REPUBLIQUE DU SENEGAL







ELIMINATING FLOODING IN A SUSTAINED MANNER THROUGH INNOVATIVE DRAINAGE SYSTEMS

In Senegal, the Dakar peri-urban area experiences recurrent flooding. The Government of Senegal has launched various initiatives in response to this, including the Stormwater Management and Climate Change Adaptation Project (PROGEP) implemented between 2012 and 2019 with technical and financial support from the World Bank, the Nordic Development Fund (NDF) and the Global Environment Facility (GEF). The considerable infrastructure work undertaken by the project enabled the setting up of primary and secondary drainage systems in Pikine and Guediawaye, two of the most vulnerable areas of Dakar's periphery.







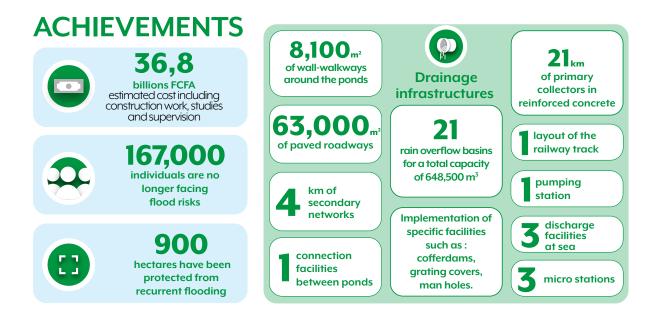
BACKGROUND

Flooding caused by stormwater has been one of the biggest natural hazards facing Senegal in the past decades. According to estimates by the Global Facility for Disaster Risk Reduction and Recovery (GFDRR)¹, between 1980 and 2008, flooding affected between 400,000 and 600,000 individuals each year and caused significant damage to infrastructure, public facilities and private property, as well as considerable economic losses.

In 2009, for example, the strongest rainstorm resulted in considerable flooding across the country, and particularly in Dakar. 360,000 people were directly affected, according to statistics published by the government. The Post Disaster Needs Assessment undertaken that year estimated the cost of flooding at USD 104 million². The private sector, which suffered 65% of damages and 64% of losses, was the biggest victim of the floods, while the peri-urban areas of Dakar, which alone registered USD 82 million in damages and losses, were the most affected areas. In response to recurrent flooding, stormwater drainage infrastructure had previously been installed in the Dakar peri-urban areas under emergency programs. From 2006, under the vast government program called the Jaxaay³ Plan, stormwater reservoirs were installed in the lowest lying areas after the residents of these areas had been relocated elsewhere (developed plots in Keur Massar).

However, it quickly became evident that the infrastructure built under this emergency program were not sufficiently robust given the scale and complexity of flood events. The capacity of the rain overflow basins was insufficient, even with pumping systems installed. The ponds were also being used to dump solid waste and wastewater, and were therefore generating a serious sanitation hazard. They were permanently filled with water and aquatic plants (typha, etc.) and were also easily accessible, leading to several cases of children drowning, as well as to spread of disease (malaria, diarrhea and skin infections, etc.).

- 2 The sectors that were the most affected, in terms of damages, were habitat (49%), health (14%), agriculture (11%), education (10%) and means of transport (8%). The recorded losses were mainly of business (20%), public urban infrastructure (15%), habitat (16%), energy (14%) and means of transport (14%).
- 3 Jaxaay is the name in Wolof of the bird that flies the highest.



¹ GFDRR: Profil pays des risques climatiques et de l'adaptation au changement climatique (Sénégal), April 2011

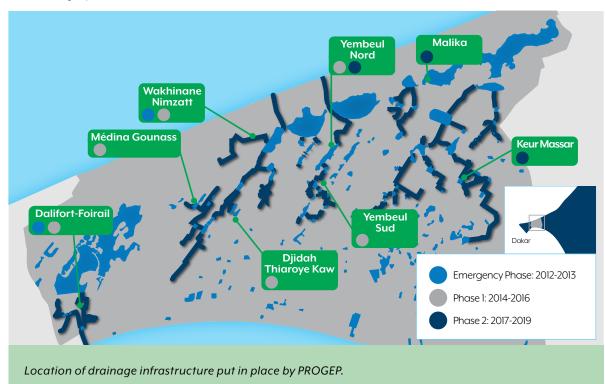
DESCRIPTION OF THE INTERVENTION

In order to eliminate flooding afflicting Piking and Guediawaye in a sustained manner, the Municipal Development Agency (ADM), under Component B.1 of the PROGEP Project - "Drainage investments and management" - coordinated the construction of stormwater drainage infrastructure in the project intervention area. The infrastructure consisted mainly in: (i) primary large section channels, both open and covered, in reinforced concrete and masonry perimeter walls, (ii) secondary collectors in PVC, (iii) fenced, and lit rain overflow basins equipped with guard boxes and wallwalks, (iv) special structures for evacuating water to the sea, (v) primary and secondary pumping stations, (vi) sanitized and lit interlocking paved roads, and (vii) landscaping around the ponds, through Community Investment Projects (PICs).

These infrastructure developments in their design all took into account the watershed which polarize them, and were guided by a logic of restoring the natural hydrographic system composed of a series of lakes that were in the past interconnected by smaller water bodies. On this basis, the design emphasized gravity drainage of stormwater towards the sea. Compared to previous initiatives undertaken in response to flooding in the region, a substantial planning phase, which produced strategic framework documents, preceded the identification and launch of infrastructure work. The following documents were produced: (i) a Stormwater Drainage Masterplan for Peri-urban Dakar (PDD), (ii) an Environmental and Social Management Framework, (iii) an Environmental and Social Impact Assessment, (iv) a Resettlement Policy Framework and Resettlement Action Plans.

In accordance with the Drainage Masterplan and taking account of the available financial resources, PRO-GEP infrastructure developments were implemented in three progressive phases: (i) Emergency Phase (2012-2013); (ii) Phase 1 (2014-2016) and (iii) Phase 2 (2017-2019). Technical assessments were undertaken for each phase by experts and contractors selected for executing the works. Supervision of the construction was contracted to specialized firms. To ensure efficient implementation of PROGEP activities, ADM signed city contracts (Contrat de Ville)⁴ with beneficiary municipalities which specified the activities that were to be implemented, as well as responsibilities and duties of each party.

4 See Capitalization Brief "Promoting community engagement to support the resilience of local populations and the preservation of drainage systems"



RESULTING CHANGES

Improved living environment in neighborhoods benefitting from infrastructure

The drainage infrastructure implemented by PROGEP enabled rapid evacuation of large quantities of stormwater through gravity drainage. Thanks to these infrastructures, 167,000 residents, of whom 52% women, are no longer facing flood risks and 900 ha have been protected from recurrent flooding in the following neighborhoods and districts within the Pikine department: Dalifort-Foirail, Djidah Thiaroye Kaw, Keur Massar, Malika, Yeumbeul Nord and Yeumbeul Sud; and in Guédiawaye department: Médina Gounass and Wakhinane Nimzatt. The improvements brought about by PROGEP are evident and tangible in these peri-urban areas. Improvements include, for instance: (i) the lowering of the water table, which made it possible to virtually eliminate capillary water rise in masonry and led to a drastic reduction in the required frequency for emptying septic tanks, an operation which had weighed heavily on household budgets; (ii) the resettlement of houses previously abandoned because they were permanently overrun by rainwater; (iii) a return to normal functioning of basic social infrastructure; (iv) improved sanitary and health conditions with a gradual decline in pathologies linked to standing water; and (v) improved mobility thanks to the construction of interlocking, sanitized, and lit paved roads.

Considerably savings for the government, territorial authorities and local communities

The rain overflow basins built in 2006 to reduce flooding under the Jaxaay Plan caused considerable disturbances to local communities despite the heavy pumping apparatus installed. Thanks to PROGEP today these ponds have been renovated appropriately and are integrated in a gravity drainage system that no longer requires pumping. The elimination of the need for pumping has led to considerable savings for central and local government, particularly concerning the costs of fuel, of electricity, and of staff responsible for the functioning and maintenance of pumping systems.

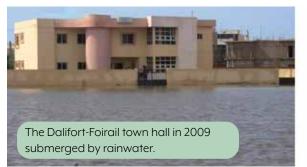
Significant lowering of water tables

Groundwater from water tables and rainwater are now evacuated throughout the year thanks to the drainage systems installed. This has resulted in the lowering of the water table by 1 to over 2 meters in some areas. The significant drop has enabled drying up of low lying zones which previously were wet and unsanitary all year round, as well as improved functioning of septic tanks, resulting in reduced costs related to emptying septic tanks for households.

Flooded or flood-prone areas freed-up and preserved

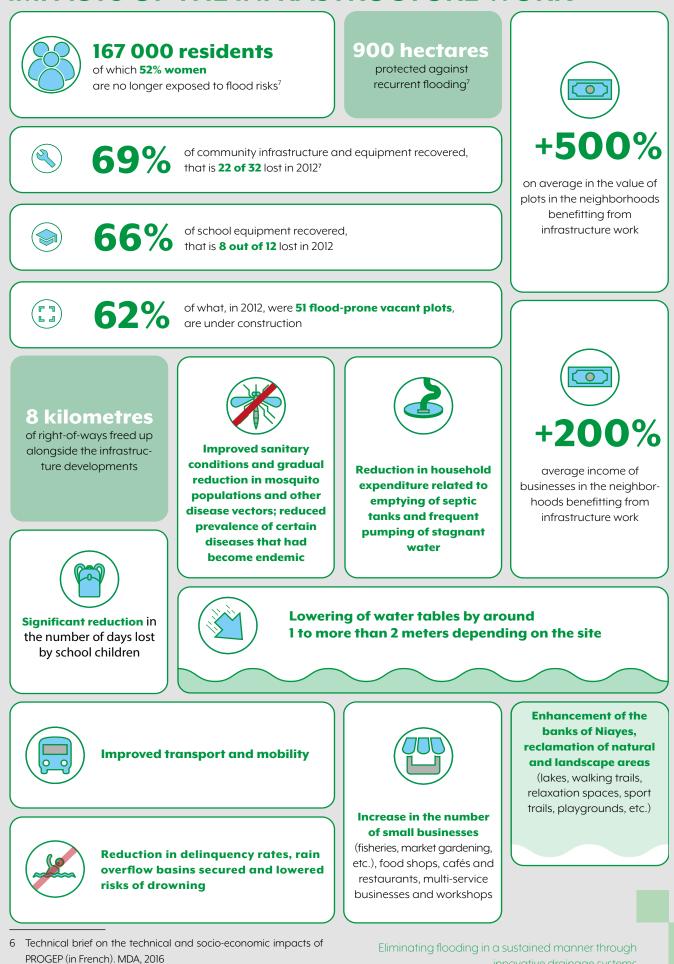
The Stormwater Drainage Masterplan for peri-urban Dakar provided a comprehensive vision for resolving flood problems in Pikine and Guediawaye. It also enabled analysis of the area and identification of floodprone areas and natural stormwater drainage paths to restore. These zones and paths were often obstructed by unplanned and irregular constructions. Freeing up the right-of-ways necessary for PROGEP infrastructure developments helped to reactivate the natural hydrographic network and clearly demarcate flood-prone areas. The preservation of the freed-up spaces was boosted by the implementation of Community Investment Projects ⁵. These projects facilitated improved integration of drainage infrastructure in the urban fabric.

5 See Capitalization Brief "Investing in community projects to boost sustainable urban development"





SOCIAL, ECONOMIC AND ENVIRONMENTAL IMPACTS OF THE INFRASTRUCTURE WORK⁶



7 Activity Progress Report nº12 (in French), MDA, April 2019

innovative drainage systems

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A STORMWATER DRAINAGE MASTERPLAN BASED ON THE WATERSHED AND GRAVITY DRAINAGE

The Stormwater Drainage Master Plan for peri-urban Dakar has given the government and territorial authorities a comprehensive vision of how runoff water can be managed in Pikine and Guediawaye. More generally, it has enabled debate on the place of water in the town, at a time when considerable efforts are being deployed to adapt to climate change. The guidelines contained in the strategic plan have thus stimulated a change in paradigm concerning the management of rain sanitation, in Senegal as a whole and in particular in the PROGEP intervention area.

The Drainage Masterplan provides guidance for an integrated drainage management approach using watershed. The structure of the system for collecting and evacuating runoff water proposed in the Drainage Plan in effect corresponds to the former hydrographic network, which had disappeared due to the drop in rainfall at the beginning of the 1970s drought. The dried-up waterways had then been colonized by unplanned habitats. The Drainage Plan's strategy was to compartmentalize the intervention zone, respecting the boundaries of the 20 watershed the zone contains. For each watershed, the plan foresaw the construction of a network of primary drainage infrastructure that would restore natural pathways for evacuating stormwater (see the diagram below which shows the Tiourour-Warouwaye Lake watershed). Drainage occurs using gravity, thanks to the natural slope of the ground, to evacuate rainwater all the way to the sea.

The optimal application of the "drainage by watershed" approach helped reduce population displacement during infrastructure construction work. It also limited disturbances to residents and minimized the expenditure by the state on financial compensation.

The choice of gravity drainage was primarily an economic choice, as it is well established that it is less expensive in terms of investment, opera-

tions and maintenance than sanitation systems based on pumping.

The study which informed the drafting of the Drainage Plan also included mapping of flooded and flood-prone areas which are to be kept free of all inappropriate occupation. The sustainability and effectiveness of the stormwater management system set up by PROGEP is highly dependent on these areas effectively remaining unoccupied. The mapping also aims to contribute to deliberate and controlled urbanization that takes into account the whole array of issues linked to stormwater management, in particular the issue of securing right-of-ways needed for water retention and evacuation.

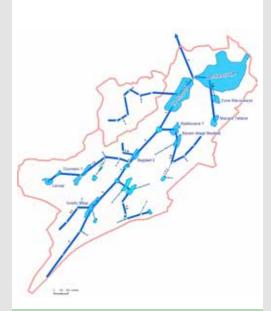


Diagram of the Lake Tiourour-Warouwaye catchment area.

MITIGATE NEGATIVE IMPACTS THROUGH ENVIRONMENTAL AND SOCIAL MANAGEMENT THROUGHOUT ALL THE STAGES OF DRAINAGE INFRASTRUCTURE DEVELOPMENT AND CONSTRUCTION WORK

PROGEP was designed to ensure that its outcomes would have beneficial impacts on communities and their environment, in terms of reducing their vulnerability to flooding and improving their living conditions. However, it must be said that without efficient planning and management, the construction work that put in place the drainage infrastructure could have had potentially negative environmental and social effects.

To contain this risk, and in accordance with relevant World Bank guidelines and with national procedures a Resettlement Policy Framework (RPF) was prepare to guide the resettlement process of persons affected by the project (PAPs). The RPF was based on the project's Environmental and Social Management Framework which presented the environmental management mechanisms for the developments and planned measures necessary to maintain affected communities' living environments. These framework documents were operationalized by (i) an Environmental and Social Impact Assessment, with included an Environmental and Social Management Plan, and (ii) a Resettlement Action Plan.

The Drainage Masterplan made choices that were intended to minimize as much as possible resettlement of residents. As such, during construction works, contractors established operational plans that optimized the routes of drainage channels and contours of rain overflow basins. Participation of local elected officials, involvement of Departmental Commissions for Census and Cost Evaluation, citizen participation in determining the routes of drainage channels and in monitoring operations all contributed to reducing social impacts and government expenditure related to financial compensation. The wide participation also meant that it was easier to respond in a more exhaustive manner to disturbances caused by the construction works to residents in proximity to the planned infrastructure.

The social engineering that was undertaken alongside the drainage infrastructure construction work, played an important role of mediating between those in charge of construction and the communities affected. Local Committees for Stormwater Management and Climate Change Adaptation Initiatives (COLIGEPs)⁸ were put in place and these helped formalize collaboration between local authorities and communities, thus facilitating understanding and tailored responses to community expectations, as well as effective management of complaints and grievances.

Cheikh Sy

Representative of Cheick SY neighborhood in Yeumbeul Sud

The infrastructure built by PROGEP has brought life back to our neighborhood. Before the construction work, there was always water everywhere. We were living in water. We thought up different strategies to be able to get by with all that water. We would lift up our charcoal stoves to cook. We would put our things as high up as possible on shelves so that they would not get wet or destroyed. It was tough. We had to spend a lot of money on pumping water and emptying septic tanks. Several families could not take it anymore and abandoned their houses because of water issues. I, personally, never stopped fighting to make policymakers aware of the situation communities in my neighborhood were faced with. My efforts were not in vain. The actions of PROGEP have been numerous and diversified. Drainage channels have been built to evacuate water towards rain overflow basins that are situated lower down in the neighborhood. Paved roads have been built allowing for better draining and improving mobility in the neighborhood. Today, we can live in peace with water. When it rains, the water comes, it flows away, and life goes on just like before. Families have come back to abandoned houses. Life in the neighborhood has come back now."

⁸ See Capitalization Brief "Promoting community engagement to support the resilience of local populations and the preservation of drainage systems"

LESSONS LEARNT

Correct sizing of infrastructure and effective social facilitation are essential for undertaking developments in dense urban settings

The drainage infrastructure construction work was undertaken in densely populated low-income neighborhoods that had irregular spatial organization and very limited spaces for maneuvering with construction vehicles. This complex situation was taken into account during the design phase of the infrastructures; these were sized so as to be compatible with the urban setting and so as to limit the number of expropriations as much as possible. This approach was accompanied by social facilitation measures to foster ownership of the infrastructure by the communities and ensure their participation in the different stages of infrastructure development and limit the risks of conflicts.

The phasing of interventions allowed for an efficient scheduling of construction works.

The construction work to be done under PROGEP were defined using multi-criteria prioritization based on: (i) the severity of flooding in the area; (ii) (upstream-down-stream) hydraulic logics; (iii) costs involved in expropriation; (iv) number of persons affected; (v) making use of existing infrastructure, even temporarily; and (vi) the need for preliminary studies or assessments prior to construction. Construction thus started in areas identified as higher priority, to be launched later in the areas requiring longer preparatory phases.

Synergies of action between stakeholders were fostered which helped to avoid delays in implementing activities

Some difficulties were experienced during construction work which had negative consequences on the schedule. These were mostly (i) of administrative nature, such as delays in obtaining the decree declaring the project of public utility and decrees of transferability, as well as the funds needed for compensating PAPs, which in turn delayed the freeing-up of right-of-ways, as well as later construction work; (ii) of procedural nature, such as the double review, by both the World Bank and the Central Directorate for Public Procurement, of certain steps in the procurement process which led to delays; (iii) or of technical nature, such as shortcomings noted in the execution of the Community Investment Projects' infrastructure and development works by some contractors.

Securing drainage infrastructure starts right from the design phase

Following assessment of the stormwater drainage infrastructure construction, it was found that certain technical guidelines in the Drainage Masterplan were not suitable, or even relevant, to the physical and institutional context of PROGEP. The Drainage Masterplan had opted for open channels for the runoff water evacuation system which have lower investment costs than closed channels. During the preliminary technical assessments before construction, analysis found that open channels would have incurred higher maintenance needs, greater insecurity, higher risks of vandalism, and continuous silting and invasion by solid waste and aquatic waste, as well as resulting in broken-up urban areas and separating communities. In light of these objective constraints and of the need to ensure the long-term sustainability of the infrastructure, the choice was finally made to use closed frame culverts for 90% of the drainage infrastructure. This choice also had the advantage of reducing hygiene and health risks caused by stagnant waters in open channels, and was better adapted to densely populated areas as it avoided displacement. Adjustments were similarly made to the design of the stormwater retention and overflow ponds so as to better ensure their long-term sustainability, their functioning, and above all the security of nearby communities. These improvements mainly involved stabilizing the embankments with riprap, or suitable vegetation such as vetiver, installing solar street lighting, and building a perimeter wall and a guardhouse.

FUTURE PROSPECTS

Ensure the maintenance of infrastructure for correct functioning

The drainage infrastructure put in place are exposed to a considerable number of risks that can limit their lifespan and correct functioning. These risks include: obstruction by rubbish, silting, accumulation of sediments that encourage growth of aquatic plants, deterioration of the embankments protecting the ponds against erosion. All these factors can affect the functioning of the drainage system, and ensuring a long lifespan of the system requires regular maintenance. One component of the PROGEP project focused on maintenance issues⁹. The funds and expertise needed for maintenance operations are currently being managed by ADM under the PROGEP project. This dynamic needs to be sustained, to ensure the long-term security of the infrastructure developed.

Promote a holistic approach enabling consolidation of infrastructure assets for the management of climate risks

It is important to consolidate and strengthen the gains that the new drainage system represents in order to protect communities against flood risks. Complementary initiatives are needed to this end. Some initiatives have already been launched under PROGEP and these need to be sustained. These include: (i) surveillance of infrastructure through strengthening of COLIGEP committees; (ii) preserving the right-of-ways identified by the Drainage Masterplan; (iii) legal protection of flooded and flood-prone areas by conferring them formal status as no-construction zones in the Detailed Urban Plan of Pikine and Guediawaye; (iv) strengthening household waste and grey water management mechanisms; (v) incorporating the investment plan from the Detailed Urban Plan in government programs and projects; (vi) strengthening synergies of action between stormwater sanitation stakeholders.

Continue implementation of the Stormwater Drainage Masterplan

The infrastructure put in place by PROGEP has contributed significantly to responding to the serious and recurrent flooding problem that affected the Dakar peri-urban region. The infrastructure was a concrete realization of part of the vision contained in the Drainage Masterplan. However, more than ever, it is necessary to pursue implementation of the initiatives contained in the masterplan in order to cover the entire Dakar peri-urban area, and even beyond. The rich experience of implementing the PROGEP project can be capitalized to this effect.

Members of the Wakhinane Nimzatt COLIGEP during an awarenessraising caravan in neighborhoods near the rain overflow basins, in Guediawaye department.



⁹ See Capitalization Brief "Promoting necessary reforms to ensure the sustainable operation and maintenance of drainage systems"

Idrissa Diallo Mayor of Dalifort-Foirail

Before the drainage infrastructure was developed, the situation in our commune had become critical. Dalifort is located in a basin. When the level of the lakes near the Technopole, just behind, rose too high, water would run off towards the direction of the sea. Our commune being on the path of the water, we were constantly flooded, especially the Belvedere and Cite Soleil neighborhoods. 17000 residents were directly affected by such flooding. 30,000 residents were indirectly affected by disturbances, such as the almost permanent presence of water. The drainage infrastructure put in place under PROGEP resolved the problem. They changed the face of the commune and the life of my fellow citizens. The living environment has vastly improved, with positive impacts at all levels: education, health, environment, security, transport, economy, etc. We particularly appreciated

the inclusive approach that the project promoted. Territorial authorities were strongly engaged in the process. We were constantly in contact with the ADM and were involved in each stage of the development works, as were the community representatives. This approach enabled good implementation of complex works in a very dense urban setting and minimized displacement of residents during construction. I think this was an important factor in the success of the operations. We noted more difficulties in implementing the Community Investment Projects and mobilizing the COLIGEP committees. These mechanisms are important for ensuring the correct functioning of drainage infrastructure which have to withstand strong urban pressure. However, it needs to be said that the COLIGEP committees need good training and greater incentives. '

Drainage infrastructure construction work took place in difficult settings, with densely populated spaces and limited room for maneuvering.



INCORPORATE NON-INFRASTRUCTURE TYPE MEASURES TO ENSURE THE LONG-TERM SUSTAINABILITY OF INFRASTRUCTURE

As planned under the implementation of PROGEP, construction of infrastructure for stormwater collection and drainage was accompanied by a significant number of non-infrastructure activities. These activities involved many components that were mutually reinforcing, thus guaranteeing the sustainability of infrastructures and protecting communities against flooding. Specifically, they included (i) provisions linked to the operation and maintenance of the drainage infrastructure, (ii) revising procedures for developing urban planning documents to ensure wider participation of local authorities and communities, and integration of issues linked to resilience to climate change effects; (iii) zoning aimed at keeping no-construction zones free from all occupation; (iv) promoting behavior change to better ensure the functionality and long-term sustainability of the infrastructure built, through, in particular, engagement with local authorities and communities.

To implement these activities, as well as better integrate climate risks in the design and operationalization of urban planning and management documents, PROGEP¹⁰ strengthened the role and skills of national and local stakeholders, such as municipalities, national directorates in the field of sanitation, NGOs, and grassroots community-based organizations. PROGEP contributed to improving knowledge of local territories through mapping of flood risks, and the preparation and dissemination of inclusive planning documents.

To ensure continued maintenance of the infrastructure that had been installed¹¹, an exhaustive diagnostic of the stormwater sanitation sector was undertaken by PROGEP. This provided a clearer understanding of the roles and responsibilities of relevant stakeholders and enabled the identification of necessary conditions for structural reforms to implement in order to ensure more efficient management and governance of stormwater sanitation in Senegal. Focus was placed on ensuring leadership by the National Office for Sanitation of Senegal (ONAS) and the establishment of a rainwater sanitation fund.

In order to facilitate community engagement¹², PROGEP also implemented, with the support of social facilitators, several activities and information, education and communication (IEC) tools and supported the establishment of COLIGEPs. Furthermore, to foster ownership of the infrastructure¹³ and its integration into the urban fabric, the project support the implementation of Community Investment Projects (PICs) and the engagement of residents in household waste management through the Clean Neighborhood Operations (*Opérations Quartier Propre*).

13 See Capitalization Brief "Investing in community projects to boost sustainable urban development"

¹⁰ See Capitalization Brief "Providing territorial authorities with urban planning and management tools that integrate climate risk "

¹¹ See Capitalization Brief "Promoting necessary reforms to ensure the sustainable operation and maintenance of drainage systems"

¹² See Capitalization Brief "Promoting community engagement to support the resilience of local populations and the preservation of drainage systems"



- Environmental and Social Management Framework, ADM, 2011 (in French)
- Resettlement Policy Framework, ADM, 2011 (in French)
- Environmental and Social Impact Study, ADM, 2011 (in French)
- Stormwater Drainage Masterplan for the Dakar peri-urban region, ADM, 2012 (in French)

- PROGEP Project Appraisal Document (PAD), World Bank, 2012
- Resettlement Action Plan, ADM, 2012 (in French)
- Fact sheet "Drainage infrastructure construction using gravity system and urban landscaping, road, sport and recreational developments », ADM, 2019 (in French)

Stormwater Management and Climate Change Adaptation Project (PROGEP)

The Stormwater Management and Climate Change Adaptation Project, PROGEP, implemented by the Municipal Development Agency (ADM), is a component of the Ten-year Flood Control Plan (PDLI). It is funded by the Government of Senegal, with technical and financial support from the World Bank, the Global Environment Fund (GEF) and the Nordic Development Fund for a total of USD 121.3 million (FCFA 60.65 billion). This urban development project implemented over seven years (2012-2019) was aimed at reducing flood risks in Dakar's peri-urban area (Pikine and Guediawaye) and at promoting sustainable city management practices in selected urban areas (Saint-Louis and Diamniadio). It sought to find sustainable solutions using an integrated approach based on a combination of infrastructural and noninfrastructural interventions.

The Municipal Development Agency (ADM)

ADM, the agency responsible for coordinating the implementation of the Stormwater Management and Climate Change Adaptation Project (PROGEP), was established in 1997 thanks to combined efforts of the Government and the Mayors Association of Senegal, AMS. The agency was established in the context of 1996 reforms, referred to as the "regionalization" reforms, aimed at reinforcing decentralization and local development in Senegal. As a key partner to local authorities, and in accordance with its Strategic Plan, ADM works to make local regions more attractive and competitive and to strengthen their governance. To this end, the agency contributes to building strategic, financial, administrative and technical capacities of local authorities. ADM helps authorities manage territorial information, facilitates cooperation between local authorities, and promotes inter-communality.

This publication is part of a series of briefs that capitalize the achievements of and lessons learned from the implementation of the PROGEP project. This capitalization brief, as well as the publications cited, can be accessed at: www.adm.sn/progep