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Working with water

Incorporating drought risk modelling as a planning tool for climate change adaptation measures in Saint Kitts and Nevis

Water conservation measures



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Contents

| | | |
|----------|--|-----------|
| 1 | Introduction | 4 |
| 1.1 | Project summary | 4 |
| 1.2 | About this report..... | 4 |
| 2 | Water conservation strategies | 5 |
| 2.1 | Water availability and use in Saint Kitts and Nevis | 5 |
| 2.1.1 | Challenges of water availability | 5 |
| 2.1.2 | Water demand in St Kitts | 5 |
| 2.1.3 | Water demand in Nevis..... | 5 |
| 2.1.4 | Main water users in St. Kitts and Nevis | 5 |
| 2.2 | Water conservation approaches | 6 |
| 2.3 | The role of water conservation measures and technologies | 7 |
| 2.3.1 | Economic benefits of water conservation | 7 |
| 2.3.2 | Social and environmental benefits of water conservation | 7 |
| 2.3.3 | Role of women in water conservation..... | 8 |
| 2.4 | Communicating water availability..... | 9 |
| 3 | Fact sheets | 10 |
| 3.1 | Water supply and storage technologies..... | 11 |
| 3.1.1 | Leakage detection and repair | 11 |
| 3.1.2 | Pressure management..... | 13 |
| 3.1.3 | Non-revenue water and demand management programme..... | 15 |
| 3.1.4 | Smart metering | 17 |
| 3.1.5 | Real-time data monitoring..... | 19 |
| 3.1.6 | Integrated water resources management..... | 21 |
| 3.1.7 | Enhanced potable water storage | 23 |
| 3.1.8 | Stormwater harvesting (small reservoirs and micro-catchments) | 25 |
| 3.2 | Water use technologies..... | 27 |
| 3.2.1 | Rainwater harvesting and storage for learning institutions..... | 27 |
| 3.2.2 | Water-efficient fixtures | 30 |
| 3.2.3 | Soil moisture conservation and monitoring..... | 32 |
| 3.2.4 | Improved irrigation efficiency | 35 |
| 3.2.5 | Greywater recycling for non-potable uses | 37 |
| 4 | Summary of water conservation measures and technologies and drought vulnerabilities | 39 |
| 5 | Considerations for the development of a drought prediction model and adaptation planning tool | 43 |
| | Tables | |
| | Table 4.1: Impacts of drought and appropriate technologies for water conservation | 40 |

1 Introduction

1.1 Project summary

In an effort to address the impacts of climate change and climate variability in a sustainable way, access to critical information within the water sector is vital. Drought prediction models can identify areas most susceptible to water supply variability and shortages, and therefore facilitate early action to manage risks. In doing so, this will increase resilience in the water sector to improve agricultural use of water resources and therefore ensure food security and water usage including from the domestic sector and the tourism sector in Saint Kitts and Nevis. The overall objective is to incorporate drought risks modelling as a planning tool for climate change adaptation measures in Saint Kitts and Nevis. The main outputs include:

- Map stakeholders and establish a stakeholder working group;
- Assess drought risk and water resources in Saint Kitts and in Nevis;
- Benchmark, design and implement a drought prediction model in Saint Kitts and in Nevis;
- Train administrators and users of Saint Kitts and Nevis to the drought prediction model.

The Project outcomes respond directly to SDG 13 'Taking early action to combat climate change and its impacts' by providing a system that will support planning and decision-making for the sustainable management and conservation of water resources in Saint Kitts and Nevis. The Project will also contribute to SDG 1 (End poverty), SDG 2 (Food security) and SDG 6 (Availability and sustainable management of water) as the drought prediction model will improve agricultural and use of water resources, improve food security and increase the income of rural communities.

1.2 About this report

The purpose of this report is to identify water conservation measures and recommend technologies to save water in the high consuming water sectors for Saints Kitts and Nevis. The measures are presented in technology fact sheets that give a short description of them alongside other information related to their implementation and operation. A matrix to highlight how the measures could have an impact on vulnerabilities across different high consuming water sectors is also included.

2 Water conservation strategies

2.1 Water availability and use in Saint Kitts and Nevis

2.1.1 Challenges of water availability

Rainfall is the only source of water in St. Kitts and Nevis. A discussion and analysis of precipitation is included in Output 2.3. Potable water is retrieved from either surface sources (springs) or groundwater (wells). In 2019, in St. Kitts, 70% (3.37 MGD) of the water was derived from groundwater and the remaining 30% (1.49 MGD) was from surface water. In Nevis, 99% (1.44 MGD) of water was derived from groundwater and remaining 1% (0.16 MGD) from surface water.

Freshwater availability in St. Kitts and Nevis is already threatened by frequent drought conditions coupled with increasing water demand. Water supply challenges will continue to grow in light of a growing population, greater socio-economic development, the impacts of climate change and the continued need for increased sanitisation and hygiene as a result of the novel coronavirus (SARS-CoV-2), and St. Kitts presently experiences a shortfall between water supply and demand, resulting in rationing and rota-cuts to supplies, with attendant impacts on users. This has also resulted in over-abstraction in critical aquifers leading to saline intrusion. In fact, a large proportion of total supply depends on the Basseterre Valley Aquifer which is under pressure from urban development and over pumping, although it is partially zoned as a national park to limit inappropriate development.

2.1.2 Water demand in St Kitts

For St. Kitts, the Water Conservation Plan (Daniel and Daniel Engineering Inc., 2013) indicated a non-revenue water component of 53% due to a combination of 24% leakage, and 22% apparent losses due to unbilled consumption, unauthorised consumption, metering and data handling errors.

These challenges understandably have direct impacts on the economy with the St. Kitts Water Service Department (WSD) unable to provide water to cruise ships, and requiring new hotel developments to utilise desalination systems thus raising their operating costs.

2.1.3 Water demand in Nevis

In Nevis, the Nevis Water Department (NWD) water sources are almost exclusively groundwater, and the three new wells currently produce 1.1 MGD of supply. The daily average NWD production is approximately 1.6 MGD.

The deep wells in Nevis help to mitigate the effects of drought. However, growing demand associated with tourism development, and ageing infrastructure, requires additional deep wells to increase supplies. At present, all sources are operating at maximum capacity, especially during the dry season when demand peaks, and there is currently no scope to carry out rehabilitation or resting of wells without impacting water services. In Nevis, non-revenue water is estimated to be between 30% and 35% (NWD pers. comm).

2.1.4 Main water users in St. Kitts and Nevis

Since climate change is expected to result in more severe and frequent droughts, assessing and developing additional water sources will be important for St. Kitts and Nevis to build long term resilience. However, effective solutions require both supply-side and demand-side measures. As such, water conservation

strategies can be a cost effective means to reduce stress on available water resources whilst also increasing resilience to climate change and the effects of drought.

Tourism is a mainstay of the economy of St. Kitts and Nevis, and requires a consistent and high quality water supply to service both hotels and cruise ships. In St. Kitts, the pressure on water supplies has led to the requirement for major new tourism developments to construct and use their own private desalination systems.

Agricultural diversification has also been an important policy, following the closure of the sugar industry almost two decades ago, but still requires much support in the face of climate change. Agriculture is generally rain-fed but there is a growing awareness of the needs of farmers for access to water for crops during the dry season.

Water is critical in the public health sector and particularly for sanitation, hygiene and ultimately to prevent the spread of infectious diseases. In an era of SARS-CoV-2, where there is a notable increase in the use of water for cleaning and sanitisation, St. Kitts and Nevis, as a water-scarce country, is at a greater risk from the socioeconomic impacts associated with drought.

Government offices are not billed for water in St. Kitts. Even though some offices have meters, it is unclear what the total consumption is. However, a report completed in 2013 estimated usage to be over 10 million gallons per month (0.3MGD). In Nevis, for 2021, no consumption is stated for the government sector for Q1 and Q2, but usage for Q3 is 7.7 million gallons (<0.1MGD) and Q4 is 22.2 million gallons (0.24MGD).

In Nevis, most (64%) of the total consumption is by the residential sector. Hotels and the commercial sectors utilise 13% and 10% respectively; government 7%; and agriculture 6%.

2.2 Water conservation approaches

Water conservation strategies aim to reduce stress on available water resources in light of growing populations, socio-economic development and climate change. There are a number of water conservation strategies and some of the most intuitive approaches include:

■ Limiting the consumption:

- Application of policies, economics, and technologies help regulate the demand. Policies may include restrictions and bans on certain types of water use, standards for fixtures and appliances, enforcement on recycling, etc. Economic measures, such as setting prices for water consumption, typically make people more diligent about their water-related activities. Technological advances may help use less water for the same function (water-economy washers, toilets, etc.).

■ Reuse and recycling:

- Designing systems for reuse and recirculation of water in both domestic and industrial applications are involved in this approach. For example, treated wastewater can be used for irrigation; or water can be recycled in certain types of car wash systems.
- Enhancing capacity to retain storm water runoff.

■ Elimination of losses:

- Regulation, metering, water-sensitive design, and smart technology are key factors contributing to this strategy. Leak identification systems and smart controllers for water use are some of such conservation technologies.

■ Pollution prevention:

- Less pollution creates more opportunity for water reuse and conserves natural water reserves. Regulatory policies are introduced on water discharging facilities. Also, numerous technologies exist to treat the effluents from domestic and industrial facilities.

2.3 The role of water conservation measures and technologies

Water conservation measures and technologies bring improved operational efficiencies to pre and post-consumer water services as well as wider economic, financial, social and environmental benefits.

It is widely accepted that periods of drought result in reduced agricultural productivity. Drought also reduces overall economic productivity (number of hours worked), particularly in the informal sector (IADB, 2021). This, therefore, suggests that drought has a direct negative impact on a country's GDP.

At the same time, drought impacts natural systems which provide ecosystem services, a means of livelihoods for many. There are, therefore, many reasons to conserve water as a finite resource essential to life.

2.3.1 Economic benefits of water conservation

- Lowers operational costs and financial losses to water producers

Water utilities are often burdened by water users defaulting on bills for several years, and in some cases, the defaulters are government offices. Reduced water usage by consumers, therefore, positively affects the financial bottom line of water utilities. The usable life of water infrastructure, particularly for treatment and distribution is also extended.

- Guards against rising costs and spinoff effects

Failing to conserve water can lead to a lack of adequate water supply which can reduce the availability of local food supplies and increase their costs. This, in turn, may affect food security and nutrition for the poor and vulnerable in society.

- Minimises costs to water users

Simply, using less water in the home and in businesses reduces the cost for users. If this is significant, saved money can be spent elsewhere.

2.3.2 Social and environmental benefits of water conservation

- Minimises the effects of drought and water shortages

Economic and population growth generally occur in a context of a fixed supply of water. By reducing water use, limited supplies will last longer. This is an important action to take generally but certainly when a drought period is anticipated.

It is an unfortunate fact that most persons do not consider the finite nature of water and the need for rationing when there is rain. When more water is available through conservation actions, this reduces water outage events and certainly improves the public image of the water utility.

- Helps preserve the natural environment

Though often not considered, reducing water usage reduces the energy needed to treat and distribute it to users, which in turn helps reduce pollution and conserve fuel resources. The St. Kitts Water Services Department is one of the largest consumers of electricity (all fossil-fuel based) in St. Kitts, so the energy savings (as well as greenhouse gas emissions avoided) in water conservation could be significant.

Even water produced by renewable energy-powered reverse osmosis should be conserved. Running the reverse osmosis plant at maximum capacity will lead to operational inefficiencies sooner rather than later. Additionally, the renewable energy (RE) technology is often damaged by storms. In both cases, the reverse osmosis plant resorts to the use of a back-up generator which uses fossil fuels.

Over-pumping due to insufficient supply to meet demand can also cause shallow wells to go dry or the water can become contaminated via saline intrusion in vulnerable coastal aquifers.

When water is conserved through avoided losses in areas where it remains stagnant, the potential for the creation of conditions for vectors to proliferate is reduced, as well the potential property damage and water system liability is reduced. This also makes water available for important ecosystems services (healthy forests / wetlands etc.).

- Makes water available for recreational purposes

Apart from ensuring that water is available for swimming pools and golf courses, particularly as tourism is beginning to recover from the pandemic; water is also used for landscaping and beautifying public parks and recreational spaces.

- Contributes to the feeling of safety and well-being

Conserving water means that some will be available to all – including hospitals and clinics, the fire service, sanitation services, fish markets, schools, health clubs, gyms and restaurants. As a result of the novel coronavirus (SARS-CoV-2), there will be a continued need for increased sanitisation and hygiene throughout society.

2.3.3 Role of women in water conservation

When water is not easily accessible from a faucet in the home, someone must go to collect water at a public standpipe - which is usually nearby. Then the water would likely be rationed, and need to be boiled for potable use. The person responsible for these activities, particularly the management of water in the home, is almost always a woman and this has been the case historically. Additionally, women generally have the primary responsibility for childcare and other reproductive responsibilities in the care economy, including cleaning, cooking and washing (UNECLAC, 2008).

A study conducted for Barbados revealed that men were more likely than women to use larger tanks for water storage at home, while women showed a preference for smaller containers. This means that, to access the same volume of water needed for household needs, women have to spend more time and energy collecting water. The disparity in roles is even more acute amongst the poor. If women spent less time doing the various water-related tasks that they engage in, they could spend more time participating in activities that could generate an income, thereby decreasing poverty.

Women have consequently accumulated considerable knowledge about water, from its quality and reliability to acceptable storage and conservation methods, and should therefore be at the forefront of discussions and decisions on water conservation. These realities could influence the design of residential rainwater harvesting systems and other technologies for the home.

The National Gender Equality Policy and Action Plan for St. Kitts and Nevis (2021) identifies five strategic actions for the cross-cutting theme of *COVID19 Recovery and Resilience*, for which water availability is essential:

1. Implement gender-transformative education programmes and services to increase health-seeking response to COVID-19 to sustain long-term recovery and resilience.
2. Integrate the health needs of men and women (especially those with health requirements arising from NCDs, HIV/AIDS etc.) into all aspects of recovery and resilience programming concerning the pandemic and other such hazards and disasters.
3. Strengthen men's and women's groups at community and other levels for action and advocacy, response planning and decision-making as part of the national disaster and risk response mechanism.
4. Promote innovative programmes to use natural resources (farmable land, water resources) as part of an integrated sustainable national recovery effort that provides income generation and feeds the country.

5. Establish temporary special measures on education, economic participation, health, and other sectors for boys/men and girls/women to recover and lead fulfilling lives. (Pay attention to the needs of the tourism and hospitality industry).

These actions can only be adequately executed and their benefits sustained, if the country manages its water resources through supply and demand side conservation measures and ensures that women and men are equally and meaningfully engaged.

2.4 Communicating water availability

For measures and technology for water conservation to be truly effective, they must be complemented by communicating water availability. Users of the technology should become familiar with it, and understand why they need to conserve water, the benefits to them and to others.

Due to subsidisation of piped water and the classification of water as a basic human right, this resource is often wasted. Furthermore, the level of public knowledge and awareness on factors that jointly influence water supply is generally low, and awareness campaigns are often limited to periods of low water availability and drought conditions.

Some methods for communicating water availability, from the level of water scarcity to prolonged drought conditions, can include:

- Drought bulletin for specific groups of users;
- Forum or mechanism through which the public can share their views on water conservation measures and actions;
- Provision of information on all waterbodies and encouraging people to value them and the environment through story sharing and profiling of environmentally related programmes and projects across catchments;
- Public campaigns and community awareness on the relationship between water quality improvement and biodiversity conservation;
- Training and communications to support communities to undertake activities to improve water quality;
- Awareness on the adaptation of conservation measures at home and business.

Under the Reducing the Risks to Human and Natural Assets Resulting from Climate Change (RRACC) project implemented in St. Kitts and Nevis from 2011-2015, a Water Conservation Plan (WCP) was developed and persons trained in water auditing. This provided the capability to assess water losses and to develop plans and skills to reduce wastage. A further major initiative of the St Kitts programme, has been the implementation of a Public Awareness Campaign (PAC) to encourage all Kittitians to become *Water Wise and Climate Conscious*.

A follow-on public awareness campaign should be developed in order to support the measures recommended in this report. This would complement Activity 3.3 which considers how the outputs from the tool will be communicated to specific users.

3 Fact sheets

The technologies highlighted in this Section have been selected due to their appropriateness for the St. Kitts and Nevis context as well as scalability, cost-effectiveness and efficiency considerations.

The technologies for water supply and storage have been gleaned from the ongoing St. Kitts and Nevis Technology Needs Assessment (TNA) as part of the TNA IV project. Many of these were informed by the recently completed Adaptation Plan for the Water Sector, 2021.

Additional technologies for water users were informed by CTCN factsheets and the EU Climate-ADAPT database and other sources.

Fact Sheets provide the following information for a wide range of different, yet complementary, water conservation measures and technologies, and may be used as stand-alone documents.

- Short description of the measure including the rationale and potential impacts;
- Benefits of the measure in terms of beneficiary groups, economic, social and environmental benefits, gender considerations and potential indicators to measure impacts;
- Implementation, operation and maintenance requirements including responsible entities or lead agencies and operation and maintenance considerations;
- Costs and timeframes for implementation, and potential sources of financing;
- Selected references for further information.

3.1 Water supply and storage technologies

3.1.1 Leakage detection and repair

| Short description of the measure |
|---|
| <p>Rationale</p> <p>Water losses can occur at both the consumer / end user side and the utility's distribution side. Real losses consist of water lost from the distribution system through leaky pipes, joints and fittings and leaky reservoirs (including overflows). This factsheet will focus on reduction of real losses and specifically on leakage detection and repair technologies.</p> <p>In 2012, the real losses on the island of St. Kitts were estimated to be over 37 million imperial gallons per month (>1MGD) (Daniel and Daniel Engineering 2013).</p> <p>Potential impacts</p> <p>Water demand management initiatives, like leakage detection and repair, lead to overall improved water use efficiency, reduction in environmental impact and improved sustainability. Reducing leakages and inefficient water use reduces strain on operations, making more water available to more customers in the dry season and under drought conditions. It can also increase pressure in the network, providing a more reliable supply for those customers that receive poor water pressure. It can also offset the need for supply side infrastructure upgrades by reducing demand growth and the impacts of climate change. Climate change is expected to result in drier condition in the region, hence managing demand will help adapt to climate change (HR Wallingford 2021).</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>Leakage detection and repair can benefit all residents of St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Minimizing leakage in water systems has many benefits for water customers and utilities. These benefits include:</p> <ul style="list-style-type: none"> • Improved operational efficiency; • Lowered water system operational costs; • Reduced potential for contamination; • Extended life of facilities; • Reduced potential property damage and water system liability; • Reduced water outage events; • Improved public relations. <p>The main environmental benefit is related to water use efficiency and the preservation of water resources. Reducing abstraction could retain more water in aquifers and springs for ecosystems services. (HR Wallingford 2021).</p> <p>Gender aspects</p> <p>The incremental increase in supply will promote equity in distribution and facilitate wider access to existing and potential users especially vulnerable persons.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Real losses as a percentage of production • Reduced operational costs. <p><i>As a specific example in St. Kitts, reducing leakages could bring significant energy savings (where the annual energy cost is estimated at 4.5 million XCD, 30% of operating costs). A reduction in leakage by 30% could reduce total production by 10% and energy costs by 0.5 million XCD per year (HR Wallingford 2021).</i></p> |

| Implementation, operation and maintenance |
|--|
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Water Services Department (St. Kitts) • Nevis Water Department <p>Operation and Maintenance</p> <p>Leak detection and repair programs should include the following:</p> <ul style="list-style-type: none"> • Update of water distribution system maps and record-keeping of all inspection and repair works; • Use of leakage detection technology (including remote sensors) for ongoing monitoring and analysis of source, transmission, and distribution facilities. Remote sensors and monitoring software can alert operators to leaks, fluctuations in pressure, problems with equipment integrity, and other concerns; and • Regular inspection of pipes (and all elements of the distribution systems like meters, valves and hydrants), and other maintenance efforts (cleaning, lubricating, exercising of valves) to improve the distribution system and prevent leaks and ruptures from occurring. |
| Costs, timeframe and potential funding sources |
| <p>Costs</p> <p>The costs of leak management, detection and repair include staff training, management, labor, and equipment. In the water conservation plan of 2013, it was estimated that over 2.25 million imperial gallons could be saved with a strategic focus on leakage detection and repair (reduction of 6% of real losses). A one-year program with a dedicated leakage detection and repair crew was estimated at about 150,000 XCD (team of 4 persons full time for 9 months, dedicated vehicle and equipment costs). The cost of training would also have to be included. These programs often pay for themselves through water conservation, reduced costs for treatment and distribution, and reduced maintenance and pipe replacement costs (Elliott et al. 2011).</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g.: Water Department budgets, Central Government funding, • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund. <p>Timeframe for implementation</p> <p>Short to medium term.</p> |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Daniel and Daniel Engineering Inc. (2016) St. Kitts Water Conservation and Drought Management Project Water Auditing, Retrofitting, Pressure Management, and Identification of Additional Water Sources. Prepared for the OECS / EU Global Climate Change Alliance (GCCA) Project on Climate Change Adaptation and Sustainable Land Management. May 2016. 2. Daniel and Daniel Engineering Inc. (2013) St. Kitts: Water Sector Assessment, Auditing and Conservation. Water Conservation Plan for St. Kitts. OECS/USAID Reducing the Risk to Human and Natural Assets Resulting from Climate Change Project. April 2013. 3. Elliott, R. et al (2011) Technologies for Climate Change Adaptation – Water. TNA Guidebook, April 2011. 4. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021. 5. Thornton, J. et al. 2008. Water Loss Control, McGraw-Hill, New York. 632 p. |

3.1.2 Pressure management

| Short description of the measure |
|--|
| <p>Rationale</p> <p>This factsheet will focus on pressure management as a means of controlling real losses. Pressure management can be defined as the practice of managing system pressures to the optimum levels of service while reducing unnecessary excess pressure and eliminating transients, both of which cause distribution systems to leak (EU 2015). Years of research have shown that leakage and pipe burst frequency increase with pressure thus wasting water (EU 2015, Fanner et al. 2007). The EU (2015) highlights three different levels of pressure management: Basic, Intermediate and Advanced. Both utilities in St. Kitts and Nevis practice basic level pressure management with some limited use of pressure-reducing valves (PRVs). Basic level management includes the following actions (EU 2015):</p> <ul style="list-style-type: none"> • Identify and reduce pressure transients and surges • Achieve continuous supply (24/7 policy) even if at low pressure • Strategic separation of transmission mains from distribution systems and zones • Monitor pressures (inlet, critical, average), flows, bursts/leaks/repairs, complaints • Avoid overflows from service reservoirs; reduce outlet pressure whenever possible. <p>Potential impacts</p> <p>Pressure management is the foundation for optimal management of water supply and distribution systems especially considering the negative impacts of climate change. There is no doubt that this type of proactive management of water systems is critical to increased resilience and adaptation to climate change (Daniel and Daniel Engineering 2016). Pressure management can potentially reduce real losses in a cost-effective manner compared to other higher capital investment options (e.g. - finding new water sources), with reduced short and long-term operational expenses on the part of the utility.</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All residents of St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Pressure management reduces leak flow rates and frequency of leaks thus extending infrastructure life, reducing pipe failures, conserving water, and saving money.</p> <p>Some of the benefits to water consumers from pressure management include less disruptions to the water supply and less issues related to damages caused to plumbing from transient pressure.</p> <p>The main environmental benefit is related to water use efficiency and the preservation of water resources. Reducing abstraction from the environment will retain more water in aquifers and springs for ecosystems services (HR Wallingford 2021).</p> <p>Gender aspects</p> <p>The incremental increase in supply will promote equity in distribution and facilitate wider access to existing and potential users especially vulnerable persons.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Real losses as a percentage of production • Reduced operation costs. |

| Implementation, operation and maintenance |
|--|
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Water Services Department (St. Kitts) • Nevis Water Department. <p>Operation and Maintenance</p> <p>Operation and maintenance tasks are summarized above for three levels of pressure management (basic, intermediate, and advanced). These are underpinned by regular monitoring of the distribution system (operating pressures), especially for district metering areas. This includes analysis of all types of data (including length of main, number connections, metering data) to pinpoint areas where leakage could be occurring.</p> |
| Costs, timeframe and potential funding sources |
| <p>Costs</p> <p>Under the OECS / EU GCCA project, it was estimated to cost about 73,000 XCD to set up two small Demand Management Areas (DMAs) (200-300 connections, 4" feeder main) in St. Kitts. This only includes the cost of the meters / PRV and installation (Daniel and Daniel Engineering 2016). Long term monitoring and data analysis would also have to be factored in.</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Short to medium term.</p> |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Daniel and Daniel Engineering Inc. (2016) St. Kitts Water Conservation and Drought Management Project Water Auditing, Retrofitting, Pressure Management, and Identification of Additional Water Sources. Prepared for the OECS / EU Global Climate Change Alliance (GCCA) Project on Climate Change Adaptation and Sustainable Land Management. May 2016. 2. Daniel and Daniel Engineering Inc. (2013) St. Kitts: Water Sector Assessment, Auditing and Conservation. Water Conservation Plan for St. Kitts. OECS/USAID Reducing the Risk to Human and Natural Assets Resulting from Climate Change Project. April 2013. 3. Elliott, R. et al (2011) Technologies for Climate Change Adaptation – Water. TNA Guidebook, April 2011. 4. European Union (EU). 2015. EU Reference Document – Good Practices on Leakage Management – Main Report. Luxembourg: Office for Official Publications of the European Communities. Online at https://circabc.europa.eu/sd/a/1ddfa34-e1ce-4888-b031-6c559cb28e47/Good%20Practices%20on%20Leakage%20Management%20-%20Main%20Report_Final.pdf. Accessed February 16, 2022. 5. Fanner, P.V. et al. 2007. Leakage Management Technologies. American Water Works Association Research Foundation. Online at https://waterwise.org.uk/wp-content/uploads/2019/09/EPA-2007_Leakage-Management-Technologies.pdf. Accessed February 16, 2022. 6. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021. 7. Thornton, J. et al. 2008. Water Loss Control, McGraw-Hill, New York. 632 p. |

3.1.3 Non-revenue water and demand management programme

| Short description of the measure | | | | |
|---|-------------------------------|--|--|--------------------------|
| Rationale | | | | |
| <p>The first step in any water loss control program is a utility water balance (including water losses) as defined by the IWA/AWWA Water Audit methodology (Daniel and Daniel Engineering 2013). The exercise of a top-down water audit allows a utility to identify weaknesses in terms of data quality and to take steps to improve data quality and ultimately to set performance indicators and monitor progress of any water loss control measures interventions taken (as shown in the figure below).</p> | | | | |
| System Input Volume | Authorized Consumption | Billed Authorized Consumption | Billed Metered Consumption | Revenue Water |
| | | | Billed Unmetered Consumption | |
| | | Unbilled Authorized Consumption | Unbilled Metered Consumption | Non-Revenue Water |
| | | | Unbilled Unmetered Consumption | |
| | Water Losses | Apparent Losses | Unauthorized Consumption | |
| | | | Metering Inaccuracies and Data Handling Errors | |
| | | Real Losses | Leakage on Transmission and/or Distribution Mains | |
| | | | Leakage and Overflows at Utility's Storage Tanks | |
| Leakage on Service Connections up to Point of Customer Metering | | | | |
| Leakage on Service Connections up to Point of Customer Metering | | | | |

Figure 1: Standard IWA Water Balance

Potential impacts

Water demand management initiatives like water auditing and universal metering lead to overall improved water use efficiency, reduction in environmental impact and improved sustainability. Reducing water losses (all types) and inefficient water use reduces strain on operations, making more water available to more customers in the dry season and under drought conditions. It can also offset the need for supply side infrastructure upgrades by reducing demand growth and the impacts of climate change. Climate change is expected to result in drier condition in the region, hence managing demand will help adapt to climate change (HR Wallingford 2021).

Benefits

Beneficiary groups

All water users in St. Kitts and Nevis.

Economic, social and environmental benefits

Minimizing water losses in water systems has many benefits for water customers and utilities. These benefits include:

1. Improved operational efficiency
2. Lowered water system operational costs
3. Reduced potential for contamination
4. Extended life of facilities
5. Reduced potential property damage and water system liability
6. Reduced water outage events
7. Improved public health through a more regular and adequate water supply
8. Improved public relations.

The main environmental benefit is related to water use efficiency and the preservation of water resources. Reducing abstraction from the environment will retain more water in aquifers and springs for ecosystems services (HR Wallingford 2021).

Gender aspects

The incremental increase in supply will promote equity in distribution and facilitate wider access to existing and potential users especially vulnerable persons.

M&E Indicators

- Real losses as a percentage of production
- Reduced unbilled authorised consumption
- Reduced operation costs.

Implementation, operation and maintenance

Responsible entity / Lead agencies

- Water Services Department (St. Kitts)
- Nevis Water Department.

Operation and Maintenance

The steps in a strategy to reduce non-revenue water (NRW) include continuous water accounting (as shown in Figure 1), identification and removal of illegal connections, audits of large-volume users and ensuring the integrity of the billing and customer information system. The other parts of a NRW reduction plan include universal metering and public awareness and outreach. Data collected can be tracked in a Management Information System (MIS), Customer Relations Management System (CRM) or basic billing software.

Universal metering includes activities such as installation of meters for all users (including public standpipes), retrofitting of old meters, fixed interval meter reading, meter accuracy analysis and meter testing, calibration, repair or replacement. Public awareness and outreach programs can include activities such as water bill inserts, social media education programmes and workshops (Daniel and Daniel Engineering 2013).

Costs, timeframe and potential funding sources

Costs

Indicative costs to start up an NRW reduction program are outlined in the Water Utility Adaptation Plan of 2021. Indicative costs for St. Kitts for an initial phase of water audit and revenue enhancement are estimated to be USD 400,000, and similarly USD 200,000 for Nevis – covering a range of review, assessment and planning activities.

Potential sources of finance include:

- Domestic funding – e.g., Water Department budgets, Central Government funding
- Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank
- Climate funds – e.g.: Green Climate Fund

Timeframe for implementation

Medium to long term.

Selected references for further information

1. Daniel and Daniel Engineering Inc. (2013) St. Kitts: Water Sector Assessment, Auditing and Conservation. Water Conservation Plan for St. Kitts. OECS/USAID Reducing the Risk to Human and Natural Assets Resulting from Climate Change Project. April 2013.
2. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021.
3. Thornton, J. et al. 2008. Water Loss Control, McGraw-Hill, New York. 632 p.

3.1.4 Smart metering

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| <p>Short description of the measure</p> |
| <p>Rationale</p> <p>Smart water meters facilitate more frequent, higher resolution and remotely accessible water consumption data compared to analogue meters. Arniella (2017) provides a good overview of automated meter reading (AMR) / automated metering infrastructure (AMI), as follows:</p> <p><i>“Smart metering is a component of the smart grid that allows a utility to obtain meter readings on demand (daily, hourly or more frequently) without the need of manual meter readers to transmit information. There are two types: (1) automated meter reading (AMR), and (2) automated metering infrastructure (AMI):</i></p> <p>Automated Meter Reading (AMR) includes the walk-by and drive-by methods as well as a fixed network, usually with only one-way communication from the meter to the billing system. The AMR technology includes:</p> <ul style="list-style-type: none"> • <i>Drive-by metering: This resource-saving metering solution allows water meter data to be collected instantly on-the-go. After installing the reading device and software in a van or work truck, the meter reading crew can quickly obtain accurate meter readings simply by driving through a service area.</i> • <i>Touch-read metering: For areas that are not conducive to vehicles, touch-read metering is an excellent meter reading solution. Touching a hand-held meter reading device directly to the water meter sends a radio signal that automatically transmits meter data and stores it in the hand-held device.</i> <p>Automated Metering Infrastructure (AMI) refers to a fixed network system, with smart meters providing two-way communications between the water meter and the utility. The use of AMI further improves the efficiency of water utilities and eliminates the costs of routine meter reading. When AMI is combined with geospatial meter data management, it increases the accuracy and precision of the meter read, reducing re-reads. This results in accurate and timely reads that are ready for billing, with an identification of failed and failing meters before actual billing, improving the utility’s cash flow.”</p> <p>Potential impacts</p> <p>Smart water metering increases resilience to climate change-driven water scarcity by making better use of limited water resources. Smart metering will also assist in improving utility cash flow over time as the utility can act on more accurate and precise data, and lowering operational costs through task automation.</p> |
| <p>Benefits</p> |
| <p>Beneficiary groups</p> <p>All water consumers in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Smart Water Metering (SWM) technology provides high resolution and frequent water consumption data which can be used to improve feedback to consumers and thus enhance water conservation and management. Other socio-economic benefits include reduced use of water restrictions and equity of water supply.</p> <p>Digital water metering and intelligent network devices can support the lessening of water restrictions by providing a range of alternative mechanisms to stimulate consumption reduction. This technology also provides the infrastructure and the information required to influence long-term water policy and vision, and thereby support the sustainable supply of water resources for future generations.</p> <p>The main environmental benefit is related to water use efficiency and the preservation of water resources. Reducing abstraction from the environment will retain more water in aquifers and springs for ecosystems services (HR Wallingford 2021). Smart water metering can also lead to reduced energy consumption and greenhouse gas emissions.</p> |

Gender aspects

The incremental increase in supply will promote equity in distribution and facilitate wider access to existing and potential users especially vulnerable persons.

M&E Indicators

- Real losses as a percentage of production
- Increased data quality and availability
- Reduced operation costs.

Implementation, operation and maintenance

Responsible entity / Lead agencies

- Water Services Department (St. Kitts)
- Nevis Water Department.

Operation and Maintenance

Universal metering includes activities such as installation of meters (analogue and digital) for all users (including public standpipes), retrofitting of old meters, fixed interval meter reading, meter accuracy analysis and meter testing, calibration, repair or replacement. Smart metering increases the amount of specialized IT technicians required to process and analyze the data collected by the meters.

Costs, timeframe and potential funding sources

Costs

The Water Utility Adaptation Plan of 2021 for St. Kitts and Nevis envisions the deployment of smart meters as part of a phased approach to NRW reduction. Smart metering is considered an advanced step of that process (last phase out of four phases of implementation). Indicative costs of an overall approach to NRW reduction are estimated to total USD 11.7 million for St. Kitts and USD 1.6 million for Nevis (also includes the costs of technologies described in other factsheets). The final phases are indicatively costed at USD 1 million and USD 300,000 for both islands, respectively.

Potential sources of finance include:

- Domestic funding – e.g., Water Department budgets, Central Government funding
- Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+
- Climate funds – e.g.: Green Climate Fund

Timeframe for implementation

Medium to long term.

Selected references for further information

1. Arniella, E.F. (2017) Evaluation of Smart Water Infrastructure Technologies. Report for the Inter-American Bank (IDB).
2. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021.
3. Thornton, J. et al. 2008. Water Loss Control, McGraw-Hill, New York. 632 p.

3.1.5 Real-time data monitoring

| Short description of the measure |
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| <p>Rationale</p> <p>Worldwide, water losses are occurring at both the consumer / end user side and the utility’s distribution side. It is a universal problem affecting in both developed and developing countries. This factsheet focuses on one aspect of reduction of losses relating to the use of real-time monitoring which can include Geographical Information Systems (GIS) and Supervisory Control and Data Acquisition (SCADA) systems. Arniella (2017) summarizes the tools available for real-time data monitoring as:</p> <ul style="list-style-type: none"> • GIS are a collection of computer hardware, software and geographic data, supported by technical staff to capture, store, update, manipulate, analyse and display all of forms of geographically referenced information. • A SCADA system is a software application supported by electronic real time data gathering, capable of automation. This can include the addition of sensors that collect data on equipment such as pressure at a pump, tank levels, water quality etc. <p>Some utilities may choose to have the data from the field sensors be tracked via a web application versus a custom-made software.</p> <p>The St. Kitts WSD has tank level controls installed which are tracked via a web app and the NWD has a SCADA system.</p> <p>Potential impacts</p> <p>Real-time data monitoring increases resilience to climate change-driven water scarcity by making better use of limited water resources. This technology has evolved rapidly and new forms of communication standards such as the NarrowBand-Internet of Thing (NB-IoT) can allow a utility to leapfrog and avoid the costly issues related to more traditional communication modes such as cellular 3G/4G/5G.</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All water consumers in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Real-time data technology provides high resolution and frequent water consumption / production data which can be used to improve feedback to all stakeholders and thus enhance water conservation and management. Other socio-economic benefits include reduced use of water restrictions and equity of water supply.</p> <p>Intelligent network devices can support the lessening of water restrictions by providing a range of alternative mechanisms to stimulate consumption reduction. This technology also provides the infrastructure and the information required to influence long-term water policy and vision, and thereby support the sustainable supply of water resources for future generations.</p> <p>The main environmental benefit is related to water use efficiency and the preservation of water resources. Reducing abstraction from the environment will retain more water in aquifers and springs for ecosystems services (HR Wallingford 2021). Real-time data monitoring and automation can also lead to reduced energy consumption and greenhouse gas emissions.</p> <p>Gender aspects</p> <p>The incremental increase in supply will promote equity in distribution and facilitate wider access to existing and potential users especially vulnerable persons.</p> |

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| <p>M&E Indicators</p> <ul style="list-style-type: none"> • Real losses as a percentage of production • Increased data quality and availability • Reduced operation costs. |
| <p>Implementation, operation and maintenance</p> |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Water Services Department (St Kitts) • Nevis Water Department. <p>Operation and Maintenance</p> <p>GIS / SCADA and similar real time data monitoring tools require a dedicated program, funding, and staff to capture, view and update data collection via a digital platform. Sensors, software, and all related equipment require regular maintenance, calibration, and monitoring to ensure proper functioning.</p> |
| <p>Costs, timeframe and potential funding sources</p> |
| <p>Costs</p> <p>The Water Utility Adaptation Plan of 2021 for St. Kitts and Nevis envisions the installation and upgrade of SCADA / GIS systems as part of a phased approach to NRW reduction and water loss control. SCADA is considered an advanced step of that process (last phase out of four phases of implementation Indicative costs of an overall approach to NRW reduction are estimated to total USD 11.7 million for St. Kitts and USD 1.6 million for Nevis (also includes the costs of technologies described in other factsheets). The final phases are indicatively costed at USD 1 million and USD 300,000 for both islands, respectively.</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation:</p> <p>Medium to long term.</p> |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Arniella, E.F. (2017) Evaluation of Smart Water Infrastructure Technologies. Report for the Inter-American Bank (IDB). 2. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021. 3. Thornton, J. et al. 2008. Water Loss Control, McGraw-Hill, New York. 632 p. |

3.1.6 Integrated water resources management

| Short description of the measure |
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| <p>Rationale</p> <p>The Global Water Partnership (GWP) defines Integrated Water Resources Management (IWRM) as a process that promotes the coordinated development and management of water, land and related resources in order to maximise economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems and the environment (GWP-C 2011). IWRM as a process in water resources management is infinitely more important and meaningful than simply having an IWRM plan. The key components of the IWRM process are:</p> <ul style="list-style-type: none"> • Managing water resources at the lowest possible level • Optimizing supply • Managing demand • Providing equitable access to water resources through participatory and transparent governance and management • Establishing improved and integrated policy, regulatory and institutional frameworks • Utilizing an inter-sectoral approach to decision-making. <p>Potential impacts</p> <p>Through management of the resource at the most adequate level, the organization of participation in management practices and policy development, and assuring that the most vulnerable groups are considered, IWRM instruments directly assist communities to cope with climate variability (UNDP Cap-Net 2009).</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All water consumers in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>IWRM is a flexible participatory approach which can improve feedback to all stakeholders and thus enhance water conservation and management. Other socio-economic benefits include reduced use of water restrictions and equity of water supply. This technology also provides the information required to influence long-term water policy and vision, and thereby support the sustainable supply of water resources for future generations.</p> <p>Ecosystems can benefit from applying an integrated approach to water management by giving environmental needs a voice in the water allocation debate. IWRM can assist the sector by raising awareness among other users of the needs of ecosystems and the benefits these generate for them. Often these are undervalued and not incorporated into planning and decision-making (Elliott et al. 2011).</p> <p>Gender aspects</p> <p>There are three basic linkages between gender and IWRM issues (UNDP Cap-Net 2009):</p> <ol style="list-style-type: none"> 1. Gender and environmental sustainability linkages <ul style="list-style-type: none"> • Women and men affect environmental sustainability in different proportions and by different means, as they have different access, control and interests. • Flood and drought events weigh heaviest on women because they lack the means to cope with disasters. 2. Gender and economic efficiency linkages <ul style="list-style-type: none"> • Technology choice affects affordability. Consulting female and male users may result in a more acceptable, user-friendly and sustainable service. (Water supply) 3. Gender and social equity linkages <ul style="list-style-type: none"> • Women rarely have equal access to water for productive use and are the first to be affected in times of water shortage. (Agriculture) |

- Women and children are the most susceptible to waterborne disease due to their roles in water collection, clothes washing and other domestic activities. (Sanitation)

M&E Indicators

- Change in the extent of water-related ecosystems over time
- Change in water-use efficiency over time
- Degree of integrated water resources management implemented over time

Implementation, operation and maintenance

Responsible entity / Lead agencies

- Water Services Department (St. Kitts)
- Nevis Water Department

Operation and Maintenance

The operational tools of IWRM are (GWP-C 2011):

- Enabling Environment (Policies, Legislative Framework, Financing and Incentive Structures)
- Institutional Roles (Institutional Framework, Institutional Capacity Building)
- Management Instruments (Water Resources Assessments, Planning for IWRM, Demand Management, Social Change Instruments, Economic Instruments, Information and Communications) - some of these tools are described in more detail in the other factsheets.

Costs, timeframe and potential funding sources

Costs

It is difficult to find documented costs for implementation of IWRM as it is very much a management process / paradigm with many components. The overall costs could be significant depending on the operational tools needed to effectively implement IWRM. In the Water Utility Adaptation Plan of 2021 (HR Wallingford 2021), the indicative costs for the preparation and upgrade of master plans for both islands were estimated at 800,000 USD.

A lot of effort is involved in coordinating the IWRM process which requires dedicated staff and funding.

Potential sources of finance include:

- Domestic funding – e.g., Water Department budgets, Central Government funding
- Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank
- Climate funds – e.g.: Green Climate Fund

Timeframe for implementation

Medium to long term.

Selected references for further information:

1. Elliott, R. et al (2011) Technologies for Climate Change Adaptation – Water. TNA Guidebook, April 2011.
2. Global Water Partnership Caribbean (2011) About IWRM. Accessed online on February 21, 2022 at <https://www.gwp.org/en/GWP-Caribbean/WE-ACT/About-IWRM/>.
3. Global Water Partnership Caribbean (2021) Draft Conceptual Integrated Water Resources Management (IWRM) Framework for the CARICOM Region. September 2021.
4. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021.
5. UNDP Cap-Net (2009) IWRM as a Tool for Adaptation to Climate Change. Training Manual. Accessed on February 21, 2022 at <https://www.gwp.org/globalassets/global/toolbox/references/iwrn-as-a-tool-for-adaptation-to-climate-change-cap-netundp-2009.pdf>.

3.1.7 Enhanced potable water storage

| Short description of the measure |
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| <p>Rationale</p> <p>Vessels or tanks for storing potable water are critical to the efficient operation of any water distribution system. Storage tanks serve two major purposes. One is to provide storage volume and the other to provide pressure to the distribution system. A particular tank can serve one or both purposes depending on its location within the system and its type of configuration. It is best practice to have at least three days of water supply in storage to provide security, thus reducing the impacts of outages due to drought or extreme weather events or any other type of emergency.</p> <p>Ground storage tanks can be installed either below or above ground. They are fabricated of concrete or steel. In St. Kitts, reinforced concrete storage tanks are common. In more recent times, in Nevis, glass-fused to steel tanks have been installed. They generally have the function of providing large volumes of storage for peak-day demand when the capacity of the source of supply is less than the maximum daily volume the specific system may need.</p> <p>It is usually necessary to pump water from a ground storage tank to an elevated storage tank to provide uniform pressure to a distribution system. Ground storage tanks can provide system pressure if they are located on hills within or near the distribution system area which is generally the case in St. Kitts and Nevis. Such situations are ideal since ground storage tanks are usually less expensive to construct than elevated storage tanks.</p> <p>Potential impacts</p> <p>Enhancing potable water storage allows for more resilience during droughts or extreme weather events. Enhanced water storage can increase reliability of the water supply and reduce impacts from service disruptions or emergencies. Long-term sustainability will depend on the ability of the water utilities in St. Kitts and in Nevis to plan strategically for security of water supplies during drought periods (HR Wallingford 2021).</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All water consumers in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>The economic benefits of a more resilient water supply include the avoided losses associated with supply interruptions to all sectors and increasing the continuity of operation of water dependent economic activities during drought events (HR Wallingford 2021).</p> <p>Increased water storage especially in the dry season for households and small farms which use public supplies for hygiene, watering and irrigation will lead to improved food security, health and livelihoods.</p> <p>The main environmental benefit is related to water use efficiency and the preservation of water resources.</p> <p>Gender aspects</p> <p>Reduced rationing and interruptions reduce disruption to households in accessing and using water for basic needs, often impacting women disproportionately.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percentage of capacity increase • Number of water shortage / water stress events (level of water stress: freshwater withdrawal as a proportion of available freshwater resources) |

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| Implementation, operation and maintenance |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Water Services Department (St. Kitts) • Nevis Water Department <p>Operation and Maintenance</p> <p>Dedicated technical staff are required to routinely inspect and maintain storage tanks. This includes inspection of tank integrity and cleaning of the tank periodically.</p> |
| Costs, timeframe and potential funding sources |
| <p>Costs</p> <p>The Water Utility Adaptation Plan (HR Wallingford 2021) estimated the cost of increasing potable water storage to be USD 15 million and USD 6 million for St. Kitts and Nevis, respectively.</p> <p>Also in 2020, eighteen (18) educational institutions were equipped with emergency onsite water storage tanks and delivery systems with a total storage capacity of 82,400 gallons of water. This project was funded by USAID for approximately 200,000 USD.</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Medium term.</p> |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Elliott, R. et al (2011) Technologies for Climate Change Adaptation – Water. TNA Guidebook, April 2011. 2. HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021. |

3.1.8 Stormwater harvesting (small reservoirs and micro-catchments)

| Short description of the measure |
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| <p>Rationale</p> <p>Stormwater harvesting is the collection, accumulation, treatment, and storage of stormwater for its eventual reuse. While rainwater harvesting collects precipitation primarily from rooftops, stormwater harvesting deals with collection of runoff from creeks, gullies, ephemeral streams, and other ground conveyances. It can also include catchment areas from developed surfaces, such as roads or parking lots, or other urban environments such as parks, gardens and playing fields.</p> <p>This factsheet covers collection, storage and use of rainfall that lands on the ground (runoff). The two broad categories are (Elliot et al. 2011):</p> <ul style="list-style-type: none"> • Collecting rainfall from ground surfaces utilizing “micro-catchments” to divert or slow runoff so that it can be stored before it can evaporate or enter watercourses; and • Collecting flows from a river, stream or other natural watercourse such as a ghaut (sometimes called floodwater harvesting). This technique often includes an earthen or other structure to dam the watercourse and form “small reservoirs.” <p>There are many different best management practices (BMPs) for stormwater collection, storage, treatment, and reuse. Some of these BMPs include traditional pond /pipe typically designed to attenuate flooding and for infiltration (and irrigation but to a lesser extent in the Caribbean) or multi-purpose basins / ponds / wetlands which provide more than storage and often include a sediment forebay to prevent clogging and a grass filter to help remove pollutants. More recently, focus has shifted to Low Impact Development (LID) practices (sometimes called green infrastructure) which reduce runoff using smaller, distributed BMPs such as rain gardens, linear bioretention, cisterns, green roofs and permeable pavements (Horsley Witten et al. 2014).</p> <p>This type of approach to stormwater management is not widely practiced in the Federation of St. Kitts and Nevis. There are examples of retaining walls / weirs constructed inside of ghauts (natural drainage channels) to retain soil runoff that can negatively impact the nearshore environment (i.e. inside the College Street Ghaut in St. Kitts). This has been effective in the past but needs regular maintenance for long-term sustainability. There are also small-scale stormwater retention ponds utilized for irrigation in Nevis. Nevis has a more clayey soil structure, and this impermeable layer makes it easier to design ponds for retention versus infiltration. These have been less effective in St. Kitts due to the need for liners to avoid infiltration, high evaporation rates and design flaws. This factsheet will focus on the use of stormwater catchment to supplement water supply to the agricultural sector and not so much for aquifer recharge.</p> <p>Potential impacts</p> <p>Collection and storage of stormwater can provide a convenient and reliable water supply during seasonal dry periods and droughts. Additionally, widespread stormwater storage capacity can greatly reduce land erosion. Stormwater collection and infiltration can also contribute greatly to the stabilization of declining groundwater tables (Elliott et al. 2011).</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All water consumers in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Lack of adequate water supply during drought and seasonal dry periods can halt economic development and hinder human health and well-being. Access to a convenient supply of stored stormwater can decrease the domestic water demand, increase agricultural productivity, and reduce depletion of groundwater resources. Increasing the availability of irrigation water during the dry season and even during short dry spells can yield increases in agricultural production and associated livelihoods (Elliott et al. 2011).</p> |

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| <p>The main benefits to the environment are reduced soil erosion and enhanced water quality in receiving water bodies for aquatic life, such as coral reefs.</p> <p>Gender aspects</p> <p>The incremental increase in supply, especially for agriculture, will promote equity in distribution and facilitate wider access to existing and potential users, especially vulnerable persons.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percentage of capacity increase • Number of water shortage / water stress events (level of water stress: freshwater withdrawal as a proportion of available freshwater resources) |
| <p>Implementation, operation and maintenance</p> |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Water Services Department (St. Kitts) • Nevis Water Department <p>Operation and Maintenance</p> <p>Maintenance is required for the cleaning of the BMPs and inspection of the gutters, pipes and taps and typically consists of the removal of sediments, leaves and other accumulated materials. Such cleaning should take place annually before the start of the major rainfall season with regular inspections.</p> |
| <p>Costs, timeframe and potential funding sources</p> |
| <p>Costs</p> <p>The Water Utility Adaptation Plan (HR Wallingford 2021) estimated the feasibility and design cost of securing alternative water sources for agriculture to be approximately USD 200,000 for St. Kitts – covering the costs of feasibility studies and design.</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank World Bank, EU GCCA+, FAO. • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Medium to long term.</p> |
| <p>Selected references for further information</p> <p>Elliott, R. et al (2011) Technologies for Climate Change Adaptation – Water. TNA Guidebook, April 2011.</p> <p>Horsley Witten Group Inc. and Group for Watershed Protection Inc. (2014) Stormwater Management in Pacific and Caribbean Islands: A Practitioner’s Guide to Implementing Low-Impact Development (LID). Prepared for NOAA Coral Reef Conservation Program. Accessed on February 22, 2022 at: https://www.ncei.noaa.gov/data/oceans/coris/library/NOAA/CRCP/project/1906/Feb2014_IslandBMPGuide_wAppendix.pdf</p> <p>HR Wallingford (2021) Vulnerability Assessment and Water Utility Adaptation Plans. St. Kitts and Nevis – Water Sector Adaptation Plan. Caribbean Community Climate Change Centre / EU GCCA+ Enhancing Climate Resilience in CARIFORUM Countries Programme. August 2021.</p> |

3.2 Water use technologies

3.2.1 Rainwater harvesting and storage for learning institutions

| Short description of the measure |
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| <p>Rationale</p> <p>Rainwater harvesting for storage, also known as <i>ex situ</i> water harvesting, is a practice in which rainwater is collected and stored for productive use, for example, drinking water, agriculture, sanitation and more. The rainwater can be directly captured in open storage systems, but can also be collected from roofs, soil surfaces or roads. The most common storage devices for harvesting rainwater are tanks. On Caribbean islands, larger cisterns are also commonplace, having greater storage capacities to meet the needs of communities or buildings that have a higher per-day water demand.</p> <p>In the case of some learning institutions across St. Kitts and Nevis, recent water audits conducted on a few school compounds highlighted a need for installing new, or for retrofitting/rehabilitating existing water storage units (tanks, cisterns, etc.) to enhance storage capacity and water security. Stored rainwater can especially be used for the non-potable purposes that comprise a significant portion of school water demand (e.g., toilet flushing, garden irrigation) (Daniel and Daniel, 2016).</p> <p>Unpredictable weather patterns and seasonal water resource scarcity make this technology relevant in assuring rainwater lasts for longer time spans. It is particularly important in arid and semi-arid areas that may experience extended periods without rain mixed with periods of intense precipitation. These challenges are further exacerbated by a changing climate.</p> <p>Potential impacts</p> <p>Artificial water storage is particularly important in regions with lengthy dry seasons and high rainfall variability, as well as areas where seasonal water availability is predicted to increase as a result of a changing climate. Storage tanks and cisterns are therefore one of the most important adaptation technologies in regions with limited and varying water availability. Increased harvesting and storage capacity have the potential to significantly reduce the rate of municipal withdrawal by schools, thereby allowing for more efficient resource allocation to other high-demand sectors, and contribute to overall water conservation efforts.</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All learning institutions in St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <ul style="list-style-type: none"> • Ensures water security through bridging seasonal (or unexpected) water shortages and stress, reducing pressures on groundwater and avoiding potential depletion. • Removes pressures on other depleted water sources. Assists in diversification of water sources. • Increases water storage, resulting in increased water security and reliable supplies for socioeconomic activities, as well as sufficient supplies during periods of low water flows and drought. • Helps reduce volumes of storm water runoff, and therefore also reduces the number of pollutants entering water collection systems in urban settings. • Wide range of low-cost technologies, flexible infrastructure and low-tech installations that make for relatively easy implementation. • Builds climate resilience. <p>Gender aspects</p> <p>The increase in water availability through harvesting and storage will promote equity in distribution at schools with installed systems and storage.</p> |

| <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percentage of change in storage capacity (generally / at learning institutions) • Percentage of change in municipal water use by institutions | | | | | | | | | | | | | | | | | | | |
|---|----------------|---------------------------|---------------------------|------------------------|-----------|---------------------------|---------------------------|----------------------------|--|--|--|--|----------------|-----|-----|---------------------------------------|----------------|-----|-----|
| <p>Implementation, operation and maintenance</p> | | | | | | | | | | | | | | | | | | | |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Ministries of Education in both St. Kitts and Nevis • Water Services Department (St. Kitts) • Nevis Water Department <p>Operation and Maintenance</p> <p>The salient features of rooftop rainwater harvesting systems include:</p> <ol style="list-style-type: none"> (1) a catchment surface where precipitation lands; (2) a conveyance system of gutters and pipes to transport and direct the water; and (3) containers to store the water for later use. <p>Tanks are commonly plastic, but also can be made from fiberglass, wood, metal, concrete, or stone and plastered tires, depending on resource availability and costs.</p> <p>Incorporating water quality protection adds one or more additional elements to the system. Water quality can be protected by adding one or more of the following: filtration/screening, chemical disinfection, or a “first flush” system. First flush systems discard the initial volume of a precipitation event in order to protect water quality. It has been suggested that, as a rule of thumb, contamination is halved for each mm of rainfall discarded. Incorporating collected rainwater into the piped system of a residence or other building greatly increases both the expense and the expertise required.</p> <p>Rainwater harvesting and storage technologies for schools and other similarly sized institutions generally benefit from economies of scale, given the larger populations these technologies serve.</p> | | | | | | | | | | | | | | | | | | | |
| <p>Costs, timeframe and potential funding sources</p> | | | | | | | | | | | | | | | | | | | |
| <p>Costs</p> <p>Estimates provided by the US EPA (2013) suggest that costs for active rainwater harvesting systems vary widely depending on the size and complexity of the system. For simple systems, which collect water from roof areas and do not require large media or vortex filters, the storage volume is the primary driver of system cost. Cisterns range in price depending on the material, size, and shape but costs are typically between USD 1.50 and USD 3.00 per gallon of storage, with per gallon costs generally decreasing with increasing tank size.</p> <p>Additional costs are incurred for filtration, pumps, distribution systems, excavation (if cisterns are placed underground), distribution plumbing and drainage connections, installation, and other components. These costs may be significant for large, complicated systems with significant filtration or distribution requirements: for instance, the installed cost for pumps, controls, filtration, and treatment can add thousands or tens of thousands to the cost of an active system, often representing an additional USD 2.00 – 5.00 per gallon of harvesting system capacity.</p> <p>Rain barrels typically require little or no maintenance, and any maintenance that is required can be performed without significant cost.</p> <p>Maintenance costs for active harvesting systems are generally low for well-designed systems. Recommended primary routine maintenance and corrective activities and costs associated with cisterns are listed below:</p> | | | | | | | | | | | | | | | | | | | |
| <table border="1"> <thead> <tr> <th>MAINTENANCE ACTIVITIES</th> <th>FREQUENCY</th> <th>UNIT COST PER EVENT (USD)</th> <th>TOTAL COST PER YEAR (USD)</th> </tr> </thead> <tbody> <tr> <td colspan="4">Routine maintenance</td> </tr> <tr> <td>Inspection, reporting & information management</td> <td>Every 6 months</td> <td>130</td> <td>260</td> </tr> <tr> <td>Roof washing, cleaning inflow filters</td> <td>Every 6 months</td> <td>240</td> <td>480</td> </tr> </tbody> </table> | | | | MAINTENANCE ACTIVITIES | FREQUENCY | UNIT COST PER EVENT (USD) | TOTAL COST PER YEAR (USD) | Routine maintenance | | | | Inspection, reporting & information management | Every 6 months | 130 | 260 | Roof washing, cleaning inflow filters | Every 6 months | 240 | 480 |
| MAINTENANCE ACTIVITIES | FREQUENCY | UNIT COST PER EVENT (USD) | TOTAL COST PER YEAR (USD) | | | | | | | | | | | | | | | | |
| Routine maintenance | | | | | | | | | | | | | | | | | | | |
| Inspection, reporting & information management | Every 6 months | 130 | 260 | | | | | | | | | | | | | | | | |
| Roof washing, cleaning inflow filters | Every 6 months | 240 | 480 | | | | | | | | | | | | | | | | |

| Corrective and infrequent maintenance activities (unplanned and/or >3yrs. between events) | | | |
|--|---------------|-----|-----|
| Intermittent system maintenance (system flush, debris/sediment removal from tank) | Every 3 years | 390 | 130 |
| Pump replacement | Every 5 years | 989 | 198 |
| <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g.: Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Short term.</p> | | | |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Daniel and Daniel Engineering Inc. (2016) St. Kitts Water Conservation and Drought Management Project Water Auditing, Retrofitting, Pressure Management, and Identification of Additional Water Sources. Prepared for the OECS / EU Global Climate Change Alliance (GCCA) Project on Climate Change Adaptation and Sustainable Land Management. 2. US Environmental Protection Agency (2013). Rainwater Harvesting: Conservation, Credit, Codes, and Cost - Literature Review and Case Studies. https://www.epa.gov/sites/default/files/2015-11/documents/rainharvesting.pdf. 3. Elliot, M. et al (2011) Technologies for Climate Change Adaptation – the Water Sector. TNA Guidebook. Published by UNEP, April 2011. 4. Climate Technology Centre and Network (CTCN) (2022). Factsheet on rainwater harvesting for storage. https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/rainwater_harvesting_for_storage.pdf. | | | |

3.2.2 Water-efficient fixtures

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|---|
| Short description of the measure |
| <p>Rationale</p> <p>Water efficiency is reducing water wastage by measuring the amount of water required for a particular purpose and the amount of water used or delivered. This can be achieved through the use of water-efficient appliances, devices and fixtures across all demand sectors, but particularly in the residential, public sector, tourism and agricultural sectors to help reduce water use per capita. Popular fixtures include toilets, showerheads and faucets - they can simply use less water while yielding comparable performance (e.g., low-flow showerheads). In the report by Daniel and Daniel (2016), it is evident that some government institutions already have water-efficient appliances or fixtures in place (e.g., low flush toilets), however, issues were noted with general maintenance. Other fixtures (aerators and low-flow showerheads) were less used or absent and recommended for installation to reduce water wastage and promote efficiency of use.</p> <p>Making efficient fixtures or devices available on the market is necessary but may not be sufficient. Three major strategies to increase the use of water efficient fixtures include:</p> <ul style="list-style-type: none"> • Mandates – mandating water efficiency standards for new construction and replacement of old fixtures; mandating use of water efficient products in government facilities. • Labeling – certification systems for water efficient products; adding the estimated cost of use, also called the “second price tag,” to labels. • Tax incentives – for purchasing and installing efficient products; for retrofitting and replacing older fixtures. <p>Potential impacts</p> <p>A warmer climate is highly likely to result in more frequent drought (IPCC, 2018). Additionally, growing population will push many countries into water stress and water scarcity by 2050 (Veldkamp et al., 2017). Water conservation is an essential part of comprehensive strategies to reduce pressure on existing water resources. The industrial and agricultural sectors account for a large majority of global freshwater use. However, total freshwater withdrawals reported for countries by the Pacific Institute showed that in the median country residential water use accounted for 16% of total freshwater withdrawals. As part of a larger programme on managing water use on the demand side, retrofitting government buildings and homes with low-flow fittings (faucet aerators and dual flush toilets) and automated faucets across the twin island federation can make a significant impact in conserving water, reducing water demand on municipal freshwater supplies and reducing operational costs for water supply.</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>All water users across St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Residential and public sector conservation and efficiency efforts can make a strong positive contribution to reducing pressure on water resources, specifically through the use of more water-efficient fixtures. On the climate change mitigation side, benefits can be realized through decreasing energy consumption and greenhouse gas emissions. There can be significant savings in the energy used to transport, treat and distribute piped water if less demand can be achieved through more efficient resource use. Populations that perceive the importance of environmental and water resource conservation and efficiency will generally be more open to changing behaviours around water, and so, any elements of a water-efficient programme need to incorporate a widespread public education component.</p> |

Gender aspects

Consideration should be given to ensure equitable distribution of and access to water-efficient fixtures, to ensure commensurate equitable benefits from water conservation and cost savings particularly for poor households.

M&E Indicators

- Real losses as a percentage of production
- Percent change in metered data at household / institutional level
- Percent change in uptake of efficient fixtures.

Implementation, operation and maintenance

Responsible entity / Lead agencies

- Ministry of Social Development and Gender Affairs (St Kitts)
- Water Services Department (St Kitts)
- Nevis Water Department
- Ministry of Social Affairs (Nevis).

Operation and Maintenance

The following guidelines identify actions that should be completed on scheduled intervals. Unplanned actions that can take place daily are another aspect of effective maintenance. These actions include:

- Regularly inspecting water-using systems and individual pieces of equipment; verifying systems are operating and performing correctly.
- Reporting and repairing all leaks, and encouraging all building occupants to contact building management or maintenance staff to report leaks, running flush valves, dripping faucets, etc.
- Reporting and repairing all damaged equipment. Examples of commonly damaged equipment include (but are not limited to) broken or misaligned sprinkler heads, malfunctioning faucet and flushometer sensors, broken flush valves, and altered showerheads.
- Inspect faucets and showerheads for missing or broken aerators and flow restrictors every six months. Aerators and flow restrictors are frequently broken or removed, causing fixtures to flow at much higher flow rates.
- Regularly check and calibrate automatic sensors (every six months) to ensure proper operation and reduce long wash cycles.

Costs, timeframe and potential funding sources

Costs

Establishing a functioning certification process may be costly depending on existing capacity. However, the costs for individual households are generally small and may be fully recovered by water savings over the lifetime of the product.

Potential sources of finance include

- Domestic funding – e.g., Water Department budgets, Central Government funding
- Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+
- Climate funds – e.g.: Green Climate Fund

Timeframe for implementation

Short to medium term

Selected references for further information

1. Climate Technology Centre and Network (CTCN). Factsheet on soil moisture conservation techniques. Accessed on March 29, 2022 at: <https://www.ctc-n.org/technologies/water-efficient-appliances-fixtures>

2. Elliot, M. et al (2011) Technologies for Climate Change Adaptation – the Water Sector. TNA Guidebook. Published by UNEP, April 2011.
3. US Department of Energy. Technical Operations and Maintenance Guidelines on Common Water Equipment. <https://www.energy.gov/eere/femp/technical-operations-and-maintenance-guidelines-common-water-equipment>.
4. IPCC, 2018: Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (eds.)]. In Press.
5. Veldkamp, T. I. E. et al. Water scarcity hotspots travel downstream due to human interventions in the 20th and 21st century. Nat. Commun. 8, 15697 (2017).

3.2.3 Soil moisture conservation and monitoring

| Short description of the measure |
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| <p>Rationale</p> <p>The main objective of soil moisture conservation is to minimise the amount of water lost from the soils through evaporation (water loss directly from the soil) and transpiration (water loss occurring through the plants) – or combined, the evapotranspiration. Preserving soil moisture is an important means to maintain the necessary water for agricultural production, and also helps minimize irrigation needs of the crops. This is especially important in areas where rainwater and/or groundwater resources for irrigation are scarce or decreasing due to climate change or other causes (CTCN 2022).</p> <p>Soil moisture conservation measures can be categorized as biological (agroforestry and agricultural) and mechanical (terracing, bunding, trenching, check dams, etc.). Generally, most methods used for soil quality improvement and conservation, will also yield benefits to soil moisture conservation. Examples of methods for reducing excess soil moisture loss include following:</p> <ul style="list-style-type: none"> • Spreading manure or compost over the soil – this minimizes evapotranspiration and also provides valuable nutrients to the soil through processes of decomposition. • Mulching – mulch is a layer of organic (or inorganic) material that is placed on the root zone of the plants. Mulching is most suited for low to medium rainfall areas, and less suited for areas with very wet conditions. • Conservation tillage – reducing or eliminating the tillage to maintain healthy soil organic levels which increases the soils capacity to absorb and retain water. • Crop rotation – growing different types of crops every season helps improve soil structure and thus water holding capacity. • Green manuring – growing of plant materials with the sole purpose of adding to the soil for improved organic matter and nutrients. • Deep tillage – suited for some areas and soils, deep tillage can help increase porosity and permeability of the soil to increase its water absorption capacity. • Mixed cropping and interplanting - cultivating a combination of crops with different planting times and different length of growth periods. • Contour ploughing – by ploughing the soil along the contour instead of up- and downward slopes, the velocity of runoff is reduced, creating even barriers, and more water is retained in the soils and distributed more equally across the cropland. • Strip cropping - growing erosion permitting crops and erosion resisting crops in alternate strips. <p>It is important for the effectiveness of these techniques to be evaluated and measured in the field. Such data provide real-time information and the ability to make adjustments to increase soil moisture. Various tools are available to measure soil moisture including tensiometers, electrical resistance blocks, granular matrix sensors and time domain</p> |

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|---|
| <p>reflectometry (Kujawski, 2011).</p> <p>Potential impacts</p> <p>This technology facilitates adaptation to climate change by optimising water use and enhancing soil quality. This is particularly relevant in areas that depend on seasonal rainfall for production and where there is uncertainty about future rainfall patterns. Water use optimization can translate into reduced consumption costs in the long-term.</p> |
| <p>Benefits</p> |
| <p>Beneficiary groups</p> <p>Farmers / agriculturalists across St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <p>Improved soil moisture goes hand in hand with improved soil quality and reduced irrigation needs thus potentially improving harvest and income / employment generated by the activity. Opportunities for using existing waste materials may considerably reduce costs and needs for waste handling. As such, application of these techniques may create new income and synergies between different crop variety farmers.</p> <p>The benefits of many soil conservation methods, depending on the material used, may also include better control of weeds, provision of additional nutrients to the soil, soil temperature control and protection of soil surface from the impacts of heavy rain and wind. Active reuse of organic waste also reduces waste management needs, returning the residue crops and plants to the soil through decomposition (CTCN 2022).</p> <p>Gender aspects</p> <p>Adopting a gender equality and social inclusion (GESI) participatory approach while conducting agronomic research and extension work has a great potential to provide more efficient approaches to agricultural diversification including soil moisture conservation, considering that many small farmers are women.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percent change in water demand on farms • Number of farms with measures in place, and number of measures used • Percent change in soil moisture parameters over time across selected farms |
| <p>Implementation, operation and maintenance</p> |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Ministry of Agriculture, Fisheries and Marines Resources (St. Kitts); • Water Services Department (St. Kitts) • Nevis Water Department • Ministry of Agriculture (Nevis) <p>Operation and Maintenance</p> <p>The operation and maintenance can be relatively easy once farmers are trained in these techniques, in using tools for measuring soil moisture <i>in-situ</i>, and have access to any equipment needed to help in land preparation and preparation of mulches.</p> |
| <p>Costs, timeframe and potential funding sources</p> |
| <p>Costs</p> <p>Most of these soil moisture conservation techniques are relatively low cost and low complexity approaches, primarily relying on the presence of required materials and technical capacity locally. Most of the upfront cost would be for procurement of equipment such as shredders and cutters, soil moisture monitoring probes and training all of the farmers.</p> |

Potential sources of finance include:

- Domestic funding – e.g., Water Department budgets, Central Government funding
- Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+
- Climate funds – e.g.: Green Climate Fund

Timeframe for implementation

Short to medium term.

Selected references for further information

1. Clements, R. et al (2011) Technologies for Climate Change Adaptation – Agriculture. TNA Guidebook, August 2011.
2. Climate Technology Centre and Network (CTCN) (2022). Factsheet on soil moisture conservation techniques. Accessed on February 9, 2022 at: <https://www.ctc-n.org/technologies/soil-moisture-conservation-techniques>
3. Kujawski, Jennifer (2011). Measuring soil moisture. Center for Agriculture, Food and the Environment. UMass Amherst. Access on March 15, 2022 at: <https://ag.umass.edu/print/9572>.
4. Kumawat, A., Yadav, D., Samadharmam, K., & Rashmi, I. (2020). Soil and Water Conservation Measures for Agricultural Sustainability. In R. S. Meena, & R. Datta (Eds.), Soil Moisture Importance. IntechOpen. <https://doi.org/10.5772/intechopen.92895>.
5. Nova Scotia Federation of Agriculture (NSCA), 2011: Soil Moisture Conservation Factsheet. Accessed on February 9, 2022 at: <https://nsefp.ca/wp-content/uploads/2014/07/NSCA-2001-Soil-Moisture-Conservation.pdf>.

3.2.4 Improved irrigation efficiency

| Short description of the measure |
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| <p>Rationale</p> <p>Improving irrigation efficiency aims at minimizing water use within the agricultural sector, while continuing to maintain optimal crop productivity rates. Water (and energy) efficient irrigation also provides a number of environmental and socio-economic benefits. High irrigation efficiency is becoming increasingly important due to the current decrease in available water resources and growing populations that drive expansion of agricultural activities.</p> <p>Technological advances for improved irrigation include more efficient irrigation systems, where water release can be controlled so that crops receive only the amount needed (e.g., pressurized irrigation systems such as drip irrigation). Other modern irrigation systems are self-propelled and include wireless sensors and GPS technology to improve site-specific and volumetric precision of water applications to match the needs of the soil and crops. Irrigation efficiency can also be improved through altering farming practices, such as crop rotation (plant crops according to seasons and soil conditions) and conservation tillage (leaving a previous year's crop residue on the field to reduce soil erosion and runoff) that help improve soil moisture conservation. Regularly monitoring equipment and repairing damages/leakages in irrigation systems are also important in improving water use efficiency for crops.</p> <p>Potential impacts</p> <p>Improved irrigation efficiency can commensurately improve agricultural production in dry areas with limited access to freshwater resources, such that yields and subsequent revenue from sale of produce can increase. More efficient water use will also create cost savings for water users. From a climate change perspective, farmers' resilience to changing freshwater availability can be increased significantly, and reduce risks to food security.</p> <p>A shift from the gravity irrigation to modern pressurised systems (e.g., drip and sprinkler irrigation) and improved conveyance efficiency provides an opportunity for reduced water demand in irrigation, but at a cost and with possible negative side effects (impacts on soil quality). A small, but growing amount of attention has been paid to deficit irrigation; or more specifically, irrigation below full crop-water requirements (evapotranspiration) aiming at the maximum production per unit of water consumed. Water productivity increases under deficit irrigation, but the application of this technique requires adjustments in agricultural systems, imposing changes at different levels (Climate-ADAPT, 2020).</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>Farmers / agriculturalists across St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <ul style="list-style-type: none"> • Reduces costs related to extraction and transport for irrigation. • Contributes to food security and income generation (cash crops) due to high crop productivity. • Increases water availability for other uses, especially during dry periods. • Reduces the amount of water extracted for irrigation purposes, and the amount of water lost (in surface runoff in the fields and evapotranspiration). Energy requirements for pumping and conveying are subsequently reduced, minimizing the carbon footprint. • Minimizes nutrient leaching and pollution of local watersheds due to decreased agricultural runoff. <p>Gender aspects</p> <p>Consideration should be given to ensure equitable distribution of and access to efficient irrigation equipment and training in use and maintenance, to ensure commensurate equitable benefits from water conservation and cost savings particularly at the household and/or farm level.</p> |

| <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percentage of change in water demand on farms • Number of farms with improved irrigation measures in place | | | | | | | | | | |
|--|-----------------------|------|--------|-----|-----------|-------|----------|-----|--------------|--------------|
| <p>Implementation, operation and maintenance</p> | | | | | | | | | | |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Ministry of Agriculture, Fisheries and Marines Resources (St. Kitts); • Water Services Department (St. Kitts) • Nevis Water Department • Ministry of Agriculture (Nevis) <p>Operation and Maintenance</p> <p>The first step is to evaluate the current levels and costs of water and energy use related to irrigation, and pinpoint where water and energy can be saved. Soil type, target crop types and water availability should then be assessed to calculate minimum water requirements and establish where it can be obtained. Further activities may include installation of a new irrigation system and equipment, equipment repair, land levelling, complementary water conservation techniques, on-site water recycling facilities, etc. A plan to monitor, maintain and evaluate the changes should be implemented to ensure high efficiency is sustained.</p> | | | | | | | | | | |
| <p>Costs, timeframe and potential funding sources</p> | | | | | | | | | | |
| <p>Costs</p> <p>The costs given below are for the adaptation of one hectare of land with drip irrigation. The main inputs are the materials for the distribution network, including the pump, the filtering and fertilizing systems and the drip line. The cost of labour for installation is also considered. Three days of training in system operation and maintenance are assumed.</p> <table border="1"> <thead> <tr> <th>Drip Irrigation, 1 ha</th> <th>US\$</th> </tr> </thead> <tbody> <tr> <td>Labour</td> <td>525</td> </tr> <tr> <td>Materials</td> <td>4,320</td> </tr> <tr> <td>Training</td> <td>180</td> </tr> <tr> <td>Total</td> <td>5,025</td> </tr> </tbody> </table> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank, EU GCCA+ • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Short to medium term.</p> | Drip Irrigation, 1 ha | US\$ | Labour | 525 | Materials | 4,320 | Training | 180 | Total | 5,025 |
| Drip Irrigation, 1 ha | US\$ | | | | | | | | | |
| Labour | 525 | | | | | | | | | |
| Materials | 4,320 | | | | | | | | | |
| Training | 180 | | | | | | | | | |
| Total | 5,025 | | | | | | | | | |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Climate-ADAPT (2020). Adaptation options: Improvement of irrigation efficiency. The European Climate Adaptation Platform (Climate-ADAPT) is a partnership between the European Commission and the European Environment Agency (EEA). https://climate-adapt.eea.europa.eu/metadata/adaptation-options/improvement-of-irrigation-efficiency. 2. Climate Technology Centre and Network (CTCN). Factsheet on drip irrigation. Accessed on March 29, 2022 at: https://www.ctc-n.org/technologies/drip-irrigation. 3. UNEP-DHI Partnership, UNEP-DTU, CTCN (2017). Climate change adaptation technologies for water - a practitioner's guide to adaptation technologies for increased water sector resilience. Water Adaptation | | | | | | | | | | |

Technology Brief: Improved irrigation efficiency. Accessed on March 28, 2022. https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/improved_irrigation_efficiency.pdf.

3.2.5 Greywater recycling for non-potable uses

| Short description of the measure |
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| <p>Rationale</p> <p>Greywater represents 50% to 80% of the total volume of wastewater all over the world. Increased attention to alternative water resources has become necessary, especially in semi-arid and arid regions, where the scarcity and variability of rainfall and high evaporation affect the water and salt balance in the soil. Greywater is the domestic wastewater from showers, hand-washing basins, laundry, washing machines, and kitchen sewage, excluding toilet wastes and food wastes derived from garbage grinders, which are considered blackwater. Its relatively lower nutrient load allows for recycling and reuse after a simple treatment.</p> <p>The exploitation of treated greywater includes indoor reuse, such as flushing toilets, and outdoor reuse, such as irrigation and vehicle washing. Given the numerous problems of the water-resource scarcity, an effective method of using alternative resources is the greywater reprocessing and its reuse, especially in the agriculture sector. The reuse of greywater recycled in agriculture can be beneficial for the environment, because it reduces the load on the source and the discharge of wastewater in ecosystems. The nutrients contained in these waters, mainly nitrogen and phosphorus, can improve plant growth, instead of polluting the aquatic environment, and requires only some simple treatment operations through less expensive processes. These nutrients originate from detergents and chemicals used in kitchens, dishwashers, or washing machines.</p> <p>Such greywater recycling also saves the economic and environmental costs related to establishing new water supplies. In some cases, treated wastewater is indirectly used for drinking purposes, for example by injecting it into groundwater aquifers to increase capacity and minimize saltwater intrusion.</p> <p>Potential impacts</p> <p>Agricultural use accounts for the majority of freshwater consumption worldwide. Therefore, augmentation of agricultural irrigation with reclaimed water could potentially yield the greatest benefits to global water resources. In fact, reclaimed water is used to supplement agricultural irrigation in almost all arid areas of the world. Water recycling and reuse is an important adaptation response to climate change as the increasingly unpredictable weather patterns and their effects, for example severe droughts and sea-level rise, are likely to have negative consequences on freshwater resource quantity and quality.</p> |
| Benefits |
| <p>Beneficiary groups</p> <p>Farmers / agriculturalists across St. Kitts and Nevis.</p> <p>Economic, social and environmental benefits</p> <ul style="list-style-type: none"> • Retains wastewater for reuse, instead of it being discharged into the environment and potentially polluting ecosystems. • Saves energy otherwise required to extract or transport freshwater to the area. • Recharges groundwater, avoiding freshwater resource degradation and salinization. • Increases water availability for potentially water stressed or arid areas. • Provides an easily accessible water source to economic sectors such as industry and agriculture, promoting economic development and food production. • Improves the quality of agriculture through use of valuable nutrients extracted from the wastewater. • Diversifies water sources, which increases climate resilience. |

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| <p>Gender aspects</p> <p>The increase in water availability through greywater recycling can promote equity in distribution at schools with installed systems and storage.</p> <p>M&E Indicators</p> <ul style="list-style-type: none"> • Percent change in municipal water use by farmers/the agriculture sector • Percent change in volume of greywater treated |
| <p>Implementation, operation and maintenance</p> |
| <p>Responsible entity / Lead agencies</p> <ul style="list-style-type: none"> • Ministry of Agriculture, Fisheries and Marines Resources (St. Kitts); • Water Services Department (St. Kitts) • Nevis Water Department • Ministry of Agriculture (Nevis). <p>Operation and Maintenance</p> <p>The characterisation of greywater and its comparison with domestic wastewater have shown the advantages of recycling this water category. Greywater recycling processes are, in general, based on the conventional processes for domestic, urban, and industrial wastewater treatment. Generally, the physical (sand filters, activated carbon filters, membrane filters, etc.), chemical (coagulation, ion exchange, chlorination, etc.), and biological (filtering marshes, RBC, SBR, and sludge blanket) treatment processes of greywater are preceded by pretreatment (sieving, decantation) to reduce the rates of particulate load of oils and greases, and function as a basin of regulation/homogenization of the flow of the load of pollution of untreated greywater.</p> |
| <p>Costs, timeframe and potential funding sources</p> |
| <p>Costs</p> <p>Grenada's National Adaptation Plan, as part of its Programme of Action (#3) for Water Availability estimated that promotion of water reclamation and reuse technologies (in the tourism and industry sectors) would cost approximately USD 50,000, to be implemented over a four year period.</p> <p>Potential sources of finance include:</p> <ul style="list-style-type: none"> • Domestic funding – e.g., Water Department budgets, Central Government funding • Grants and IFI - e.g.: Caribbean Development Bank, Inter-American Development Bank, World Bank • Climate funds – e.g.: Green Climate Fund <p>Timeframe for implementation</p> <p>Medium to long term</p> |
| <p>Selected references for further information</p> <ol style="list-style-type: none"> 1. Climate-ADAPT (2020). Adaptation options: Water recycling. The European Climate Adaptation Platform (Climate-ADAPT) is a partnership between the European Commission and the European Environment Agency (EEA). Accessed March 29, 2022: https://climate-adapt.eea.europa.eu/metadata/adaptation-options/water-recycling. 2. Filali, H.; Barsan, N.; Souguir, D.; Nedeff, V.; Tomozei, C.; Hachicha, M. Greywater as an Alternative Solution for a Sustainable Management of Water Resources—A Review. Sustainability 2022, 14, 665. https://doi.org/10.3390/su14020665. 3. UNEP-DHI Partnership, UNEP-DTU, CTCN (2017). Climate change adaptation technologies for water - a practitioner's guide to adaptation technologies for increased water sector resilience. Water Adaptation Technology Brief: Water recycling and reuse. Accessed on March 28, 2022. https://www.ctc-n.org/sites/www.ctc-n.org/files/resources/water_recycling_and_reuse.pdf. 4. Government of Grenada (2017). National Climate Change Adaptation Plan (NAP) for Grenada, Carriacou and Petit Martinique 2017 – 2021, Ministry of Climate Resilience, the Environment, Forestry, Fisheries, Disaster Management and Information. Accessed on March 29, 2022: |

https://www4.unfccc.int/sites/NAPC/Documents/Parties/Grenada_National%20Adaptation%20Plan_%202017-2021.pdf

4 Summary of water conservation measures and technologies and drought vulnerabilities

The following matrix provides a summary of the most appropriate water conservation technologies included in Section 3 to reduce drought vulnerabilities in selected sectors.

The list of measures is not exhaustive and, in some cases, measures have been proposed for specific users in the Fact Sheets. However, they are highly relevant to other users and sectors in St. Kitts and Nevis as indicated in the matrix below.

Table 4.1: Impacts of drought and appropriate technologies for water conservation

| Sector | Potential impacts from drought | Most appropriate technology for water conservation and Fact Sheet reference |
|--|---|--|
| <p>Water resources (including watersheds and water supply infrastructure)</p> | <p>Reduced aquifer recharge and reducing sustained yields from ground water sources Possible over-pumping in coastal aquifers leading to salinisation Water deficits for all users – compounded by increasing evapotranspiration losses Possible increased reliance on desalination, imported or bottled water sources Indirect waste management issues related to bottled water packaging Water stress to vegetation and increase in fire risk Increased watershed degradation and changes in vegetation succession to less humid-adapted plants Desertification of marginal lands in extreme cases – with increased dustiness Reduced infiltration capacity related to denuded soils Increasing hillside denudation can lead to increases in wind speeds, which can exacerbate dustiness and wildfire risk Loss of forest cover and decline in infiltration rates, which impact aquifer recharge potential and water supply</p> | <ul style="list-style-type: none"> ■ Leakage detection and repair (3.1.1) ■ Pressure management (3.1.2) ■ Non-revenue water and demand management programme (3.1.3) ■ Smart metering (3.1.4) ■ Real-time data monitoring (3.1.5) ■ Integrated water resources management (3.1.6) ■ Stormwater harvesting (small reservoirs and micro-catchments) (3.1.8) ■ Soil Moisture Conservation and Monitoring (3.2.3) |
| <p>Agriculture</p> | <p>Higher losses in farms unable to transition away from rainfed agriculture (as is the case in St. Kitts) – farmers rely on rains between September and October Increasing demand for irrigation and soil moisture retention technologies Declining profitability of producing high-water demand crops Declines in crop yields and quality of pasture for livestock Decline in soil fertility with lower organic and moisture content, increasing friability and erosivity Declining quality of pasturelands and increased demand for feedstock or greater acreage to support herds Increased competition with non-agricultural consumers for water supply Shortages of traditional foods and national Staples Increased reliance on imported, frozen and processed foods.</p> | <ul style="list-style-type: none"> ■ Integrated water resources management (3.1.6) ■ Stormwater harvesting (small reservoirs and micro-catchments) (3.1.8) ■ Rainwater Harvesting and Storage (3.2.1) ■ Soil Moisture Conservation and Monitoring (3.2.3) ■ Improved irrigation efficiency (3.2.4) ■ Greywater recycling for non-potable uses (3.2.5) |

| Sector | Potential impacts from drought | Most appropriate technology for water conservation and Fact Sheet reference |
|--------------------------|--|---|
| | <p>Possible impacts on crop diversity, which can affect the economics of farming and resilience to shocks</p> <p>Increased need for government relief for farmers to maintain domestic food production systems</p> <p>Increased susceptibility to diseases and pests – resulting in higher costs</p> <p>Possible impacts on pollinators</p> <p>High vulnerability and risk of economic losses of rainfed systems (90% of all farms in St Kitts and Nevis)</p> <p>Increased costs associated with irrigation and soil moisture retention. Indirect impacts on the cost of mulch grass species</p> <p>Possible declining productivity and yields of crops that require higher moisture</p> <p>Nevis is particularly vulnerable to low and unreliable rainfall and extended periods of drought – limiting food security on that island and increasing reliance on imported food</p> | |
| Human health | <p>Heavy use of pesticides in vector control activities may impact human health</p> <p>Increased need to disinfect and protect domestic water supplies (boil water etc.)</p> <p>Increased dustiness and smoke (from wildfires) impact respiratory health</p> <p>Dehydration and illness</p> <p>Declines in hygiene and sanitation due to water shortages, lock-offs and low pressures</p> <p>Increased water storage domestically (black tanks and barrels) which may lead to increased waterborne illnesses and vectors</p> <p>Declines in sanitation and hygiene -impacting overall health</p> <p>Mental health issues related to trauma of extreme events and loss of social cohesion</p> | <ul style="list-style-type: none"> ■ Enhanced potable water storage (3.1.7) ■ Rainwater Harvesting and Storage (3.2.1) ■ Water-efficient Fixtures (3.2.2) ■ Greywater recycling for non-potable uses (3.2.5) |
| Built environment | <p>Water shortages and rationing</p> <p>Costs associated with maintenance of silted up water and wastewater systems due to low flows</p> | <ul style="list-style-type: none"> ■ Leakage detection and repair (3.1.1) ■ Pressure management (3.1.2) can be implemented at any facility. ■ Smart metering (3.1.4) ■ Enhanced potable water storage (3.1.7) |

| Sector | Potential impacts from drought | Most appropriate technology for water conservation and Fact Sheet reference |
|----------------|--|---|
| Tourism | <p>Visual aesthetics decline with lower levels of landscaping, dustiness etc. Lower tourism product and experience due to water lock offs, low pressure etc. An increase in dry days is better for tourists' participation in outdoor activities and benefits the tourism value chain outside of the hotel</p> | <ul style="list-style-type: none"> ■ Rainwater Harvesting and Storage (3.2.1) ■ Water-efficient Fixtures (3.2.2) ■ Greywater recycling for non-potable uses (3.2.5) <p>The measures proposed for agriculture can be used in landscaping at tourism facilities. Additionally, succulents and other drought-tolerant plants can be used for landscaping Similarly, measures for homes and other institutions can be employed</p> <ul style="list-style-type: none"> ■ Pressure management (3.1.2) can be implemented at tourism facilities ■ Rainwater Harvesting and Storage (3.2.1) ■ Water-efficient Fixtures (3.2.2) ■ Improved irrigation efficiency (3.2.4) ■ Greywater recycling for non-potable uses (3.2.5) |

5 Considerations for the development of a drought prediction model and adaptation planning tool

Although starting as a slow-onset hazard, drought can affect individuals, society and even change the course of a country's economic development. Therefore, analysing short-, medium-, and long-term variations in water availability helps decision makers design and implement measures that mitigate the negative effects of water scarcity and drought.

Effective drought preparedness is site-specific, strategic, proactive, and well-coordinated. It involves prevention (water conservation), mapping, monitoring and early warning systems, as well as disaster response. All stakeholders involved should have clear and specific roles and responsibilities which are articulated in the St. Kitts and Nevis Drought Management Plan and the Adaptation Plan for the Water Sector, and which complement this work to develop a drought prediction planning tool. These directives and tools should work together to avoid the worst socioeconomic impacts of drought by helping water managers make objective, planned, and progressive decisions.

The outputs from the drought modelling tool being developed as part of this assignment, will include drought indicators corresponding to levels of water availability – including the onset and ending of drought conditions. The tool will therefore provide the evidence-base to support water providers and regulators in making decisions (about water conservation on both the supply and demand sides) to prevent deterioration of water status and to mitigate negative drought effects.



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