SMEC

Member of the Surbana Jurong Group

Winnovators Challenge 2023

Design a holistic approach to ensure that communities facing sea level rise and salination of groundwater, have access to year-round water.

SMEC Australia Pty Ltd

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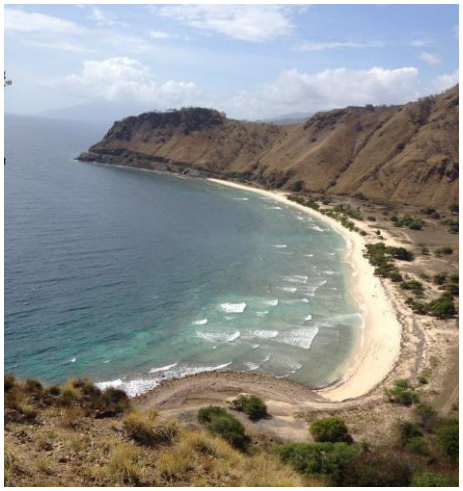
Background

Timor-Leste



Overview

- **Location:** 9º South, 125º East
- **Population and spread of population:** 1.32 Million, Dilli 245,000
- **Topography and elevation:**
- **Climate:** tropical climate, heavily influences by West Pacific Monsoon. Wet Season; December to May. Dry Season; June to November. Impacted by ENSO leading to variations in rainfall intensity and timing by up to 50%.
- **Rainfall:** Northern areas 1,000 mm/year. Southern areas 2,000 mm/year. Highest altitude in centre 2,500 to 3,000 mm/year

Water Infrastructure Overview

- The latest 2020 JMP data show that Timor-Leste has positive/improvement trends in basic water and sanitation access, with 85% and 56%, respectively.

The Problem

Technical

- Climate change – unknown frequency of rainfall. Issues with data available to inform models.
- Extreme Events: leading to flash flooding events (2020, 2021) causing damage to water and sanitation infrastructure. Strong La Nina in 2021/2022 caused drought, crop dying events, landslides, strong winds, flash flooding.
- Sea Level Rise: paired with prolonged droughts leads to risk of saline intrusion with decreasing groundwater recharge.
- Poor condition of existing infrastructure; water and adjacent utilities

Social

- Communities value “fresh” flowing water from the ground. Leads to a preference to not use rainwater as a source.
- Reluctance to use at home disinfection e.g. chemicals in rainwater tanks (consider it poison and bad tasting)
- Storage at home is within open containers
- Bottled drinking water are widely used and preferred

Current Solutions

Future Investments

- Desalination
- Feasibility studies – New Dam (only for capital city Dili)
- New and innovative water source monitoring to inform use of water tanks in communities

Exclusions from Future Investments

- Treatment plant condition assessment and repairs.
- Supply of electricity to run treatment plants

Proposed Solution

Working towards a solution

Initially, our team considered a range of solutions such as capturing rainwater, utilising hydro panels, and an education campaign aimed at improving understanding of hydraulics, water treatment and smart water practices (e.g. turning off taps).

However, following the mid-program Q&A it became clear that these approaches might not be as effective as intended. Rainwater collection is difficult without gutters, and large plastic rainwater tanks and also hydro panels do not utilise local materials. Further challenges are maintenance and technical repairs, contamination and community buy-in, meaning these options may not present a sustainable, long-term solution.

During our initial research, several team members found sources that included, a hydrogeological map of Timor Leste, groundwater mapping describing aquifer types and salination, climate change impacts on water resources and land use data. We realised that maybe the best way to combat the salination of groundwater might be to address the problem directly and 'push back' against saltwater intrusion through aquifer recharge.

Our proposed solution

Aquifer recharge can be achieved through a variety of activities. Increasing vegetation/revegetation reduces the speed of surface water runoff which increases infiltration. Detention basins also increase infiltration to groundwater, boosting aquifer levels and nearby vegetation. Basins can be constructed at a micro scale on farmer's land, slowing runoff and supporting plantings. Larger purpose-built basins provide permanent or semi-permanent water bodies, potentially enhancing the local ecology as well as increasing flow to groundwater. One option for groundwater recharge is to transfer the captured water by pipe to a distant location where low groundwater or intruding seawater are causing problems for a community.

Aquifer recharge can directly address the issue of groundwater salination, while providing an opportunity for local communities to learn about groundwater processes and assess and implement solutions themselves. Hence, this presents a potentially sustainable solution and may have long term impacts on the salination of groundwater, as well as for communities.

Aquifer recharge can fit into a larger program of solutions, which could include:

- Water quality testing to track the impact of aquifer recharge to enable communities to manage their water resources.
- Education campaigns which can include groundwater movements and strategies to increase aquifer recharge, particularly for water user and women's groups.
- Rural WASH program
- Rainwater tanks with water level indicators to enable community management of water resources
- Decontamination of water, for example using:
    - Water filters constructed using local materials (i.e. clay filters), similar to those produced by Abundant Water.
    - Sterilisation of water using glass bottles + sunlight.

Tracking Salination of Groundwater Sources

The understanding of how groundwater systems operate by Timor Leste communities is key. A more detailed understanding of the impacts of climate change and how groundwater pumping will influence the availability of groundwater enables management into the future.

The Vulnerability assessment of climate change impacts on groundwater resources in Timor-Leste by Geoscience Australia (and supported by Timor Leste and Australian Governments), provides a framework to collect, categorise, map and monitor groundwater sources and provides hydrogeological map based on investigations done between 2010 and 2012.

This information and strategies can be used to inform access to groundwater for communities, by measuring and tracking the salinity of nearby aquifers, targeting recharge to aquifers that would most benefit and ensuring the groundwater utilised is the cleanest available.

Detention Basins

Detention basins utilise earthworks to create uphill dams or reservoirs to capture surface runoff following rainfall. Once detained, this water infiltrates into the groundwater table, while being naturally filtered by the infiltration process. Utilising rainfall patterns and hydrogeological data, detention basins and similar schemes can be targeted to direct flows into aquifers

that need it the most. Micro-basins can be constructed by hand or small earthworks plant and can boost soil water levels and vegetation.

Detention basins and micro-catchments can be constructed and maintained using readily available local materials such as clay, sand and gravel. Clay cores in the wall retain the water, and sand and gravel can be used upstream to filter the water before storage, or on the bed of the basin to filter the groundwater inflow. For basins transferring the water to another site, the pipe intake can be covered with a sand and gravel filter. For elevated basins, the piped water increases in pressure as it flows downhill. **Figure 1** shows how this can be used to recharge an aquifer in low lying areas at some distance from the water source without the use of pumps or power supply. Timorese communities are typically in flatter ground near the coast, so are at risk of saltwater intrusion of their local aquifer. Passive recharge from a distant elevated basin may be a viable solution for specific sites in Timor Leste. Aquifer recharge replenishes water levels for ongoing extraction without mechanical pumps or power supply, maintaining water levels to push back sea water intrusion, or both.

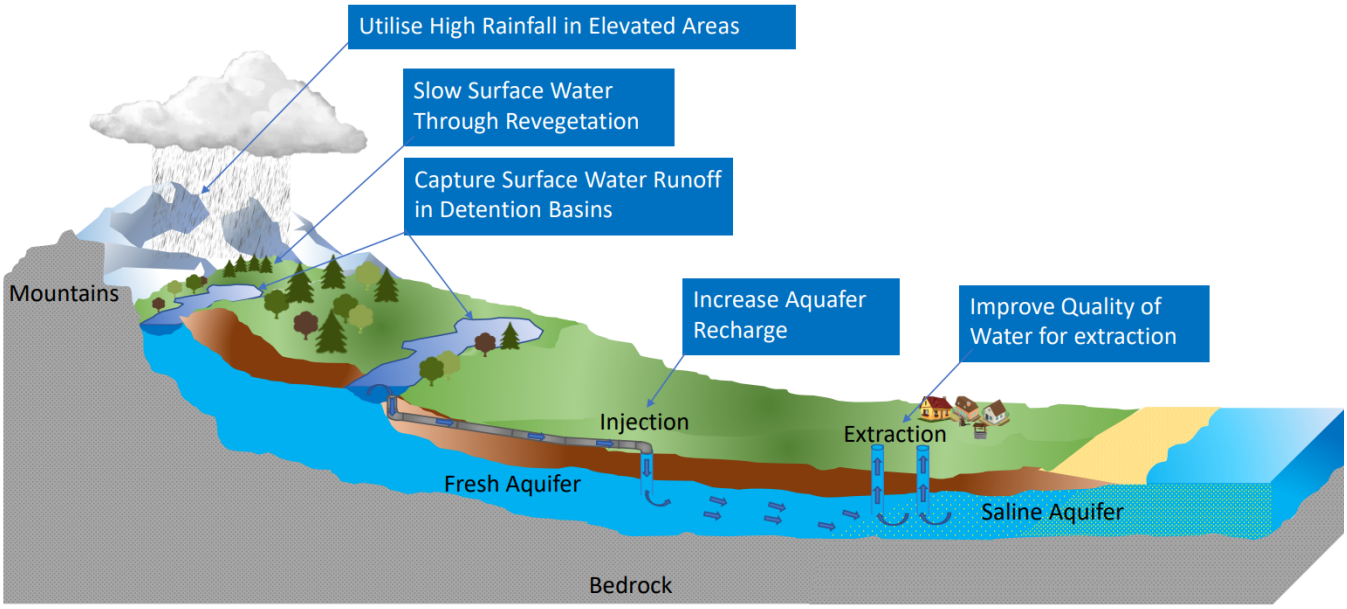


Figure 1: ***Alpine retention basin to passively recharge a coastal aquifer***

Revegetation

Revegetation aids aquifer recharge by slowing down the flow of rainwater across the surface of the land, and hence increasing surface water infiltration and therefore groundwater levels and availability. The introduction of trees and deep-rooted vegetation can help stabilize the soil and to reduce erosion caused by surface water runoff, allowing water deposits to be retained and filter more efficiently into the ground.

Initiatives such as the GEF Small Grants Programme in Timor-Leste address revegetation by helping to reduce land clearing for farming and shifting agricultural cultivation towards more sustainable practices. Surveys of existing flora and fauna around Timor-Leste such as for the proposed Tutuala-Lore National Park can be used to identify species of plants suitable for revegetation. Small manually constructed techniques such as micro-catchments used successfully in Kenya and other African countries may be useful here also, particularly in areas of topsoil loss from rapid surface runoff, or to simply enhance plant growth and increase infiltration to groundwater.

Revegetation presents an opportunity for the community to take ownership of solution to fight back against the salination of aquifers. As part of this program, it is important to educate the community on the impacts of deforestation and how revegetation can sustainably improve the quality of their water in the long term.

Liquiçá Case Study for Aquifer Recharge

The application of groundwater recharge initiatives will vary based on the local conditions, topography, hydrogeology and level of salination of groundwater sources. Taking Liquiçá as a case study (**Figure 2**), there is potential to increase vegetation on slopes above existing water courses to reduce the speed of surface water runoff, increase infiltration in these areas. Existing water courses can be explored to determine suitable locations to construct and divert flows into detention basins, increasing aquifer recharge. These activities should be combined with an assessment of the hydrogeology and salination of existing aquifers to direct recharge into areas that are most affected.

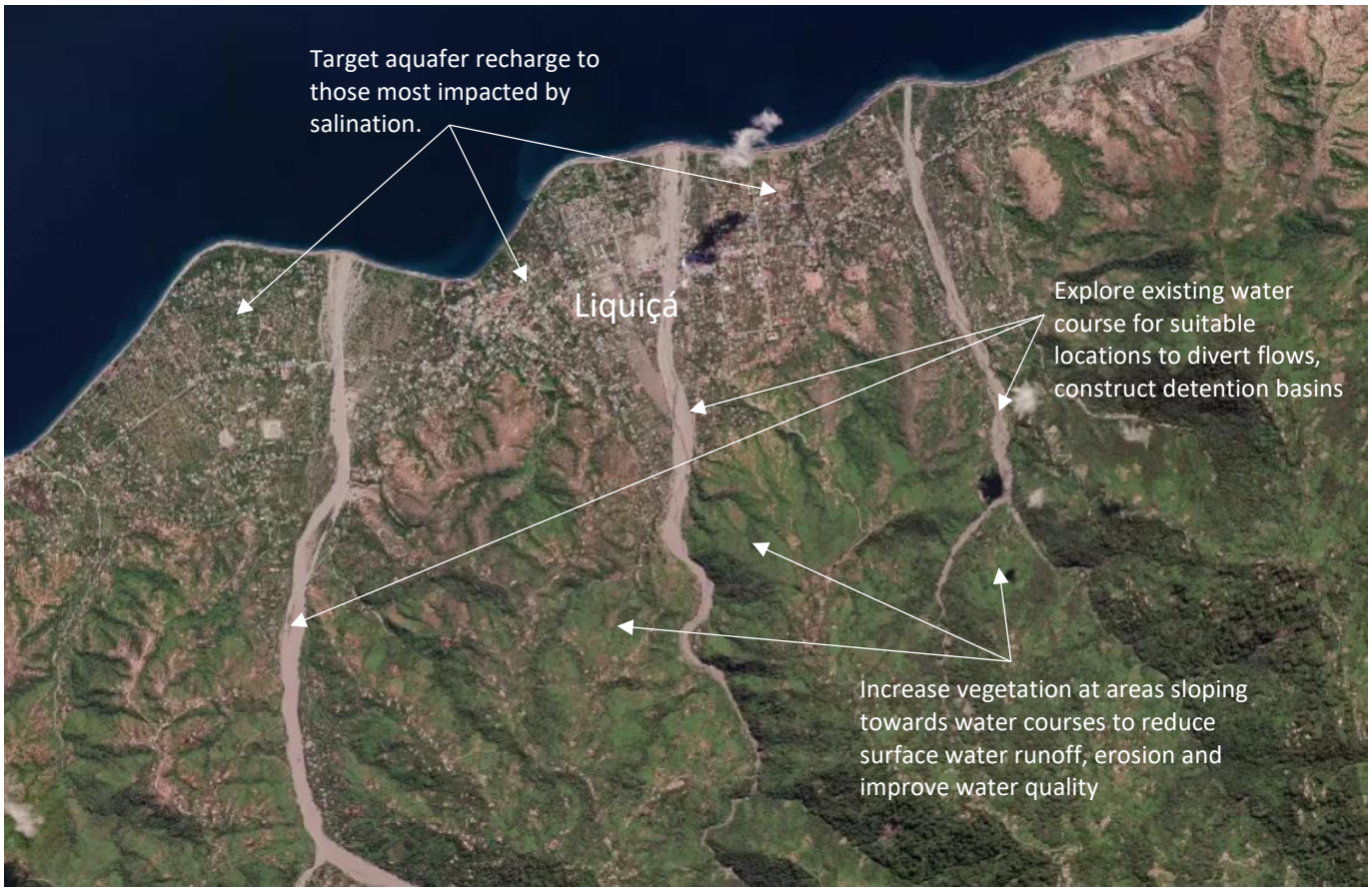


Figure 2: ***Potential application of detention basins and revegetation to increase aquifer recharge in targeted areas around Liquiçá, Timor Leste (Source: Metro Maps).***

These actions will form part of a wholistic solution and aim to provide a long term and sustainable solution, to reduce the salination of groundwater sources and contamination by household septic tank use in the area (by increasing the overall volume of groundwater in the aquifer). Further, by directly addressing the groundwater issue, residents can continue to utilise fresh flowing water from the ground.

Additional components of a wholistic solution should aim to reduce reliance on boiled water for treatment, as this leads to localised deforestation, disturbs the catchment area, increases erosion, and impacts groundwater recharge and runoff. Reducing reliance on wood-fired boiled water could be achieved through use sustainable combustible materials, or using alternative filters constructed from locally available materials. Both alternative fuel and local filter material could be supplied locally by choosing appropriate fuel of fibre plant species in the revegetation projects.

One of the most important components of the holistic solution is an education campaign to involve the local community members. Engaging with women's groups around the sources of contamination of their current supplies and appropriate treatment methods will achieve multiple results, particularly in children's health. The broader community, particularly the farming community can be shown threats to their water quantity and quality such as the processes leading to groundwater salination or falling aquifer levels. A local and regional campaign can introduce the full suite of local solutions, from turning off taps, improved water quality and options available for aquifer recharge.