# Securing Mauritius' Water Future Under Deep Uncertainty

## Integrating Machine Learning, Groundwater Modelling and Robust Decision Making for Adaptive Water Management

## Introduction

Mauritius has long appeared water-secure on paper, yet recurrent droughts, rationing and stressed aquifers reveal a system that is finely balanced rather than comfortably supplied. This study examines how the Central Water Authority (CWA), Water Resources Unit (WRU) and wider government can secure reliable, affordable water services over the next 20–30 years in the face of climate volatility, socio-economic change and tight fiscal space. It reviews hydrometeorological, groundwater, demand, asset and financial data for Mauritius; assesses existing MODFLOW-type groundwater models; and synthesises emerging machine-learning applications for recharge, inflow, demand and leakage forecasting. Drawing on international experience with Decision Making under Deep Uncertainty (DMDU), it develops a Robust Decision Making (RDM) framework that stress-tests combinations of supply- and demand-side measures across many plausible futures rather than a single forecast. The focus is less on designing individual projects and more on aligning investments, regulations, data systems and institutional arrangements with an adaptive, portfolio-based strategy for long-term resilience.

## Key Findings

- **National "abundance" coexists with fragile service reliability.** Renewable resources of roughly 2.6–2.8 billion m³ a year contrast with recurrent rationing, reflecting marked seasonality, rapid runoff to the sea, limited storage and operational constraints, rather than simple physical scarcity. [Statistics Mauritius 2019–2020]
- **Cutting non-revenue water is the cheapest way to free new supply.** Around half of treated water is still lost through leaks, illegal connections and metering issues, implying that Mauritius effectively wastes a volume comparable to total residential demand; tackling these losses could unlock well over 100 million m³ per year at far lower cost than large new dams. [Peeroo & Sultan / Global Development Network]
- **Climate change will deepen volatility more than it will change annual averages.** Warming of more than 1°C since the 1970s, increasing frequency of dry years and projections of uncertain but potentially lower winter rainfall mean the country can no longer plan on the basis of historical hydrology or a single climate model trajectory. [World Bank – Climate Risk Country Profile: Mauritius; CIWA Drought Resilience Profile]
- **Groundwater is both a strategic buffer and a growing vulnerability.** Five main aquifer systems supply roughly half of domestic water, yet numerical models for the Western, Southern and Northern aquifers show heavy exploitation, significant discharge to the sea and real risks of salinisation and pollution if abstraction and recharge are not actively managed. [WRU; UNESCO Northern Aquifer project]
- **Data and modelling assets are substantial but fragmented.** Mauritius already holds long hydrometric series, water accounts, SCADA data and several calibrated aquifer models, and local researchers have begun to apply machine-learning methods to recharge and groundwater behaviour. These assets are not yet linked into an integrated decision-support system that can inform real-time operations and long-term planning in a consistent way.
- **Traditional deterministic master plans are ill-suited to deep uncertainty.** Optimising a fixed set of projects against a small number of "most likely" scenarios risks oversizing rigid infrastructure, under-investing in flexible options such as non-revenue water reduction and managed aquifer recharge, and leaving the system exposed if climate or demand depart from the central forecast. [Groves et al., RAND RDM case studies]

- **Fiscal and climate-finance constraints sharpen the need for robustness.** With public debt close to 90 per cent of GDP and adaptation capturing only a minority share of global climate finance, Mauritius cannot afford a trial-and-error approach; it must prioritise portfolios that deliver resilience under many futures and that can credibly attract concessional and private finance. [IMF Article IV; Global Center on Adaptation]

## Recommendations

- **Institutionalise Robust Decision Making in water-sector planning.** Mandate the use of RDM or related DMDU methods in the next Water Master Plan, including explicit uncertainty ranges, system stress-tests and clear robustness criteria agreed with ministers and regulators.
- **Develop a national "digital water twin".** Build an integrated data and modelling platform that brings together hydrometeorological, groundwater, demand, asset and financial data, with open interfaces for machine-learning models and groundwater simulators, to support both day-to-day operations and strategic scenario analysis.
- **Prioritise a time-bound non-revenue water reduction programme.** Treat NRW reduction as a central investment pillar, using asset-management analytics, pressure management, active leak detection, district metered areas and performance-based contracts to drive losses towards 25–30 per cent over the next decade.
- **Upgrade and extend groundwater modelling and monitoring.** Update and operationalise MODFLOW-family models for the Western, Northern and Southern aquifers, densify monitoring networks, and link models to ML-based recharge forecasts so that sustainable abstraction limits, managed aquifer recharge schemes and salinity-risk zones are defined on a sound technical basis.
- **Use machine learning selectively, with strong governance.** Focus ML applications where they clearly add value—seasonal inflow and recharge forecasting, demand modelling, leakage hot-spot detection and water-quality risk prediction—underpinned by transparent validation, model documentation and clear "model cards" understood by engineers and managers.
- **Embed flexibility, signposts and triggers in major decisions.** Structure large investments (for example desalination modules, reservoir raisings or network reinforcements) so that capacity can be added, delayed or re-sequenced in response to observable indicators such as sequences of dry years, demand growth, or shifts in financing conditions.
- **Strengthen cross-sector governance and data-sharing.** Create a standing multi-agency water-security platform linking CWA, WRU, wastewater, environment, finance and local government, with agreed roles for data stewardship, joint scenario development and periodic RDM reviews.
- **Align tariffs, social protection and climate finance.** Use evidence from RDM analyses to prioritise high-impact resilience projects in the national sustainable finance framework, while designing tariff reforms and targeted support so that low-income households are protected and utilities remain financially capable of maintaining and renewing assets.
- **Invest in domestic technical capacity and long-term partnerships.** Build teams in data science, hydrogeology, modelling and decision analytics within Mauritian institutions, supported by structured collaboration with universities and international agencies, so that sophisticated tools translate into enduring local capability rather than one-off consultancy products.

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