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A Shared Vision for the Cutzamala System

A Model Basin in Water Management

CONAGUA
COMISIÓN NACIONAL DEL AGUA

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WORLD BANK GROUP

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Technical Cooperation between Mexico's National Water Commission (CONAGUA), the Basin Agency for the Valley of Mexico (OCAVM), the Engineering Institute of the National Autonomous University of Mexico (UNAM), the Mexican Institute for Water Technology (IMTA), and The World Bank

The Cutzamala System: A Dynamic Interaction between Human Activities and the Environment

The Cutzamala System is a complex inter-basin transfer built in three stages, from the late 1970s to 1994, to supply water from the Cutzamala River to the Mexico City Metropolitan Area ("MCMA") and to the Valley of Toluca Metropolitan Area ("Toluca"). The transfer elevates the fluid more than 1,100 meters in elevation difference for its final use as drinking water, relying on seven reservoirs, six pumping plants, 322 kilometers of canals and tunnels, and a large water treatment plant, 'Los Berros'. This infrastructure is vital to the lives of millions of Mexicans in those two large metropolitan areas. At the same time, however, the System is located in a social and physical space where the lives of thousands of inhabitants unfold in more than one thousand rural towns and several larger cities in the headwater sub-basins of the Cutzamala River, located in the States of Mexico and Michoacán. These mountainous sub-basins are naturally forested and are home to a collection of rivers and springs whose water is used for diverse purposes. The water volume produced in these sub-basins is currently sufficient to support the livelihood of the populations living there and to partially meet the needs of the people living in the two metropolitan areas. That being said, a more sustainable use of the natural resource is fundamental for the region of the sub-basins, Toluca, and MCMA.

Today, the System's and the region's sustainability are at risk, a problem perceptible in numerous ways and often sharpened by the discrepancies in the information that is readily available for stakeholders who possess divergent perceptions of the current situation of the area, its natural resources, and its future. Conflicts in the region have historically existed and persist. The resolution to these conflicts must consider the communities' legitimate concerns and expectations about their interactions with the environment, principally water availability and use. From time to time, these conflicts tend to heighten as a result of institutional inefficiencies and the absence of appropriate instances for negotiation and collaboration in the various communities that exist in these sub-basins.

Three decades after the initial operation of the Cutzamala System, it is imperative to revisit and rebuild the view that society and the relevant institutions have about the water-transfer infrastructure, its geographical spread, and the populations and economic activities in its sub-basins, understanding that these three realities are interwoven and thus, inseparable. Such is the starting point of an indispensable dialogue and social collaboration aimed at long-term sustainability.

Mexico City Metropolitan Area, Valley of Toluca Metropolitan Area, and the Communities in Tuxpan, El Bosque, Villa Victoria, Valle de Bravo, Ixtapan del Oro, and Chilesdo-Colorines Sub-basins

The Cutzamala System is one of the most significant engineering works in the country, providing nearly 15 cubic meters of water per second to meet the daily needs of an estimated 5 million urban citizens. Its main aqueduct conducts one of the largest flows and pumping loads in the world, a source of pride for Mexico's engineering community. Figures 1 and 2 show, respectively, the inter-basin transfer connecting the State of Michoacán, the State of Mexico, and the Federal District, as well as the 1,100 elevation difference that must be overcome in order to deliver bulk water to the country's capital. Together, the six sub-basins, Tuxpan, El Bosque, Villa Victoria, Valle de Bravo, Ixtapan del Oro, and Chilesdo-Colorines, constitute one artificial basin that gives life and origin to the System, to the water it transfers, and to the benefits derived from its service.

Mexico City and Toluca Metropolitan Areas

With a population approaching 21 million people, MCMA is considered the most populated urban center in Latin America. The water supply to this region, which accounts for an estimated 38% of Mexico's GDP, is complex, having evolved over centuries since its days as the former Tenochtitlan, the capital city of the Aztec Empire, in order to keep pace with the demands of a growing population. Today, it receives its freshwater from three principal sources. These include groundwater aquifers, which account for approximately 68% of the total freshwater supply, the Lerma System (8%), and the Cutzamala System (24%). Toluca Metropolitan Area, on the other hand, boasts a population of approximately 1.9 million people and receives 0.8 cubic meters of water supplied by the Cutzamala System.

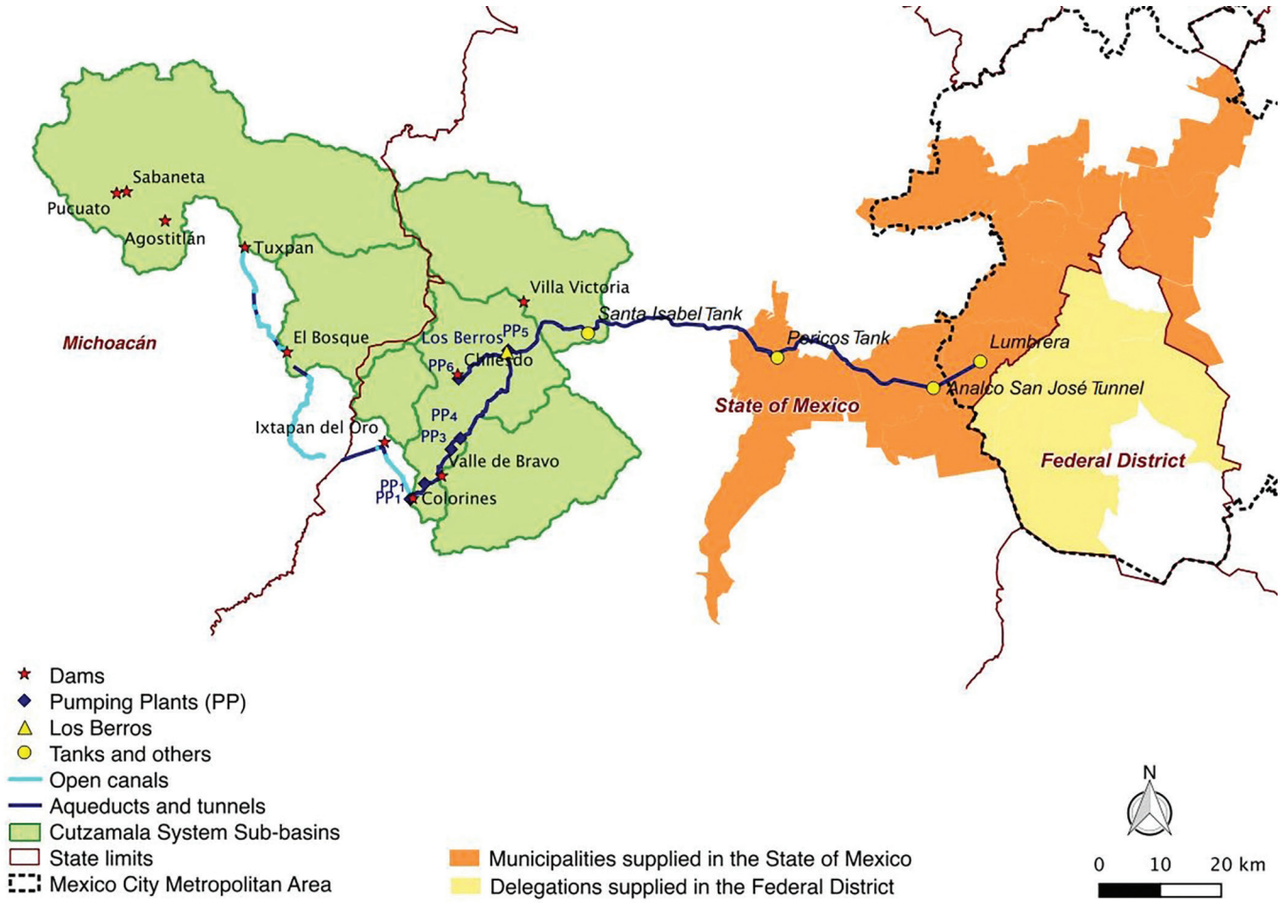
Communities in Six Sub-basins

Similarly and of equal importance, the population living within the six sub-basins of the Cutzamala System has ascended from approximately 367,000 inhabitants in 1970 to 723,000 in 2010. By 2030, this population is projected to reach just short of one million people. The rising population in Toluca, MCMA and in the Cutzamala System's water-producing basin coupled with an increase in a variety of economic activities, shed light on the evolving importance of the water for the population in the sub-basins and for the millions of Mexicans in the two metropolitan areas.

A Model Basin: Collaboration between CONAGUA, OCAVM, UNAM, IMTA and The World Bank

Over the last 30 years, the Cutzamala System and the environment under which it operates have drastically changed. The population of Greater Mexico City has integrated roughly 7 million additional inhabitants in the same thirty years, the size of the population of

Figure 1:



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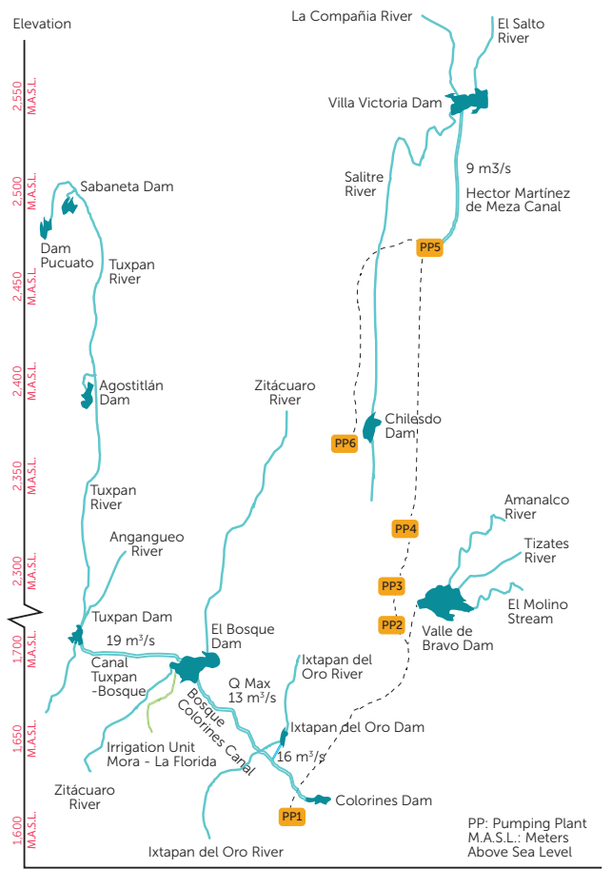


Hong Kong. Despite the extra water supply generated by the Cutzamala System, the water availability per capita in the MCMA remains the lowest in the country and continues to decrease: from 190 m³/capita year to 160 m3/capita year over the past ten years.

In 2013, in response to these evolving conditions, the Basin Agency for the Valley of Mexico (OCAVM), the entity responsible for the operation of the Cutzamala System's infrastructure, proposed a technical cooperation project with UNAM, IMTA, and The World Bank to Mexico's National Water Commission (CONAGUA). Its principal objective is the creation of an integrated basin management plan with corresponding investments and institutional reforms that focus on natural resources management, rural livelihoods, and infrastructure management, based on the principles of integrated water resources management (IWRM) and sustainable development of codependent natural resources, namely, soil, forest, air and biodiversity.

This basin management plan will be built from a shared vision of the System's infrastructure, the services it provides, and the water availability for the populations in the sub-basins and their respective livelihoods and aspirations.

Such a vision, which is to be attained through an inclusive and participatory process, would act as an umbrella for a series of plans and investments at different levels, whose interaction and coordination would be fostered by institutional innovation and improved communication.

CONAGUA-OCAVM hired the Engineering Institute of the National Autonomous University of Mexico (UNAM), the Mexican Institute for Water Technology (IMTA) and The World Bank to provide analytical and advisory services. The World Bank's support was requested, in large part, due to its vast experience in approaching the complexity of large inter-basin transfers. This global experience is complemented by the renowned capacity and experience offered by the UNAM and IMTA.

The project builds on the extensive knowledge of these three institutions and on their personnel, some of whom have participated in similar endeavors such as Mexico's 1975 National Hydraulic Plan, an IWRM plan that continues to be regarded as one of the most successful and pioneering efforts of its nature at a global scale. Since the commencement of the technical cooperation, CONAGUA and OCAVM have also received support from the Balsas Basin Agency (OCB), National Association of Water and Sanitation Suppliers (ANEAS), State of Mexico Water Commission (CAEM), Mexico City Water Systems (SACMEX), the National Forestry Commission (CONAFOR), College of Mexico for National Resources (COLMERN), and Mexico's National Institute for Ecology and Climate Change (INECC). Civil Society and user organizations have also partaken in the technical cooperation including the Basin Council for the Valley of Mexico, Valle de Bravo-Amanalco Basin Commission, Villa Victoria-San José del Rincón Basin Commission, Valle de Bravo Pro Cuenca Fund, A.C., and Board of Provalle, A.C.

Technical Cooperation

The technical cooperation between CONAGUA and The World Bank will last two years and will consist of five main components that culminate in the basin management plan mentioned above. Through these five components, the cooperation aims to attract the best national and international experience in integrated water resources management and sustainable development. Knowledge exchange opportunities will be promoted at an international level such as the 7th Annual World Water Forum in Korea, the Annual Latin America Water Week, and through technical Study Tours to other parts of the world. Further, CONAGUA and OCAVM have also expressed their interest in hosting a global learning seminar gathering water practitioners from various large metropolitan areas with similar challenges in order to share response strategies to address the challenges faced by the Cutzamala System.

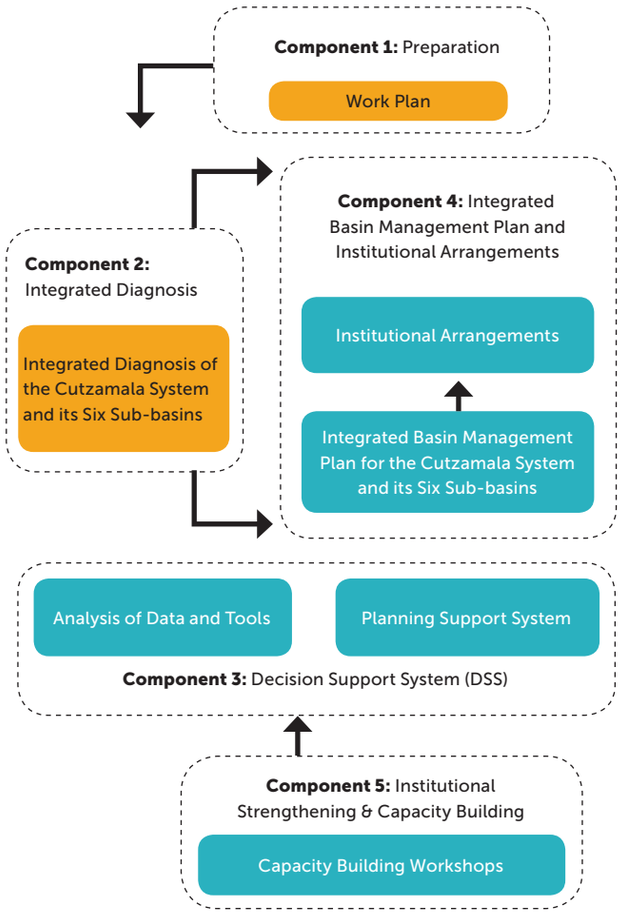
Components

The technical cooperation consists of the following five components divided into two phases:

- **Phase 1:**
  1. Preparation: The first component is the development of a comprehensive Work Plan detailing the approach of the collaboration between CONAGUA-OCAVM and The World Bank.
  2. Integrated Diagnosis: The objective of the diagnosis is to obtain a multidisciplinary overview of the current situation by using the existing information and knowledge about the Cutzamala System. The diagnosis, once validated and disseminated, will provide a reliable knowledge basis for further analysis by concerned stakeholders and communities and for the formulation of the Cutzamala System management plan.

- **Phase 2:**
  3. Decision Support System: A Decision Support System (DSS) will be developed with the stakeholders involved in the elaboration of the Integrated Basin Management Plan to help assess the current and future state of the Cutzamala

Figure 3:

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System and its water producing sub-basins. This will cover the 'business as usual' situation, as well as scenarios of change in infrastructure, soil use, population dynamics, climate change and variability, and operation and management practices among other issues. The DSS is intended to support all levels of decision-making, including local communities, with better and more accessible information and to nurture planning processes that empower actors to voice their ideas, concerns, and initiatives, in order to engage more directly with the authorities.

4. Integrated Basin Management Plan and Institutional Arrangements: Through an iterative process with the basin's users, decision-makers, and other stakeholders, the integrated basin management plan along with its validation and implementation strategy will be developed. The actions prioritized in the plan will be designed to contribute to the region's and System's sustainability and to aid in meeting the aspirations of the populations living within the basin as well as the end users in Toluca and the Mexico City Metropolitan Area.

5. Institutional Strengthening and Capacity Building: The last component of the technical cooperation consists of institutional strengthening and capacity building. This component is paramount in the incorporation of international experiences, technologies, and practices. One example of this is a technical study tour for a delegation of Mexican water practitioners to the Catskill Mountains in New York State, USA. The technical visit will cover topics such as the project launched by New York City to protect its drinking water by preserving the ecosystem services of its watershed.

Status of Project: Diagnosis, Early Findings

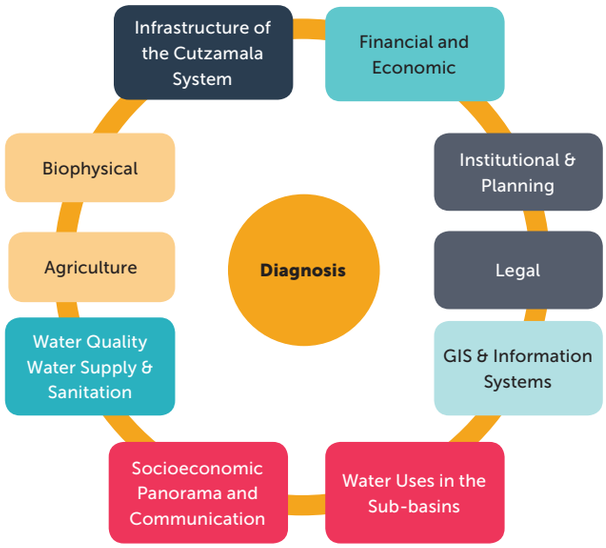
Phase 1 of the technical cooperation has been completed. CONAGUA-OCAVM, UNAM, IMTA, and The World Bank are now in the process of defining the scope of Phase 2, which will build directly off the Integrated Diagnosis. The results of the Diagnosis decode many of the uncertainties previously unknown about the System, its basin, and its adjacent populations. To obtain this comprehensive overview of the System, the team was divided in 10 thematic working groups totaling over 120 participants; each specialized in a specific discipline and each integrated by members from the various institutions aforementioned in this document. Figure 4 shows the 10 working groups and the respective fields they analyzed. The groups were:

1. Institutional & Planning
2. Legal
3. GIS & Information Systems
4. Water Uses in the Sub-basins
5. Socioeconomic Panorama and Communication
6. Water Quality, Water Supply and Sanitation

7. Biophysical Environment
8. Agriculture
9. Infrastructure of the Cutzamala System
10. Financial and Economic

Through this approach, the team was able to delve into the history and the current state of the Cutzamala System and its sub-basins. Broadly speaking, the challenges it faces can be categorized by: (a) increased competition for water, (b) deteriorating water quality

Figure 4: Thematic Working Groups



reaching the 'Los Berros' Water Treatment Plant; (c) the institutional and legal complexity limiting OCAVM's action in responding to the deteriorating conditions of the sub-basins, (d) widespread poverty and marginalization in the sub-basins; and (e) the lack of financial sustainability in the operation of such large infrastructure. In detail:

Increased Competition for Water

The number of competing water uses in the six sub-basins has evidently grown since 1982. As previously mentioned, a mounting population combined with increasing economic activity has produced additional stress on the System and on its biophysical environment. This stress has manifested itself in several forms, primarily in an expanding irrigated agricultural sector that relies on the Cutzamala System's water and in the presence of unregulated water extractions through traditional pumps and hoses along open canals, depleting the availability of the resource for its intended purposes. Adding to this pressure is the uncertainty of global climate change, which threatens to reduce the availability of water in the System.

Deteriorating Water Quality

Over the last two decades, the water stored in the reservoirs of the Cutzamala System has suffered serious deterioration in its quality. This quality reduction can be attributed primarily to discharges of untreated sewage from adjacent urban and rural populations into the System's reservoirs, and changes in land use. This decline in water quality has culminated in the seasonal presence of blue-green algae, or cyanobacteria, in the Valle de Bravo and Villa Victoria reservoirs, which complicate the drinking water treatment process, thus making it more costly.

Institutional Constraints

OCAVM's jurisdiction over the management of the Cutzamala System is limited to its infrastructure: reservoirs, canals, pumps, water treatment plant, etc. The management of the water resource, as well as the land surrounding the Cutzamala System, including factors that relate to soil erosion, untreated discharges, and deforestation are within the authority of another Basin Agency, OCB. Consequently, complex institutional coordination ensues, affecting the immediacy and efficiency with which emerging issues are treated or addressed.

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Poverty and Marginalization in the Sub-basins

As described earlier, the population in the six sub-basins has witnessed a remarkable growth since the 1970s. The standard of living of these individuals, however, continues to lag compared to the living standard of the rest of the populations in their respective states (State of Mexico and Michoacán), including in terms of water supply and sanitation coverage. Poverty and marginalization characterize the living conditions these populations are experiencing, many families still relying on traditional subsistence farming while lacking viable livelihood opportunities. These conditions are particularly unfavorable towards women (high levels of teen pregnancy, illiteracy, single parent families) and young adults who may resort to organized crime in lieu of school or professional development. Spreading through 1,000 rural towns and villages, these marginalized populations often lack a space for institutional dialogue.

Infrastructure and the System's Financial Sustainability

The current financial scheme governing the Cutzamala System is characterized by (a) a strong disconnect between the fees charged for the service of bulk water provision and the costs of operating, maintaining, and renovating it and (b) a similar disconnect between the institutions financing the system and the institution operating it. The financial cost of providing the service is estimated at 4.6 billion pesos per year (306 million USD), of which 48% is paid through fees charged for the service and 52% by federal funds. These costs do not include the stress caused by the increased competition for water nor the environmental damage cost associated with the pollution from the expansion of irrigation schemes, the use of fertilizers and pesticides, or the discharges of untreated sewage, among other factors. When these externalities are included, the cost increases to about 7.7 billion pesos per year (513 million USD), of which 29% is paid through fees charged for the service, 31% through federal funds, and 40% by society (which continues to experience environmental degradation, reduction of water quality, and deficiencies in public water supply services). This lack of coordination between fees and costs discourages the use of water-efficient technologies and practices by most users, causes distortions in water management planning, and increases the cost of water supply. To maintain the present levels of service and the security of the system, investments in the equipment and infrastructure that will guarantee its sustainability are essential. Fortunately, the system was robustly designed and has been carefully maintained over the last 30 years; however, to assure its future operation and to improve water management, proper actions should be taken now.

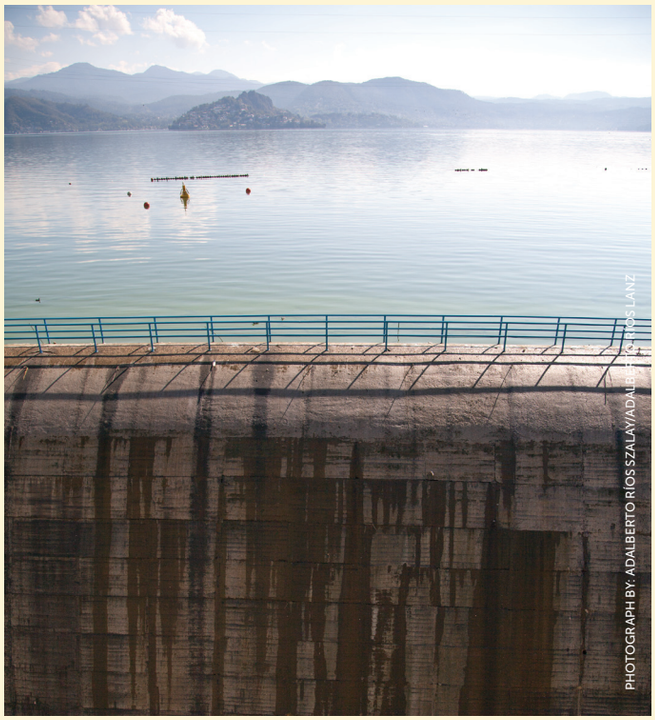
Towards a Shared Vision

In response to these evolving circumstances and their consequences, the current administration has taken action to ensure the System's ongoing performance. This includes both urgency measures (e.g. the application of activated charcoal to control the blue-green algal blooms) and more structural ones, such as the construction of a third distribution line, which is meant to reduce the number of service interruptions caused by reparations to the pipeline network. Due to OCAVM's limited field of action (i.e., restricted to the operation and maintenance of the System's infrastructure), however, few measures for the enhancement of the conditions of the sub-basins and their populations are within its reach. Current conditions will allow the System to operate, with difficulty, over the next 10 years. The risk of failure and vulnerability, however, remains high if the status quo remains in terms of practices and investments.

Integrated Management Plan for the Cutzamala System

In summary, the diagnosis allows for a common base, a shared vision, to be established from which an Integrated Management Plan for the Cutzamala System can be conceived and further implemented. This shared vision will foster a feasible future in which the availability of water is, while subject to applicable IWRM and sustainability principles, sufficient to warrant medium and long-term development in the sub-basins and to meet the growing demands of MCMA and Toluca. These principles include:

- Institutional, technological, and financial excellence in infrastructure, facilities, and operation practices for the Cutzamala System
- Institutional strengthening of OCAVM, OCB, Balsas Basin Council, and the sub-basins' councils



- Prioritized execution of multiannual programs for maintenance, rehabilitation, monitoring, and modernization of infrastructure and operation practices
- Technological improvements that enhance the competitiveness and efficiency of the irrigated schemes
- Rural-urban regional development based on community revitalization and improved inter-municipal collaboration
- Identifying competitive commodity systems at regional, national, or international levels
- Coordination and complementarity of public policies, granting a central role to local and municipal development plans
- Watershed management to reduce nutrient load entering the reservoirs, and reservoir management to reduce algae concentrations
- Improved efficiency and increase in social spending in the municipalities of the six sub-basins
- Enhanced coverage and performance of basic services in the sub-basins, including water supply and sanitation, social security, education and job trainings
- Systematic evaluation and participation at the local level
- Fostering private and public investments in sustainable regional economic growth as well as urban planning, and rural territorial development
- Fostering partnerships that include the participation of populations of the sub-basins, acknowledging their potential contributions to the region.

The formulation of the Integrated Management Plan for the Cutzamala System and its Sub-Basins is scheduled to begin in May, 2015.

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