Turning Saline Borehole Water into Safe Drinking Water Using Solar-Powered Reverse Osmosis: The Case of Mukaange Community in Makueni County

County:	**Makueni**		
Sector/s:	Environment and Climate Change	**Sub-sector/Theme:**	Climate-resilient water supply
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Target Audience:	County Governments, Development Partners, Climate Change practitioners, Community-Based Organizations, water sector professionals, policy makers and development practitioners		
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Introduction:

Water scarcity had long defined daily life for residents of Mukaange Village in Masongaleni Ward, Kibwezi East Sub-County, Makueni County. Mukaange Sub-location has an estimated 1,480 residents across eight villages. Recurrent drought, erratic rainfall and the area's arid climate forced many households to walk more than seven kilometres in search of safe drinking water, while others relied on the crocodile-infested Athi River, exposing themselves to significant safety risks. The limited access to safe water affected household health, food production and community's overall resilience to climate change.

In 2022, the County Government of Makueni drilled the Kiambani Borehole to improve water access for the community. The borehole was drilled to a depth of 160 metres and produced approximately 12.5 m^3 of water per hour. Although the borehole produced adequate quantities of groundwater, laboratory tests revealed that the water contained high levels of salinity, making it unsafe for human consumption. Consequently, a significant public investment remained underutilized while the community continued to face acute water insecurity. Through the Participatory Climate Risk Assessment (PCRA) conducted under the Financing Locally Led Climate Action (FLLoCA) Programme,

the Mukaange community identified access to safe drinking water as its highest climate adaptation priority and proposed optimizing the existing Kiambani Borehole rather than investing in a new water source. The County Government pursued an innovative solution to transform the saline groundwater into safe drinking water while integrating complementary interventions to strengthen livelihoods, restore ecosystems and enhance long-term climate resilience.

Implementation of the practice:



Figure 1A resident collects water at Kiambani Water Kiosk in Masongaleni Ward

The Mululuni–Kiambani Water and Livelihood Enhancement Project, valued at KES 10 million, was implemented by the County Government of Makueni in partnership with the Financing Locally-Led Climate Action (FLLoCA) Programme during the 2023/2024 financial year. The Ward Climate Change Planning Committee, the County Government of Makueni and the World Bank through the FLLoCA Programme appraised the proposal before its approval. The County Department of Water and Sanitation then coordinated implementation with community representatives.

The project optimized the existing Kiambani Borehole through the installation of a solar powered Reverse Osmosis (RO) Water Purification Plant, converting previously saline groundwater into safe drinking water for human consumption. The untreated water had Total Dissolved Solids (TDS) of 3,900 mg/L, chloride of 1,340 mg/L, sodium of 670 mg/L, copper of 4.6 mg/L and a pH of 6.2. Iron, sulphates and fluorides were also reported, although their concentrations were not provided.



Figure 2The solar-powered Muliluni–Kiambani Water and Livelihood Enhancement Project facility

RO was selected because of the high salinity, as it uses a semi-permeable membrane and high pressure to force water molecules through while eliminating dissolved salts, bacteria, and organic matter (Veolia Water Technologies & Solutions, 2026). The treatment house and associated infrastructure were installed in February 2025. A 13.2 kW solar photovoltaic system powers water abstraction and treatment. Saline water pumped from the borehole is first stored in two masonry tanks of 150, 000 and 50, 000 liters capacity. Then it is passed through the RO treatment system which has a feed flow of 8 m^3 per hour and produces 4 m^3 per hour of treated water (permeate), while 2 m^3 per hour of brine or concentrate is recycled within the system. The treated water is stored in two 10,000-liter tanks, with a total capacity of 20,000 liters. It is piped about 1.1 kilometer to Muliluni and distributed through community access points such as Kwa Mwee Water Kiosk and Katulyi Dispensary. Each of these distribution points has a 5,000-liter storage tank.





Figure 3The Governor of Makueni County, H.E. Mutula Kilonzo Jr. CBS inspects the Masongaleni water treatment facility ahead of its commissioning

Recognizing that water security alone would not adequately address the community's climate vulnerabilities, the project adopted an integrated climate resilience approach by combining safe water access with sustainable livelihoods and ecosystem restoration. The intervention included;

- The establishment of a 50-hive community apiary, complemented with apiculture training and honey value addition
- Promotion of Farmer Managed Natural Regeneration (FMNR) to restore the Muliluni Community Forest
- Establishment of a ¼-acre Climate-Smart Agriculture (CSA) demonstration farm
- Distribution of 300 kg of pasture grass seed
- Establishment of 100 household kitchen gardens, comprising 50 vertical sack gardens and 50 conical gardens
- Training farmers on climate-smart agricultural practices to improve food and nutrition security.

Technical oversight was provided by county engineers and contractors built the civil, mechanical, and electrical components. Community members participated in project planning and implementation and formed local management structures.

To promote long-term sustainability, the Community Sustainability Committee and other local management structures were strengthened to oversee the operation and maintenance of the facilities. This community-led governance model has enhanced local ownership and ensured the continued management of the investment beyond the project period.



Figure 4A farmer tends crops supported by the Masongaleni water project

Results of the practice

The intervention has demonstrated how existing public investments can be transformed into sustainable climate adaptation solutions through appropriate technology and community-led implementation.

- ***Improved public health and safety:*** Access to treated drinking water has contributed to a reduction in water-borne diseases while reducing community dependence on the crocodile-infested Athi River, thereby lowering the risk of human-wildlife conflicts.
- ***Improved access to safe drinking water:*** More than 1,480 residents now have access to safe and clean drinking water from the previously saline Kiambani Borehole, significantly improving water security within the community.
- ***Strengthened climate-resilient livelihoods:*** Climate-smart agriculture, household kitchen gardens, pasture development and apiculture have diversified livelihood opportunities while improving food and nutrition security.

- ***Enhanced environmental sustainability:*** Farmer Managed Natural Regeneration and renewable energy have supported ecosystem restoration while reducing greenhouse gas emissions associated with conventional water pumping systems.
- ***Increased community resilience:*** By integrating safe water access, sustainable livelihoods, ecosystem restoration and community management into a single intervention, the project has strengthened the community's capacity to adapt to the impacts of climate change.

Lessons learnt:

- Existing public investments can be revitalized through appropriate technologies to address climate challenges and maximize value for money.
- Groundwater development should be accompanied by water quality assessments to ensure that appropriate treatment technologies are incorporated where necessary.
- Integrating safe water access with climate-smart agriculture, sustainable livelihoods, renewable energy, and ecosystem restoration interventions delivers broader and more sustainable climate adaptation outcomes than stand-alone infrastructure investments.
- Meaningful community participation throughout the project cycle strengthens ownership, accountability and long-term sustainability of climate adaptation projects. The project also highlighted the importance of community-managed operations for sustaining water infrastructure.

Recommendations

Counties facing similar groundwater salinity and water insecurity should consider optimizing existing water infrastructure before investing in new facilities. Integrating renewable energy, water treatment technologies, ecosystem restoration, climate-smart livelihoods and community-led management can deliver resilient, cost-effective and scalable climate adaptation solutions while maximizing the value of public investments.

Further reading:

- https://pmts.makueni.go.ke
- https://makueni.go.ke
- Makueni County Participatory Climate Risk Assessment Report, 2023.
- Makueni County Climate Change Action Plan, 2023–2027.

Photo Gallery



Figure 8Community representatives responsible for managing the Mulilluni–Kiambani Water and Livelihood Enhancement



Figure 5A community member responsible for managing the project demonstrates how the system works



Figure 7A community member draws water from the treatment system



Figure 6Crops growing at the Mulilluni–Kiambani project site