

THE COOK ISLANDS APPROACH TO STORMWATER MANAGEMENT: WHERE 'OTHER' PRIORITIES MERGE

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ABSTRACT

In a Pacific Island nation with diverse and geographically separated island communities, with basic needs not yet addressed, with high reliance on aid funds for project implementation, and with tourism as the leading element of the economy, it is understandable if one perceives proactive stormwater management as only secondary to potable water supply provision, sanitation improvement, lagoon water quality maintenance, and roads enhancement.

Despite the lack of spotlight for stormwater management in the Cook Islands, their initiatives and projects show that it has become an inherent component of every scheme. The reason is explained by the inevitable impact of uncontrolled surface water on private properties, the land, and the receiving water bodies. All these impacted objects are part of a Cook Islander's sense of identity – significant to one's culture, history, and family heritage.

The Cook Islands Government now recognises the importance of policy and planning as a proactive approach to become future ready. This paper presents various ways on how drainage management becomes a vital consideration in development. The paper aims to show that planning for necessities such as road infrastructure and sanitation point towards a single aim that is stormwater management.

The urban context can easily draw us practitioners into more advanced stormwater management methods. Let us learn from the challenges faced and solutions implemented by this Pacific island nation, and support them with their long-term vision for stormwater management.

KEYWORDS

Drainage, stormwater management, Pacific Islands, Cook Islands, resilience, roads, sanitation, water supply

PRESENTER PROFILES

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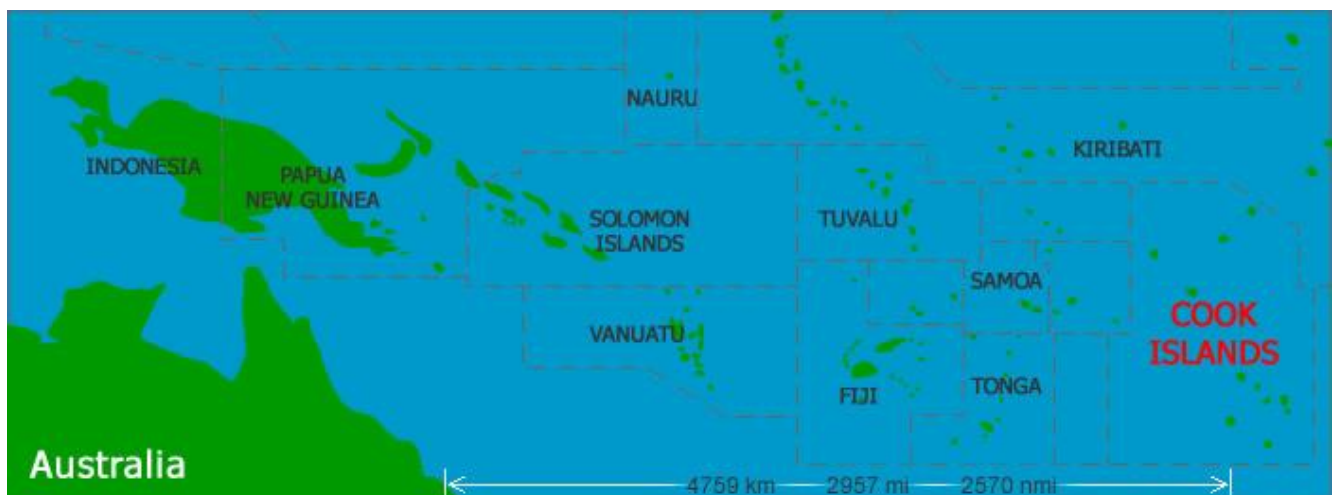
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1 INTRODUCTION

The Cook Islands is a self-governing island country in the Pacific with a population of approximately 14,000. The country comprises 15 islands stretched out over a vast expanse (around two million square kilometres) of the South Pacific Ocean as shown in Figure 1 below. The islands consist of low-lying atolls (one to two metres above sea level), and elevated islands including volcanic islands and raised atolls.

The neighbouring Pacific Islands include Samoa and Tonga to the west, Tahiti to the east, Hawaii and Kiribati to the north, and New Zealand to the southwest. Rarotonga, being the capital and main commercial centre, is home to 70% of the Islands in the Pacific resident population, where Central Government resides, and where legislation, regulations, and design guidance are primarily founded on. This paper focuses on stormwater management on the main island of Rarotonga, with some applications on the outer Cook Islands (i.e. the rest of the Cook Islands apart from Rarotonga).

Figure 1: Location of the Cook Islands in the Pacific (Tourism Cook Islands, 2017)



2 CURRENT STORMWATER MANAGEMENT

2.1 STREAMS AND NATURALLY FORMED DRAINS

The current stormwater network (more commonly known as 'drainage') in the Cook Islands, particularly on the main and most developed island of Rarotonga, mainly consists of naturally formed drains and streams (in both private and public land), with each stream named after the corresponding district where it is located. The term 'drainage' as translated in Cook Island Maori, is the same as a stream or small stream 'ara vai'. Streams are located all around the volcanic island of Rarotonga, with its highest peak at approximately 658 m above sea level. Streams discharge to the lagoon surrounding the island.

Current design guidelines towards water sensitive design in the urban context, such as in Auckland, New Zealand, emphasise the value of natural streams and waterways as part of the stormwater system. However without stringent controls on stormwater discharge and strict implementation of development restrictions adjacent to watercourses (to
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minimise downstream erosion, degradation of stream water quality, and flooding risks), Rarotonga has seen an increase of issues associated with inadequate drainage or stormwater management.

2.2 ROAD DRAINAGE

Roads are generally drained via naturally-formed roadside drains discharging to nearby streams. For majority of the areas, there is currently no defined reticulated drainage network collecting and treating runoff from existing roads. In the town centre of Avarua, Rarotonga, the first flush of stormwater contaminants (e.g. Total Suspended Solids, Hydrocarbons, Copper and Zinc) following rainfall is managed by the use of swales, grassed drains, wetlands, and grassed basins. More advanced treatment methods may be required here where there is piped stormwater and relatively greater areas of sealed road surface.

Problems along roadside drains have increased over the years with the increased frequency and intensity of rainfall causing flash floods, drain blockages, erosion/scouring and embankment slope instability. Damage to private property is also evident as a result of flooding.

2.3 REACTIVE MAINTENANCE: FORMAL AND AD HOC RESPONSES

Major issues associated with excessive flooding are currently being addressed by the 'Bridges & Drains' programme implemented by Infrastructure Cook Islands (ICI). This programme involves condition assessment of existing bridges (including culverts), and prioritisation of rehabilitation work to improve bridge structural integrity and drainage.

Minor issues such as drain blockages are addressed in an ad hoc manner. Some communities band together to fix what they can (e.g. stream clean-ups and repairs of eroded embankments).

2.4 PROACTIVE PLANNING: DEVELOPMENT PERMITS

The most relevant proactive initiative carried out by the Cook Islands Government is the implementation of development restrictions. There are existing rules governing discharge to streams, mainly enforced by the National Environment Services (NES). These rules limit development close to streams and restrict alterations to existing drain alignments unless an Environmental Impact Assessment (EIA) is carried out and the outcomes prove that potential adverse impacts can be mitigated, and/or beneficial ones are obtained.

The EIA is a requirement under the Environment Act 2003, which involves evaluating the likely environmental impacts of a proposed project or development. Factors including socio-economic, cultural and human-health impacts are all taken into consideration. The outcomes of the assessment are presented for public consultation for 30 days. Public feedback are presented in writing to NES, with an opportunity for a public meeting if deemed necessary by NES.

The implementation of the EIA requirement and the development restrictions is currently variable among the various islands. Only six islands in the Southern Cook Islands, including Aitutaki, Atiu, Manihiki, Mauke, Mitiaro and Rarotonga have adopted the act as a means to safeguard their environment.

3 IDENTIFIED ISSUES

It is understandable why proactive stormwater management only becomes secondary to other primary issues faced by the Cook Islands, including potable water supply provision, sanitation improvement, lagoon water quality maintenance, and roads enhancement. However, the Cook Island Government now recognises that inadequate stormwater management impacts the livelihood and well-being of its own people. Therefore Infrastructure Cook Islands (ICI) has identified a number of issues relating to stormwater management, as part of the government agency's master planning and policy development.

3.1 GAPS IN FUTURE CATCHMENT PLANNING

There is currently no town planning for Rarotonga, although individual proposed developments are dealt with separately under the EIA process. This gap prevents the holistic management of stormwater. For instance, proposals for developments can include a number of stormwater discharge options such as direct discharge to waterways and soakage.

Land availability for the installation of stormwater drains and treatment devices is challenging, due to the extensive consultation requirements posed by private land ownership. Recent and current projects for water supply and sanitation upgrades have, and are currently developing effective methods for consultation to secure land requirements for the public utilities. If successful, it is envisioned that a similar process should be development for the future stormwater catchment planning.

Earthworks and fills on development land result in loss of natural wetlands and watercourses which provide stormwater treatment and conveyance. Lost watercourses are not necessarily replaced or compensated for by the benefits proposed by developers, as benefits from developments are primarily economic or tourism-related, which are prioritised over environment protection.

3.2 LACK OF STORMWATER RETICULATION NETWORK

There is no centralized reticulation network for Rarotonga, nor on any of the outer Cook Islands. This results in uncontrolled discharge to stream outlets without proper erosion protection and allowance for flood levels. Flooding results in damage to private property and to valuable vegetable gardens and taro patches.

Photograph 1: Erosion on private property due to blocked drains (ICI, 2016)



3.3 UNREGULATED DISCHARGE QUALITY

As witnessed by local residents, sedimentation occurs in the lagoons and harbours following high intensity storm events. Runoff from adjacent land are being discharged onto roads without restrictions. The sediments from adjacent land, combined with the contaminants from road vehicles, all discharge to the nearby streams and eventually to the lagoon.

The Muri lagoon off the eastern coast of Rarotonga, is exhibiting water quality issues, posing an impact to the tourism industry. This is a significant concern as tourism is the primary source of income for the country. The contamination of lagoon water quality is suspected to be due to the high concentration of nitrogen and phosphorus in effluent water discharges from on-site wastewater treatment facilities. Although upgrades to the facilities have been and are currently being facilitated by a division of ICI, the assessments are still ongoing and the most effective solution is yet to be confirmed.

3.4 LIMITED FUNDING FOR ADDRESSING STORMWATER ISSUES

Due to the high costs associated with addressing flooding and water quality issues, including installation of a reticulation network where necessary, and introduction of on-site stormwater treatment devices, communities tend to rely on government to address stormwater needs. Available funds are primarily allocated to the sectors that have a direct impact on the tourism industry, such as improvement of road infrastructure, and addressing water quality issues in Muri.

4 PREPARING FOR THE FUTURE

Policy and planning is the Cook Islands' strongest tool for securing their future, including in the stormwater sector. In the past, stormwater was only addressed when it causes flooding and damage. The Cook Islands Government now recognises the importance of policy and planning in order to be future ready. Stormwater management is now considered an important aspect of development.

A number of specialist areas within government contribute to the policy and planning for infrastructure development in the Cook Islands. The Office of the Prime Minister (OPM) and ICI have locally based qualified staff and volunteers from institutions such as

Volunteer Service Abroad, and Local Government New Zealand, contributing to policy and planning.

4.1 NATIONAL VISION AND GOALS

In 2016, The OPM launched its National Sustainable Development Plan (NSDP) 2016-2020, which encapsulates the aspirations and ambitions of the Cook Islands over a five year period. The country's national vision is "to enjoy the highest quality of life consistent with the aspirations of its people, and in harmony with their culture and environment."

This is the overarching principle which governs future plans for the Cook Islands. Out of the 16 goals presented in the NSDP, five of these present linkage to the management of stormwater.

4.1.1 SUSTAINABLE MANAGEMENT OF WATER AND SANITATION

Goal 4 of the NSDP is the sustainable management of water and sanitation. The plan recognises that water and sanitation are basic necessities of its people, economy and environment. Preservation and management of freshwater reserves involve a holistic as well as in-depth understanding of the water cycle – rainfall prediction (incorporating climate change impacts), proactive capture of rainwater for domestic use, and managing stream flows for groundwater recharge if necessary, resulting in less runoff volumes and reduced unwanted contamination at outlets.

Management of sanitation relates to stormwater management such that overall discharges to lagoons both include effluent from on-site wastewater facilities, as well as indirect discharges from inland (including from areas where agriculture exists, with animal excreta discharging to nearby streams, affecting downstream water quality). Sanitation also relates to the stormwater sector in that it requires management of land-use, thereby affecting the quality of runoff discharging to the lagoon.

4.1.2 INCREASE SUSTAINABLE AGRICULTURE

Goal 10 in the NSDP is to achieve food security and improved nutrition, and increase sustainable agriculture. This goal relates to stormwater management in that it aims to preserve arable land, limiting the opportunities for increased urbanised impermeable surface areas (usually tourist use) which would otherwise result in more runoff volumes.

Drainage improvement on taro patches is already being carried out by some outer island communities in an effort to save their taro plants from excessive salt water intrusion during high intensity storm events compounded by high tides. As an example, as shown on the image below, the taro plantation area on the Northern Group outer island of Pukapuka was a big pit inland that had limited water outlets. As a result of heavy rain, flooding was a problem. The new drainage allows for excess water to drain out.

Photograph 2: Drainage improvement on taro patches on the Northern Group outer island of Pukapuka (Climate Change Cook Islands or CCCI, 2016)



4.1.3 PROMOTE SUSTAINABLE LAND USE AND PROTECT BIODIVERSITY

Goal 11 recognises the importance of land management, as the Cook Islands has a small proportion of land mass compared to its vast ocean. Protection of wetland areas (including estuaries, swamps, and marshes) is important as they function as natural filters to treat and regulate runoff. The issue causing the degradation of wetlands is primarily the development activities that fill up these areas, especially on Rarotonga. Wetland areas are also planned to be included in protected land zones to maintain and improve ecosystem health and biodiversity.

The current Ridge to Reef project focuses on catchment management, addressing stormwater across the land to streams and how it's discharging along the coast. This project also facilitates integrated catchment protection plans.

4.1.4 SUSTAINABLE MANAGEMENT OF OCEANS, LAGOONS AND MARINE RESOURCES

Goal 12 focuses on the timely monitoring and enhancement of lagoon water quality. This goal relates to stormwater management such that it recognises that unsustainable land use practices cause sedimentation on the lagoon. Management of stormwater quality will positively impact the quality on the lagoon.

4.1.5 STRENGTHEN RESILIENCE TO COMBAT THE IMPACTS OF CLIMATE CHANGE AND NATURAL DISASTERS

Goal 13 requires the consideration for climate change and natural disasters, as they impact all facets of the Cook Islands lifestyle. One result of climate change is the more frequent and higher intensity rainfall events, resulting in damage to property and threat to human life. Under this NSDP goal, future stormwater management, if to be implemented by the Cook Islands, must incorporate climate change impacts when designing stormwater infrastructure.

4.2 NATIONAL INFRASTRUCTURE AND INVESTMENT PLAN

Further to the high level vision of the Cook Islands, a more focused plan has been developed to prioritise the investments on infrastructure. The Cook Islands National Infrastructure Investment Plan (CI NIIP) outlines the country's priorities and plans for major infrastructure over the next 10 years. Ten infrastructure investment categories were included in the plan. The direct inclusion of road transport, water supply, and sanitation investments, indirectly includes drainage or stormwater management. For all infrastructure investments, the implications of climate change were all incorporated.

The most relevant inclusion of drainage in the CI NIIP is within the road transportation sector. The document points out that existing roads have minimal roadside drainage. Investment planning includes rehabilitation, strengthening and maintenance of road pavements and drainage structures.

Plans for drainage and stormwater management not only focus on the current needs, but also incorporates climate proofing response to more intense short-duration storm events. The following strategies to address these under the CI NIIP include the provision of the following:

- *Increased capacity of transverse drainage system* – Where the intensity of short-duration rain events increases, the capacity of transverse drainage system will be increased by providing additional relief culverts.
- *Improved longitudinal drainage* – The ability of the longitudinal drainage systems to accommodate the higher quantity of runoff due to the higher precipitation rates will be improved by lining drains and providing larger ones.
- *Erosion protection* – Areas in the vicinity of the road at risk of erosion will be protected using bioengineering techniques. In addition, steeply graded streams in the vicinity of the road will be provided with check dams to reduce sediment loads on the road drainage system.
- *Increased maintenance* – The quantity of maintenance increases in response to the faster rate of physical deterioration.

A planned project within the ICI agency is the widening of roads, which incorporates improved roadside drainage. Regulations / requirements for inclusion of drainage on roads is specified in the latest Roads and Drainage Policy as discussed in the next section below.

4.3 ROADS AND DRAINAGE POLICY

The Draft Roads and Drainage Policy was released in 2017 by ICI, which will be the lead government agency to implement this policy. The policy is entitled the Roads and Drainage Policy, to highlight drainage as an important and sometimes overlooked aspect of road construction and maintenance, as without adequate drainage, roads will rapidly deteriorate.

In addition to the consideration for road drainage for the primary drainage system, climate change effects such as extreme rainfall events are also considered in the policy. Under this policy, road design and maintenance needs are to consider sea level rise, increased incidence and intensity of cyclones, flooding from both rainfall and sea surge, and drought conditions.

In accordance with this policy, drainage will be included in the proposed Roads and Drainage Regulations and Master Plan, which will help regulate the use of appropriate construction materials for drainage design, and the provision for treatment of stormwater from roads to remove or neutralise first flush contaminants.

The policy also aims to deliver updated legislation to clearly mandate the responsibility for the construction, operation and maintenance of public roads, and provision for easements for utilities in the road reserve (including any stormwater drainage and treatment devices).

Another important feature to be incorporated on the Road and Drainage Regulations is the implementation of restrictions on discharge of water from adjacent land onto roads. This will reduce the contamination of stormwater from adjacent land, which would otherwise add road contaminants to the resulting runoff quality.

4.4 RAIN WATER HARVESTING AND ALTERNATIVE WATER SOURCES ON OUTER ISLANDS

Two divisions from the Office of the Prime Minister: The Pa Enea (Outer Islands) Governance Unit (PEGU), and Climate Change Cook Islands (CCCI), are prioritising water security projects on the outer islands.

The Cook Islands are divided geographically into the Northern Group and the Southern Group islands. The Northern Group islands primarily rely on rain water harvesting as their source of potable and non-potable water supply. The Southern Group islands have either groundwater supply or use rain water harvesting for domestic use. More recently, impacts of climate change have affected the readiness of these outer islands to drought response.

The geographical split between the two island groups causes the country to experience opposite climatic effects between the two island groups. In the Southern Group, water scarcity is experienced as shown in Photograph 2 below. PEGU and CCCI actively liaise with volunteer organisations and donor agencies to secure technical input and funding to provide additional tanks for rain water storage, and to investigate other water sources. Although drainage management is more ad hoc on the outer islands, the water cycle eventually depicts that rainwater harvesting reduces the amount of stormwater runoff generated from private land.

Photograph 2: Comparing stream water levels on the Southern Group outer island of Mangaia (CCCI, 2016)



Photograph 3: Example of water tanks provided on the Southern Group outer island of Atiu on the image on the left; A local resident manually testing flow rates from a potential water source in Mangaia on the image on the right (CCCI and PEGU, 2016)



4.5 SANITATION (WASTEWATER MANAGEMENT) POLICY

The management of wastewater is a matter that needs to be addressed because of its potential impact on human health and the environment. As already mentioned previously, the Cook Islands faces some particular pressures due to increasing development mainly associated with tourism. This policy identifies the vision, purpose, scope and timeframe.

Although stormwater is not the direct subject of this policy, indirect links to wastewater management triggers the need for stormwater management. The Sanitation Upgrade Programme previously implemented by the Water, Waste and Sanitation (WATSAN) division of ICI, recognises that uncontrolled surface water on properties can have a detrimental impact on the proper operation of onsite wastewater treatment and disposal systems, and that current investigation works to scope the most effective wastewater reticulation and treatment option eventually aims to reduce nutrient contamination of stormwater discharging to the lagoon.

5 CONCLUSIONS

Although stormwater management is only secondary to potable water, wastewater, and roads asset management, the work being investigated and put in place by the Cook Islands Government have direct and indirect impacts on stormwater management. Stormwater management has in the past been taken for granted, but now ICI and the wider government are taking steps to remedy this.

The Cook Islands demonstrates its willingness to prepare itself for the challenges of the future. It has recognised the importance of sustainable management of water and sanitation, agriculture, land-use, and strengthening resilience to the impacts of climate change – all of which have indirect impacts to the management of stormwater quality and quantity.

As evident in the plans in place and the projects stated in this paper, the country has already taken a number of proactive steps to get ready for the next phase of stormwater management, as well as be prepared and adaptive to climate change impacts. Planning is one step, and the challenge now lies within the ongoing implementation and monitoring of these plans already in place, as well as those initiatives that already started. The ongoing support of aid organisations is highly appreciated by the government and the local communities.

The Cook Islands is an example of a resilient nation, although not yet at the peak of its stormwater infrastructure development, it is proactively taking sustainable steps towards addressing issues associated with stormwater management. Generally, despite their small size, geographically and in population, Cook Islanders are doing their part to protect the things they value – their families, their environment, and the future generations.

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