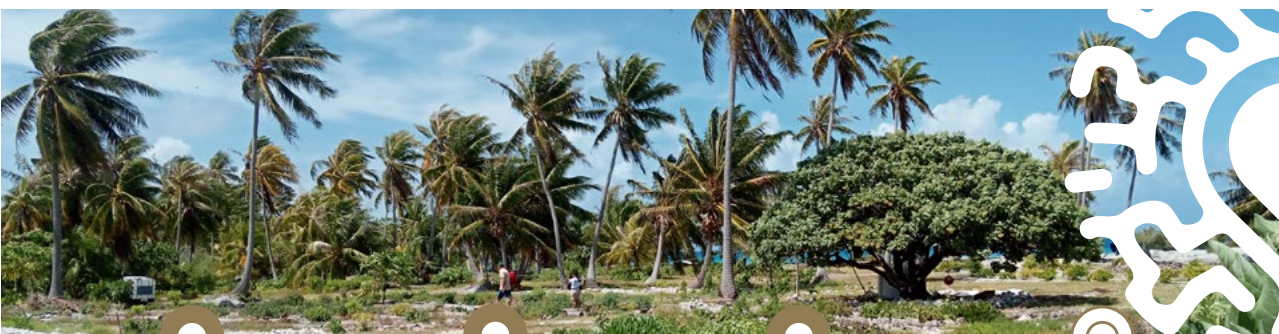


AGROECOLOGICAL MANAGEMENT OF WATER RESOURCES



New Caledonia

French Polynesia

Wallis & Futuna

Pitcairn Islands

 BUDGET: EUR 250,000 (XPF 29.8 million)

 ACTION TIME PERIOD: January 2020 - December 2023

 PARTNERS:




VALORGA
Association agricole



• CFPPA de Moorea
• Vai-Natura

BRIEF SUMMARY

 Effective freshwater management is one of the major challenges facing the many Pacific Islands, especially atolls. The effects of climate change will certainly heighten tensions among the various users of this crucial resource. In agriculture, better integration of the water-soil-plant system is needed to achieve more sustainable water management. This will require optimising the use of water resources (e.g. rainfall and underground water) and reducing water losses (e.g. runoff, evapotranspiration, etc.).

So, the **PROTEGE** programme supported the acquisition of knowledge on the dynamics of water resources, especially on atolls, as well as the evaluation and dissemination of effective water-use practices in agriculture. In addition to its work on managing various forms of irrigation, PROTEGE promoted water-efficient agricultural systems that increase the amount of water stored in soils. These include agroforestry and practices that help reduce water losses in agrosystems.





BACKGROUND

Island countries and territories face a threat from climate change not only from rising sea levels. Climate change will also exacerbate tensions regarding fresh water in the Pacific Islands, especially those that rely on seasonal rainfall to meet their water needs. Low islands, such as atolls, are particularly vulnerable due to the lack of surface water and very limited groundwater availability. On those islands, water resources are heavily dependent on rainfall, which is variable and alternates with periods of drought, thereby posing a serious threat to the future of island residents. High islands, which benefit from groundwater and surface water resources, face qualitative problems. These islands are threatened by

"Climate change is going to heighten the water-resource vulnerability of islands"

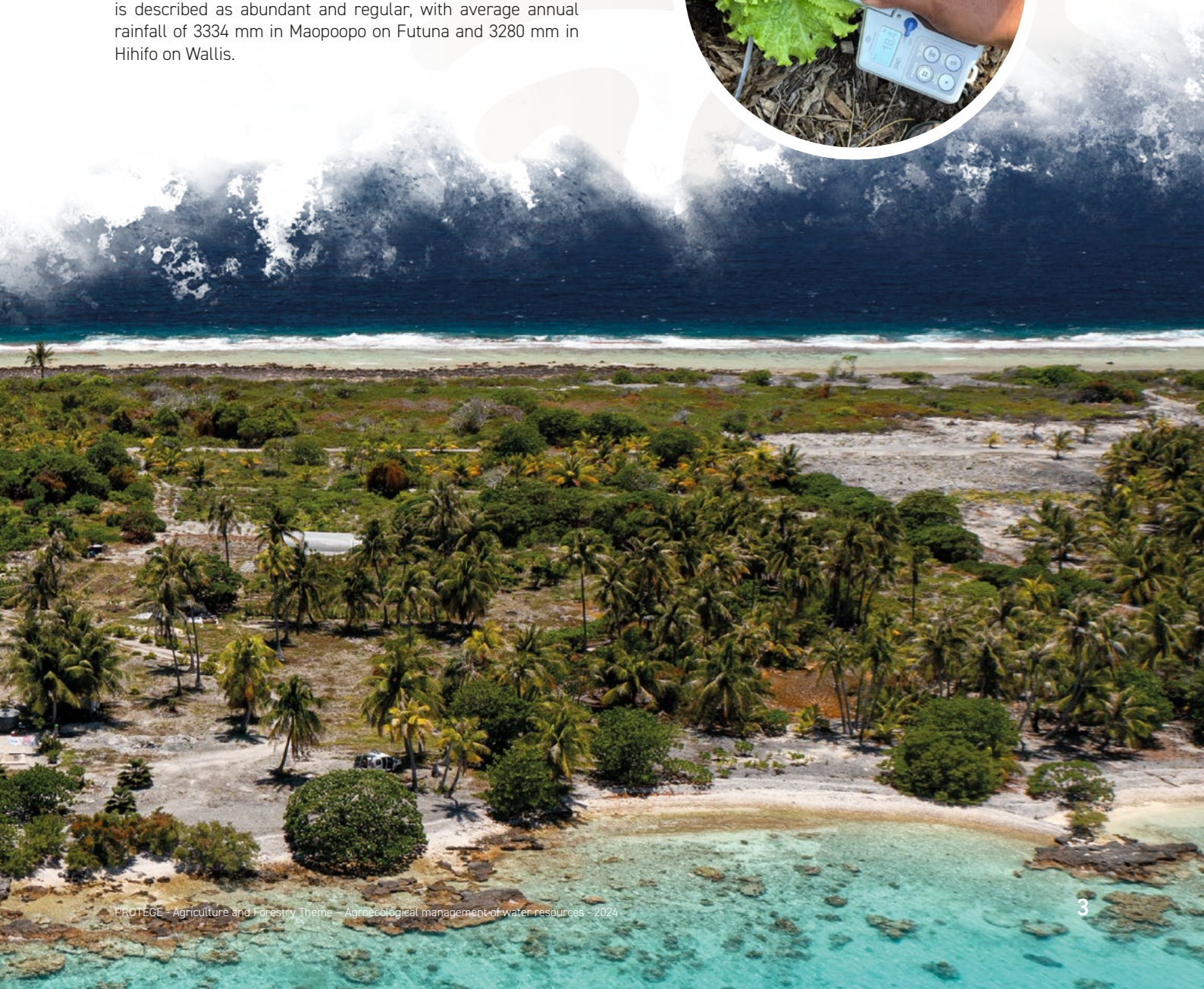
increased rainfall, in particular from more frequent extreme rainfall events, which leads to heightened risks of flooding and runoff. Other phenomena linked to climate change can also have an impact on water resources. Higher temperatures, for example, foster evapotranspiration. Another concern is the growing number of tropical cyclones as even though the rain associated with them helps recharge freshwater lenses, tropical cyclones cause waves that can damage infrastructure and lead to the mixing of fresh and salt water. And, above all, the El Niño climate phenomenon is predicted to become more frequent, and increased drought occurrences on the Pacific Islands are expected, judging by its past effects.



In **French Polynesia**, the Tuamotu island group includes 690 sq. km of land spread over 76 atolls, 38 of which are inhabited. They are home to 6% of the French Polynesian population. The French Polynesian government would like to increase the food self-sufficiency of the people of Tuamotu and promote the economic development of these low islands through short circuits. To this end, it encourages small-scale multicrop-livestock farming carried out by farmers who hold a variety of jobs. However, this hoped-for growth in agricultural activity must not compromise the precious but already limited freshwater resources on these islands. Currently, the quantity of freshwater per day available per person living on atolls is around 50 litres, compared with 130 to 500 litres on high islands. In the Marquesas Islands, some areas can be described as semi-arid, with a high annual water balance deficit. This strongly affects animal and plant production there.

In **New Caledonia**, crop and cattle production is particularly affected by alternating El Niño years, which bring severe drought, and La Niña years, which bring intense rainfall. The agricultural sector must therefore adapt its practices to cope with the increasing intensity of extreme weather events (e.g. droughts, cyclones, etc.) and the greater variability of rainfall throughout the year.

The islands of **Wallis and Futuna** enjoy a tropical maritime climate, with high levels of heat and humidity. Precipitation is described as abundant and regular, with average annual rainfall of 3334 mm in Maopoopo on Futuna and 3280 mm in Hihifo on Wallis.





ISSUES & OBJECTIVES

📌 All the PROTEGE initiatives involved working with stakeholders in the three territories to reconcile the development of agricultural activities (which are needed to boost food self-sufficiency there) with the preservation of water resources on both low and high islands.

The challenge was to develop market-garden, food and fruit crops, ideally combined with small-scale units for raising chickens or pigs, based on water-efficient agronomic practices that restore soil fertility.



TO MEET THESE CHALLENGES, THE ACTIONS SUPPORTED BY PROTEGE PURSUED 3 OBJECTIVES:

- ☑ Knowledge on atoll water resources and their dynamics
- ☑ Improved knowledge on water needs and irrigation management
- ☑ Promotion of water-efficient farming systems and practices





ISSUES & OBJECTIVES

Knowledge on atoll water resources and their dynamics

In **French Polynesia** and on its atolls, the objective was to improve knowledge on the dynamics of freshwater lenses. Understanding this issue is crucial to accurately estimating the volume of fresh water available, which in turn helps determine the most appropriate pumping scheme to meet the domestic and agricultural needs of a specific area. Two areas were monitored: one on the island of Rangiroa and the other on the island of Fakarava.

"Technical factsheets on irrigation"

Improved knowledge on water needs and irrigation management

These actions were implemented by farmers in the Tuamotu and Marquesas Islands, the two island groups of **French Polynesia** where water resources are a limiting factor for agricultural production. In the Marquesas Islands, where several consecutive years of drought have been recorded, knowledge of the water status of plots is crucial for optimising irrigation management. In the Tuamotu Islands, monitoring the salinity of irrigation water and cultivated beds is essential to avoid compromising the growth of crops that might be affected by increases in the salt levels of freshwater lenses or soil salinity. In **New Caledonia**, where water resources may be limited at certain times of the year, the adoption of smart water-management tools is a key lever for optimising irrigation management. In **Wallis and Futuna**, the introduction of rainwater recovery and reuse systems for agriculture marks a first step towards optimised irrigation management in market gardening.

Promotion of water-efficient farming systems and practices

One of the major objectives for all **three territories** was to improve the water-retention capacity of their soils by increasing their organic matter content. To explore this approach, the principles of **syntropic agriculture**, in particular, were applied, by using atoll vegetation to maintain or even improve soil organic matter levels. This practice seeks to increase not only soil fertility, but also its water-retention capacity, thereby reducing the need for irrigation. Limiting water loss caused by evaporation, for example through the use of organic mulch, is another crucial issue for developing water-efficient practices.

In **Wallis and Futuna**, a key objective was the promotion of a detachable drip-irrigation system to accompany crop rotations. Another crucial issue identified was the controlled and reasoned management of pig watering in rotating pens. This management method helps limit pressure on the water network and improve productivity, through the supply of water according to the specific needs of plants and animals.

At the same time, in **French Polynesia**, a series of tools was tested to measure or better manage available water. For example, portable sensors were provided to four farmers on demonstration farms to measure soil moisture and salinity or to measure water-lens salinity. Similarly, Waterboxx buckets with wicks were installed on two farms in the Marquesas Islands to facilitate the planting of young seedlings.



OUTCOMES

Knowledge on atoll water resources and their dynamics

Two years of monitoring and knowledge production on water lenses made it possible to provide farmers in the Tuamotu Islands of **French Polynesia** with some recommendations. It was suggested that they (1) increase the number of pumping points in the aquifer and alternate their use; (2) limit the pumping time per well; (3) monitor the salinity of the water drawn, to stay below the threshold of 2500 $\mu\text{S}/\text{cm}$ (the commonly accepted limit for optimal growth of the main plants used for market gardening); and (4) draw large amounts of water during rainy periods and store it in tanks so that it can then be used freely.

Improved knowledge on water needs and irrigation management

Several farms in **New Caledonia**, in particular those in the agroecology demonstration network, were equipped with smart irrigation tools. By pooling observations from these farms and sharing experience among farmers, a variety of case studies were obtained to draw up overall recommendations to help all the farmers. Meteorological data as well as data from tensiometric monitoring and irrigation were used when organising a workshop to co-develop a decision-support tool for irrigation management. Hydraulic and agricultural technicians, as well as farmers, participated in this workshop, which focussed on irrigation management in open-field market gardening that uses a drip-irrigation system. Technical factsheets were produced with the support of technical agents from the Northern and Southern Provinces and REPAIR (see below).

In **French Polynesia**, TDR (Time Domain Reflectometry) probes helped obtain the volumetric water content (VWC) in soil under water stress, making it possible to adapt watering to plant needs without wasting water. Farmers can now use these moisture probes as a tool to ensure that their crops are not under water stress. In the Marquesas Islands, the maximum moisture percentage observed in soils was 50%. In the Tuamotu Islands, market gardening plants can be successfully

grown at a minimum 20% moisture level, with around 30% being optimal. In comparison, some local plants can grow with as little as a 10% moisture level on the atolls. The TDR probes also provide the salt content in soils. This is key data on atolls, because beyond certain thresholds production potential is affected, even if growing conditions are optimal. The data obtained confirm that watermelons, melons and coconut palms tolerate high salt levels in atoll and *motu* soils, but that most plants used in market gardening are sensitive to such conditions. In the Marquesas Islands, especially on the island of Hiva Oa, manual watering of crops can sometimes take up to eight hours a day using a simple pipe system in which someone moves the pipe every 30 minutes on an area of less than 1 hectare. Regular monitoring using a TDR probe helped obtain better understanding of water-retention capacity at several points on the farm plots. These data were then used to carry out a spatialised soil analysis, which made it possible to design a watering system that meets the water requirements of each area with precision. Thanks to this approach, automatised irrigation according to the specific needs of each area can be considered, in order to free up work time for the farm's other activities.

Waterboxx use produced some questionable effects: its effect on soil moisture was non-existent or even negative near roots in rainy weather, in which case the umbrella effect of the Waterboxx outweighed the effect of diffusion via the wick. Nonetheless, a positive effect was observed on moisture near the roots during periods of drought. These findings show that it is crucial to configure the wick so that it diffuses water correctly.

In **Wallis**, gutters were installed on the roofs of the main dwellings of some farmers, along with a water tank fitted with a booster at the gutter outlet. Two trenches were dug, one of which directs the water to the market-garden plot, where it supplies a drip-irrigation system. The tank is also connected to the drinking water supply (DWS) system for added safety. This system eliminates the need to use water from the DWS system to irrigate market-gardening plots, thereby boosting more sustainable management of water resources.

Promotion of water-efficient farming systems and practices

In **French Polynesia**, a training course was held for 17 people from the atoll. It was organised in partnership with the Fakarava municipal team and led by Moorea's CFPPA (Centre for professional training and agricultural promotion). An easy-to-understand presentation of the key information on atoll soils and freshwater lenses was also given at a public meeting at the Fakarava omnisport hall. The mayor of the atoll and about 40 residents attended. The PROTEGE programme included actions to improve organic matter content in soils through the composting of plant and animal waste. This is a key way of boosting soil fertility and water-retention capacity, particularly in the Tuamotu and Marquesas Islands. On Ahe Atoll and other islands, work was carried out to produce compost, for its crucial role as a soil sponge. Tests were conducted in Fakarava, comparing plots with and without mulch for several crops. The findings revealed that mulch thickness plays a crucial role in reducing evaporation. A thickness of 3 cm was inadequate, but 5 cm greatly reduced evaporation. However, it is important to watch out for the "nitrogen starvation" effect when using mulch: the bacteria that degrade mulch can compete with plants for nitrogen, leading to yellowing or slow crop development.

In **New Caledonia**, various communication tools were developed to promote best practices, in particular mulching and irrigation management. These tools come in the form of technical factsheets, testimonial videos and video tutorials, which aid in disseminating knowledge to farmers (see below).

Finally, **in all three areas**, PROTEGE promoted agroforestry as an essential practice for managing the water cycle at different scales (specific locations, plot or farm). Trees play a multifunctional role, as they help make crops and livestock more resilient to climatic variations. The results obtained are detailed in the "Reintroducing trees into farming systems" lessons-learned factsheet.





KEY FIGURES

13 farms
 equipped with smart irrigation management tools in New Caledonia

4 wells
 monitored in the Tuamotu Islands

2000+
 TDR measurements
 over one year in Hiva Oa to determine the water-retention capacity of the plot

500+
 TDR measurements
 in Ua Huka to measure the improvement in soil moisture under the Waterboxx buckets, as close as possible to the young root system

1 microplot trial
 with a control microplot to measure the effect of mulching in Fakarava in French Polynesia

Technical exchanges between
4 New Caledonian agroforesters with farmers from Fakarava and Rangiroa in French Polynesia

FIRST-HAND ACCOUNTS



TEHEI ASINE

farmer in Fakarava, French Polynesia



The biggest benefit of PROTEGE for me has been sharing data and knowledge between farmers and with agricultural bodies and associations (SPC, DAG, IUCN, AGIR NC). As for water management, I've always paid attention to my water consumption for watering my fa'apu.

On this issue, PROTEGE was valuable with regard to managing water quality (salinity), thanks especially to permanent probes and mobile monitoring probes. And also thanks to various cultivation methods, such as mulching, composting and syntropic agriculture, which reduce evapotranspiration.



CHLOÉ SAGLIBENNE

Water Management in Agroecology Coordinator,
New Caledonia Chamber of Agriculture and Fisheries



The system set up for smart irrigation tools enabled us to discuss irrigation on a Territory-wide scale for the first time (responsibility for this issue is at the provincial level and not the Territory), to pool approaches and to enable technicians and farmers to talk about the issues together. Farmers who are members of the PROTEGE agroecology demonstration farm network and who have benefited from this equipment were included in the approach, enabling them to better understand irrigation and the dynamics of water on crops.

This action thus enabled us to test innovative smart tools and discuss good practices to optimise irrigation despite the difficult context of three La Niña years in New Caledonia.

As for future prospects, we hope to continue this type of action beyond the PROTEGE project.





PROSPECTS AND SUSTAINABILITY

In French Polynesia, one farmer involved in the operation installed an intermediate tank on one of his wells, on the advice of the consultancy firm that had worked on water-lens dynamics in Fakarava. This set-up will enable him to pump from the water lens under favourable conditions and irrigate his crops independently of weather, tides and swells. Generally speaking, the work carried out by PROTEGE has helped demonstrate the effectiveness of certain types of equipment. It has also shown the relevance of and value in investing in decision-support tools (whether low-cost or digital), some of which are already available locally.

In **New Caledonia**, the Northern Province is going to set up tensiometric monitoring for a fodder production trial in collaboration with Adecap Technopole. Irrigation management using tensiometry requires an adaptation period so that farmers can familiarise themselves with the equipment, understand water movements and optimise probe positioning (e.g. depth, dripper intervals, etc.). Additional observation and testing time is required to set the irrigation thresholds, which depend on specific factors for each farm and plot monitored, such as the irrigation system, topography, organisation,

"Tools shown to be relevant"

crop planted, growth stage, etc. Technical support will make it possible to propose improvements and gradually refine the threshold values. Organising and running workshops at the end of each growing season would help involve all stakeholders (agricultural and hydraulic technicians, farmers) to take stock of the past season and prepare for the next. These workshops would also help consolidate reference material for irrigation management using tensiometric monitoring of various crops in different contexts, while sharing this knowledge between the various stakeholders, with the purpose of better mobilising water resources. In addition to thresholds specific to crops and their stages of development, **it is essential to share the approach and the keys to informed decision-making between farmers and technicians.**

In **Wallis and Futuna**, the Department of Agriculture will continue to monitor the introduction of drip-irrigation systems in order to encourage their adoption by market gardeners, as well as the use of watering systems to limit water losses in rotating pig pens.





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REPORTS

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Émission Résilience épisode 6 "Au nom de la terre"

Version longue



Version courte



Lentille d'eau douce : comment se forme-t-elle ? L'exemple des atolls de Polynésie française

Version française



Version tahitienne



Lentille d'eau douce : que se passe-t-il lorsque l'Homme puise dans les ressources ?

Version française



Version tahitienne



L'installation d'une station d'irrigation connectée Episode 9, CAP NC

Version courte





Find all the lessons-learned factsheets on Agriculture and Forestry **freely available on our website.**



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