de Aguas)—Agência Nacional de Águas (ANA), Brasil." Presented at ANEAS Mérida, Yucatán, November 10.

Nolasco, D. 2014. "Electricity Use and Potential Generation at Wastewater Treatment Utilities—The Case of Santa Cruz de la Sierra, Bolivia." Presented at the Energy for Water Workshop organized by the King Abdullah Petroleum Studies and Research Center (KAPSARC), Paris, September 15.

OECD. 2011. *Benefits of Investing in Water and Sanitation: An OECD Perspective*. Paris: OECD.

Rojas, Alberto, Lucina Equihua, and Fernando Gonzalez. 2012. "Tenorio Project: A Successful Story of Sustainable Development." In *2012 Guidelines for Water Reuse*, produced by the U.S. Environmental Protection Agency (EPA). Washington, DC: EPA. https://www3.epa.gov/region1/npdes/merrimackstation/pdfs/ar/AR-1530.pdf.

WHO (World Health Organization) and UNICEF (United Nations Children's Fund). 2017. *Progress on Drinking Water, Sanitation and Hygiene: 2017 Update and SDG Baselines*. Geneva: WHO and UNICEF.

World Bank. 2014. "Applying Results-Based Financing in Water Investments." Water Papers 89326. World Bank, Washington, DC.

——. 2015. "Wastewater to Energy: A Technical Note for Utility Managers in EAP Countries." World Bank, Washington, DC.

——. 2017. *Rethinking Infrastructure in Latin America and the Caribbean Spending Better to Achieve More*. Washington, DC: World Bank.

PPIAF
Enabling Infrastructure Investment

GWSP
GLOBAL WATER SECURITY & SANITATION PARTNERSHIP

WORLD BANK GROUP

SKU W17090