Research brief: Climate resilience of water supply on the Isle of Barra

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Introduction

Climate change is affecting global resources at a range of scales [1]. The provision of drinking water is heavily influenced by climate, especially in regions which rely on rainwater for its supply [2]. It is important to understand the risks and resilience associated with drinking water provision to establish suitable adaptation plans, including for infrastructure and resource management.

This project investigated the potential impacts of climate change on drinking water provision on the Isle of Barra (Eilean Bharra), Scotland. The Isle of Barra was chosen as a case study due to its potential exposure to climate change impacts given the reliance on one surface reservoir Loch an Duin for water supply, anticipated vulnerability of islands in northwest Scotland to hydrological drought [3], the importance of specific transport links to supply key goods and services, the impact of water scarcity events on drinking water provision in recent years, and exposure to coastal flooding events [4]. However, the Isle of Barra is not unique in this regard: many islands in the Western Isles have similar water and connectivity arrangements and are vulnerable to climate change impacts [5].

Research findings

It was not possible to assess the specific resilience of infrastructure and management strategies on the Isle of Barra due to limited available data and literature. However, the research identified important considerations that must be further understood to ensure climate resilient water supply in coming decades. These include:

1. **Risk of water scarcity on the Isle of Barra is likely to increase due to climate change, but these risks and impacts are poorly understood.** Decreased rainfall in summer months due to climate change [6] is expected to increase incidences of water scarcity, which in turn could cause drinking water shortages [5]. The Isle of Barra has faced several water scarcity events in recent years, with moderate water scarcity declared for three-weeks in 2021 [3]. Despite the recurrent instances of water scarcity and the anticipated decrease in rainfall due to climate change, the risk of such events happening in the future is still poorly understood for the Western Isles, including the Isle of Barra.
2. **Drinking water quality may be affected by heavy rainfall events due to climate change, particularly in periods when water reservoir levels are low**. The north and west of Scotland are expected to receive significant increases in rainfall during the winter months, which may lead to spatially and temporally patterned flooding events in the future [2]. Floods can carry contaminants into drinking water supplies

and compromise the water quality, ultimately diminishing the supply of safe potable water to consumers [2]. Areas at greatest risk are small island communities where there may be a sole drinking water supply at relatively low elevation which is exposed to multiple types of flooding event, including coastal flooding [7]. Many water sources in the Western Isles are at high risk of dissolved organic carbon (DOC) contamination due to climate change [8]. This is the case for the Isle of Barra, where DOC levels in the drinking water reservoir Loch an Duin may become elevated with increasing numbers of heavy rainfall events.

There is high potential for surface water flooding around the Loch an Duin reservoir [9]. The soil surrounding the reservoir contains high carbon content [10], thus DOC could leach into water catchments after heavy rainfall. Water with a high DOC content will impact the quality of the treated drinking water; DOC reacts with chlorine during the disinfection process to produce disinfection by-products, such as trihalomethanes. Rising DOC levels is an issue for large parts of Scotland, with several contributing factors. Improvements to water treatment infrastructure can remove DOC from untreated water before it reaches the disinfection stage of water treatment. There are several alternative treatment processes such as enhanced coagulation and nanomembrane filtration; however, such infrastructure must be adapted to each location to effectively mitigate the issue.

3. **A combined approach to manage water supply and demand sustainably and inclusively is needed.** Long-term climate resilience and mitigation strategies require local empowerment, high social capital and good governance [11]. There are particular complexities in regions with high numbers of seasonal visitors [12]. Scottish Water currently employs demand management strategies across Scotland including the Isle of Barra to manage water resources and reduce the risk of water scarcity. However, the Isle of Barra's small resident local population and large number of seasonal visitors could reduce the efficacy of such demand management strategies, or may require specific, different, interventions[*]. Scottish Water should work with stakeholders including the Isle of Barra communities to develop water management plans specific to place and context, including sensitivity to Barra's small resident local population and large number of seasonal visitors.

   Water resource management plans could consider supply management, also, such as alternative abstraction sources, in addition to Loch an Duin. For example, Loch Uisge has been used as a drinking water reservoir in the past, and Loch nic Ruaidhe has minimal risk of surface flooding, but it is not easily accessible via the main road. Regardless, it is difficult to conclude whether any alternative freshwater source on Barra would be suitable for (emergency) abstraction without further data on loch water volumes or water quality.

Recommendations

Our research finds that further work on drinking water provision is needed to improve the understanding of the risks and resilience to climate change on Scottish islands, and to ensure island communities have sustained and sustainable water supply. Specifically, research should focus on confirming the severity of risk that climate change presents to water provision in a certain location, such as the Isle of Barra. For

[*]Research being undertaken as part of the Decentralised Water Technologies Programme is investigating this topic.

instance, as well as tracking water levels at Loch an Duin, DOC levels could be monitored and analysed with weather patterns to understand their relationship. Such work would inform the choice and design of any required interventions, as well as predict and plan for future water scarcity events. Water management plans must be developed that are specific to place and context, including sensitivity to seasonal changes to island populations and existing pressure on key services. It may be appropriate to investigate alternative infrastructure and management plans for water provision in a changing climate, to ensure sufficient plans are put in place for a resilient water supply for island communities in Scotland now, and in the future.

Research Method and Data

To examine the climate resilience of water infrastructure on Barra, a desk review was coupled with Geographic Information System (GIS) analysis. SEPA water scarcity reports were analysed to identify the frequency and intensity of water scarcity events on the Isle of Barra since 2019 [13]. No water scarcity data was available prior to 2019 due to the major cyber-attack experienced by SEPA during 2018, which led to the loss of valuable information, including water scarcity reports from before 2018. A GIS project was populated with data including topography [14], flood risk maps [9], water infrastructure location [15], and soil data [10]. GIS workflows were used to assess the area and elevation of fresh water sources on the island, and to analyse impact of sea level rise on Barra from high and low climate scenarios [16]. From these, together with insights from desk review, the potential consequences on freshwater reservoirs or water provision could be explored. For example, if a fresh water source is at risk of flooding, or increased risk due to climate change, then it may not be suitable for drinking water abstraction. Different scenarios were examined to investigate climate risk to drinking water provision including (a) business as usual, (b) invest to upgrade, (c) improved demand management, and (d) a combination of scenarios (b) and (c).

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