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Indigenous Pacific biosecurity network – Réseau de coopération pour la biosécurité dans le Pacifique

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Glossary

CEN :	Conservatoire d'Espaces Naturel
DAVAR :	Direction des Affaires Veterinaires, Alimentaires et Rurales
IAC :	Institut Agronomique neo Caledonien
IKAPALA:	Institut Kanak des Plantes, de l’Artisanat et des Langues Autochtones
IUCN:	International Union for Conservation of Nature
PFR:	Plant and Food Research
SIVAP:	Service d'inspection vétérinaire, alimentaire et phytosanitaire

Executive summary

Indigenous Pacific biosecurity network – Réseau de coopération pour la biosécurité dans le Pacifique

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July 2020

The kaupapa

Indigenous peoples of the South Pacific have in common a complex, holistic and interconnected relationship with nature and its resources. This traditional and ancestral link makes them particularly vulnerable to biological invasions; in some cases, this can result in changes in lifestyles, the loss of traditional ecological knowledge and practices for future generations. The extent of these socio-cultural impacts is often overlooked and rarely considered in the development of management plans for invasive species at the Pacific scale. Biosecurity incursions are similarly impacting the cultural and environmental resources of Maori, the indigenous people of New Zealand where initiatives have begun to resource indigenous knowledge development and governance of biosecurity risks. In May 2019, a grant agreement from the Pacific Funds of the Embassy of France in New Zealand was signed with The New Zealand Institute for Plant and Food Research Limited to build a biosecurity network that will strengthen the relationships between the indigenous communities from the Pacific and learn about their challenges when dealing with biological invasions. The funding was sought to develop the first phase of the project to initiate the relationships with the Kanak people of New Caledonia and the Tahitian Ma'ohi of French Polynesia. The purpose of this project was to:

- connect the indigenous communities of New Caledonia and French Polynesia with indigenous biosecurity representatives in a culturally significant setting of co-learning, co-development and co-innovation;
- understand the impact new and invasive biosecurity incursions are having on their ability to interact and subsist in a traditional cultural context within the environment they live in;
- learn about their experiences in mitigating or managing the myrtle rust incursion.

Key results

Cultural exchanges and network development were successfully carried out in both New Caledonia and French Polynesia. Biosecurity workshops have been organised in both localities to understand the main challenges when dealing with invasive species. Along with our visits and discussions with the scientific and local communities, we discovered that a certain number of threats possibly caused by unknown pathogens are affecting culturally important plant species. Overall, our visits highlighted that there is a common and strong feeling of guardianship and protection of the environment among the different indigenous people we represent and interacted with and this is likely to extend across the Pacific. Collaboration and learning from one another are key to improving border defences and protections against various pests and diseases.

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1 Introduction

In May 2017 myrtle rust (caused by the exotic fungus *Austropuccinia psidii*) was discovered on mainland New Zealand at a plant nursery in Kerikeri, Northland. Since the first positive identification, myrtle rust has spread rapidly across the North Island of New Zealand, now threatening the long-term existence of some species, namely ramarama (*Lophomyrtus bullata),* pōhutukawa (*Metrosideros* spp.) and monkey apple (*Syzygium* spp.).

Myrtle rust is not the first biosecurity incursion to threaten native New Zealand flora and it most definitely will not be the last. What is most concerning to the indigenous people of New Zealand, the Māori people, is the frequency with which incursions are occurring and the impacts they are having on the environment on which they rely so heavily. These interactions are in line with the traditional practices of kai (food source), rongoa (use native plants for medicine), whakairo (use of wood species for carving), and tangi (native greenery for ceremonial use). As well as being a provider of sustenance for Māori, the native estate serves as an environmental indicator, providing signals to the people of the time to plant, to harvest and to store food from a variety of sources, including the marine domain.

We know that the people of Aotearoa/New Zealand are not the only ones affected by new incursions like myrtle rust, and that this is a concern for many indigenous people across the Pacific. We want to share the knowledge we have gained, and our experiences of these incursions with these Pacific communities, to understand if synergies exist and to learn from the experience of others. This project will develop a three-way connection with the Kanak people of New Caledonia and the Tahitian Ma'ohi of French Polynesia to link culturally to learn about the impacts that biosecurity incursions are having on their communities and their ability to interact in a traditional context with the environment in which they live.

2 Purpose

The indigenous peoples of all countries have a vested interest in their land, not only for food, water and other resources but also a spiritual and whakapapa connection that is the essence of their cultural identity and health. For them they have nowhere else to call home. The Māori people of Aotearoa/New Zealand regard this as kaitiakitanga (guardianship): being responsible for the land (Papatūānuku), water (He Wai Māori, He Wai Tai), and species (Te Wao Nui o te Ao) that co-exist in this environment and regard it as their home.

The purpose of this project was to connect the indigenous communities of New Caledonia and French Polynesia with indigenous biosecurity representatives from Aotearoa/New Zealand in a culturally significant setting of co-learning, co-development and co-innovation to understand the impacts that new and invasive biosecurity incursions are having on their ability to interact and subsist in a traditional cultural context with the environment in which they live, and to learn about their experiences in mitigating or managing the incursion.

The comparative dimension, combined with the interaction sought between the indigenous communities of New Caledonia, French Polynesia and Aotearoa/New Zealand, will allow the project to contribute to an improved understanding of the impacts that biosecurity risks like myrtle rust can have on the indigenous communities of each country. The relationship development will contribute to the French overseas countries and territories integration into the Pacific region through a mutual learning process based on traditional cultural ideologies and joint learning opportunities from shared experiences, knowledge and practices through cultural exchanges and workshops.

Our team recognise the value and importance of building trustful relationships. From an indigenous perspective this is always achieved by performing welcomes that link to our traditions and heritage. In Māoridom this is called a Pōwhiri. This is done at the beginning of any new engagement and relationship, especially for first-time visitors to a country, island or region. The purpose of pōwhiri is to welcome visitors (manuhiri) to your land (whenua). They arrive under a veil of tapu (sacredness), so need to have that removed (whakanoa), which is done doing the pōwhiri so that the visitors (manuhiri) become one with the host people.

In both New Caledonia and Ra'iātea (Tahiti) a similar process was delivered by the Kanak (New Caledonia) and Ma'ohi (Ra'iātea) people to our party, welcoming us and extending their hospitality as hosts. During this process we were able to introduce ourselves and the purpose for our visit in our native tongue, enabling an immediate connection to be established. This was deliberate, as it allowed us the opportunity to share our culture and traditions during this phase.

3 Aims

The project aims were to forge and establish relationships and understanding of the plight of indigenous communities when faced with new and potentially devastating biosecurity incursions that threaten the livelihood of some communities and the health of affected species. Central to this was the exposure to the indigenous cultures of New Caledonia, French Polynesia and Aotearoa/New Zealand, and the experiences and interactions with the people and their communities.

A series of wānanga (workshops) and exchanges were organised in New Caledonia and French Polynesia, firstly to introduce the research team to the culture of their host as well as to introduce attendees to the challenges Māori in Aotearoa/New Zealand face by the introduction of new and invasive pathogens that can cause devastating diseases like myrtle rust and kauri dieback, which are both present in New Caledonia but not yet in French Polynesia. These exchanges served a number of purposes:

- Sharing traditional practices in ceremonies and learning about each other's cultures
- Identifying cultural similarities and differences
- Understanding and identifying the significance and uniqueness of indigenous culture to each country
- Creating a connection/relationship with indigenous communities affected by new and invasive biosecurity incursions.

4 Outcomes

4.1 New Caledonia

4.1.1 Key contacts in New Caledonia

The first step of our work in New Caledonia was to identify a list of people and stakeholders to contact and with whom to engage. This process took several months, until contacts had been made with Josine Tiavouane from Dayu Biik, and Subama Mapou from Institut Kanak des Plantes, de l'Artisanat et des Langues Autochtones (IKAPALA).

Dayu Biik is a local association managed by members of the local communities bordering the Mount Panié, the highest point of New Caledonia (1,629 metres) and classified as a wilderness protected area by The International Union for Conservation of Nature (UICN) (status 1B). The main focus of Dayu Biik is to safeguard the unique fauna and flora biodiversity of this protected area. Their missions comprise the implementation of management plans, including pest control and the development of economic activities linked to nature conservation and ecotourism. Since its creation in 2004, the association is also deeply engaged within the community by connecting people, educating youngsters and raising awareness about the biodiversity threats and nature conservation. Dayu Biik is working with researchers from New Zealand to identify a pathogen attacking the *Agathis montana* (one of the New Caledonian kauri) growing on Mount Panié. Dayu Biik is a critical partner in the region and was very supportive of being part of the network we have initiated. Thanks to their existing network, we were able to reach out to several representatives of the Kanak culture during our workshop in Hienghene.

IKAPALA is a non-governmental organisation bringing together actors involved in the valorisation and protection of Kanak traditional knowledge. Funded in 2017, IKAPALA plays a consultative role between different stakeholders, including scientists, and the Kanak community. IKAPALA and the Customary Senate promote a code of conduct for all the projects related to the Kanak identity, to be respectful of the rights of indigenous people. Thanks to IKAPALA and particularly to its cofounder (Subama Mapou) we were able to initiate the conversation in New Caledonia by respecting Kanak customary laws. Subama also enabled us to connect with people from the south of New Caledonia.

An interesting point that we need to highlight and something all visitors wanting to engage indigenous communities around the world should be aware of is the deep-seated suspicion of any visitors to their shores and *why* they are seeking to connect with them. There are some very negative views of past experiences with foreigners and visiting researchers. This was very much our experience in New Caledonia.

The response we received to our initial request to meet with IKAPALA was one of caution and suspicion. The protection mechanism was evident when we sought an audience with the Senate of IKAPALA, with many questions pertaining to the reason for our visit being asked. We were also prevented from directly contacting people in the north of New Caledonia, as visiting researchers in the past had not engaged the community for a mutually beneficial outcome but for their own purposes and benefit. The community in some ways felt exploited and somewhat exposed, noting the sensitive nature of some of the information that was shared.

We were able to overcome many of these barriers by being able to connect culturally to the Kanak people. This was in the form of a traditional Māori response to the welcome we received at the Senate. Being able to acknowledge our hosts in the traditional language and song of New Zealand brought a degree of understanding that our purpose was more a cultural connection rather than one with other purposes. The exchanging of hongi (a traditional New Zealand greeting) and gifts helped to demonstrate this.

A point to note is that New Caledonia is not unique in this approach. This also occurs in New Zealand when our communities are approached through an intermediary. Our first questions are “Why do they seek a meeting with us and what do they want?” This is soon answered in the pōwhiri (welcome) process used in New Zealand and a demonstration of the paramount importance of face to face connections, as opposed to a phone call or email, in any new engagement.

4.2 Itinerary in New Caledonia

Date	Programme
1/12/2019	Arrival in New Caledonia, meeting at the Kanak Customary Senate
3/12/2019	Biosecurity workshop in Hienghene
4/12/2019	Meeting Severine Bouard (IAC) in Pouembout (local partner)
5/12/2019	Meeting with DAVAR-SIVAP in Noumea with representatives of the biosecurity agency in New Caledonia
7/12/2019	Visit to kauri plantation with Subama Mapou in Yate area and to Parc de la rivière bleu
8/12/2019	Meeting with cultural representatives from Yate and visit to Goro area (nickel mining)

Itinerary within New Caledonia is provided in Appendix 9.1.

4.2.1 The Kanak Customary Senate

To be able to conduct our work in New Caledonia, we had been advised to go to the Kanak Customary Senate prior to starting any engagement with the local population. The Customary Senate is an assembly composed of sixteen representatives from the eight customary areas of New Caledonia and designed according to customary rules. Kanak culture and beliefs have many customary rules whose purpose or effect is to protect people, natural resources and culturally important places. The Customary Senate’s main role is to protect and safeguard the Kanak culture and identity and it must be consulted on projects relating to these matters. The Senate can therefore give an opinion on whether the project follows and respects the customary rules.

Our introductions to the Kanak Customary Senate was coupled with a congress on traditional knowledge organized by IKAPALA on 3 December 2019 where we were invited to present our work (Figure 1). The theme of this congress uniting members of cultural and environmental associations was "Traditional knowledge: Protection, transmission and development".

Because all the attendees were non-english speakers, all of our presentations and speeches were translated in French.

The meeting first started by a welcoming introduction speech (mihi) by Alby Marsh.

Following this, Julia Soewarto gave a presentation in French about the environmental and economic impacts of invasive species and the lack of knowledge about the sociocultural impacts

Alby continued with a presentation delivered in English (translated into French by Julia for the benefit of the audience) on the integration of Māori cultural knowledge and perspectives (mātauranga Māori) into Western science that benefits the management of invasive species in New Zealand. Alby continued the presentation by introducing the current project of building a relationship network between the indigenous people of the Pacific, to help each nation to better fight those invasions. Therefore, as our first step of engagement with the Kanak community, we asked for permission to conduct our project in New Caledonia.

The meeting ended by a customary ceremony where the representatives of IKAPALA and of the Customary Senate approved the work that was undertaken and gave us authorisation to carry on with this work. To show mutual respect, gifts from Aotearoa/New Zealand and from New Caledonia were exchanged.

Figure 1. Project presentation at the Kanak Customary Senate, during the congress organised by Institut Kanak des Plantes, de l'Artisanat et des Langues Autochtones (IKAPALA), Noumea, 1 December 2019.

4.2.2 Biosecurity workshop in the north of New Caledonia (Hienghene)

Time (approximate)	Programme	Facilitator
8:00 AM	Welcome participants	Josine Tiavouane (Dayu Biik), Julia Soewarto (Scion)
9:00 AM	Customary ceremony	Subama Mapou (IKAPALA), Goni Bealo (Direction de la culture, Gouvernement de la Nouvelle Calédonie), Alby Marsh (Plant & Food Research)
9:30 AM	Project introduction	Julia Soewarto
9:45 AM	Kaitiakitanga & Māori-led solutions to myrtle rust	Alby Marsh
10:15 AM	Morning tea	
10:30-12 AM	General discussion	All participants
12 AM - 1:30 PM	Lunch	
1:30-14:45 PM	Group workshop	Josine Tiavouane, Severine Bouard (IAC), Julia Soewarto
14:45 - 15 PM	Closing of workshop and thanks	Alby Marsh

The initial workshop was about introducing the project to people and communities and initiating the discussion about the challenges with invasive species.

The workshop has been hosted by the Hienghene council (Mayor Andre Levi) and members of Dayu Biik association (Josine Tiavouane, Leon Razafindrakoto, Ferdinand Wanguewe, Jonas Tein). A total of **28 people attended, including members of cultural and environmental associations, cultural representatives of tribes, councils, scientists, and public interest groups. Individual email invitations had been sent by Josine Tiavouane to her network of contacts within the local community. Invitations were also sent to the target audience of regional leads and technicians.**

The workshop was divided in two parts; the first part was dedicated to project presentation and general discussion, the second part involved people working as groups to answer questions around biosecurity and the cultural impacts of invasive species.

The discussion started around the current threats caused by exotic invasive species on Mount Panié. Mt Panié summit is the highest peak in New Caledonia, located in the Chaîne Centrale mountain range in the Hienghene area. The summit is of high cultural significance for the Kanak community, as it represents the rooftop of New Caledonia. It is also home to iconic and endemic kauri trees, *Dayu Biik.* The native forest of *A. montana* is restricted to an area of at least 5000 ha above the cloud line (between 900 and 1600 m in altitude). This keystone species is threatened by damage caused by pigs and deer (introduced in New Caledonia), but also by other factors such as climate change and pathogens. Altogether, these factors are suspected to cause dieback of *A. montana* trees, resulting in severe population decline over the last decades and precipitating the species towards extinction.

A. montana has very high cultural and spiritual value for Kanaks; it represents the spirit of their ancestors. The decline and potential extinction of this species would have a very strong impact on the local population.

Attendees supported the project of building a relationship network between indigenous communities in the Pacific. They approved of the Māori way of using traditional knowledge to solve environmental problems. Kanak and Māori views of the world are similar and very connected to nature.

Some of the attendees pointed out that a possible solution to resolve the problem with kauri dieback (Phytophthora species) in Mt Panié might lie in traditional Kanak knowledge. Dayu Biik's main focus is to integrate traditional knowledge to protect the environment. The association is organising meetings with elders in the tribe to seek possible solutions to save the kauri.

Some of the attendees said that there was a lack of engagement from people to implement biosecurity procedures. For example, Dayu Biik established biosecurity/cleaning protocols to limit the spread and impact of kauri dieback in the forest, but the public is not following them. Dayu Biik wish that the people better understood the implications of these measures to save the kauri. A similar lack of engagement was noted with other community issues and highlights the difficult challenge of energising communities to enact sustainable change. Some examples are given by Dayu Biik of action to try to involve the population:

- Educating the youth
- Hunting competition to control invasive animal species
- Building technical capability to improve understanding of the issues
- A scientific programme to evaluate the health of mangrove swamps

- Production of maps in collaboration with the tribes and the scientific teams
- Planting trees to restore the environment.

Some attendees emphasised that even if Dayu Biik is involved with the local population, their work and actions are still not widely known/shared with the rest of the population and ask how they can improve the communication?

Some of the attendees emphasised that biosecurity challenges are not only to protect the species but also to protect the people and traditional knowledge against biopiracy.

The second part of the workshop involved working in groups, to allow each participant to have a voice and express themselves. The workshop process was to split the attendees into three groups, each of 4–6 people, to brainstorm around five questions (Appendix 9.2). Participants had access to sticky notes on which to write their answers. At the end of this process, each group placed their sticky notes on a large poster sheet, and a representative of each group explained how they worked and what the conclusions of their brainstorming session were (Figure 2).

Figure 2. Photographs illustrating the one-day workshop in Hienghene, 3 December 2019.

4.2.3 Initiating relationships in the south of New Caledonia

We met and held a customary ceremony with Andre Vama, president of Rhéébù Nùù, an environmental organisation managed by members of the local communities to watch the activities of the Goro Nickel mining company operating on their customary land in the extreme south of New Caledonia. Rhéébù Nùù means "eye of the land" in the local Djubea language. During our visit to Goro, Andre explained to us the challenges of protecting the environment (Figure 3). The Kanak tribes living within the boundaries of the towns of Yate and Mont-Dore, where the mining project takes place,

have pressured the company to take into account Kanak cultural identity. It is important for the Kanak tribes living in the south where most of the mining activity is, to guarantee sustainable environmental development and participate in a real benefit-sharing programme between VALE-INCO (the mining company) and New Caledonia.

Andre Vama has invited us back in Yate to organise a workshop and share knowledge about myrtle rust and kauri dieback.

Figure 3. Meeting with Andre Vama and visit to the Goro area and the Kanak totem.

4.3 French Polynesia

4.3.1 Key contacts in French Polynesia

A list of invitees was provided by Jean-Yves Meyer for the workshop. Despite numerous follow-up emails, only a few responses were received. Not having any prior interaction or previous introductions to people being invited proved challenging. This was reflected in the numbers who attended the workshop. Other contributing factors were unfamiliarity with the theme of the workshop, and distance. What we also discovered was that people were very busy.

The COVID-19 situation also caused disruption to the project, with some attendees not able to travel to attend the workshop.

Limited funds did not enable us to spend more time in French Polynesia to establish more connections.

We appreciated the time and effort provided by those who attended.

4.3.2 Itinerary in French Polynesia

Date	Programme
8/03/2020	Arrival in Papeete
9/03/2020	Meeting with Jean Yves Meyer (local partner)
10/03/2020	Visit to Mt Aorai with Jean Yves Meyer
11/03/2020	Biosecurity workshop
13/03/2020	Visit to Mt Temehani on Ra'iātea island and meeting with Romy Tavaeri

Itinerary within French Polynesia is illustrated in Appendix 9.1.

4.3.3 Biosecurity workshop in Papeete

Hosts: The workshop was hosted by Jean-Yves Meyer, of the Délégation à la recherche de la Polynésie Française (Avenue Pouvanaa a OOPA, bâtiment du gouvernement, 1er étage. BP 20981, 98713 Papeete, Tahiti, French Polynesia).

Attendees: Eight people, including members of the cultural association, an environmental consultant, as well as representatives of:

- Governmental research department (Délégation à la recherche de la Polynésie Française)
- International Union for Conservation of Nature (IUCN)
- Governmental biosecurity department (Direction de la Biosécurité)
- Governmental phytosanitary department (Service du Développement rural – département Phytosanitaire)
- Governmental environmental department (Direction de l'environnement).

Time (approximate)	Programme	Facilitator
8:30 AM	Welcoming participants	Jean Yves Meyer (Délégation à la recherche de la Polynésie Française)
9:00 AM	Welcoming 'Ōrero	Jean Yves Meyer, Jean Kape (Académie Pa'umotu), Alby Marsh (Plant & Food Research)
9:30 AM	Invasive species and definitions	Jean Yves Meyer
10:00 AM	Myrtle rust: a threat for the Pacific	Julia Soewarto (Scion)
10:30 AM	Te Ao Māori	Alby Marsh
10:30-11 AM	Morning tea	
11:30 AM	Tiare apetahi and pathogens threatening native species in French Polynesia	Fred Jacq (environmental consultant)
11:30-12 AM	General discussion	All participants
12:00 AM	LUNCH	
1-2 PM	Meeting with Hinano Murphy, president of Association Te Pu Atitia (Moorea)	Alby Marsh, Julia Soewarto

The first part of the workshop was dedicated to presentations by scientists from both French Polynesia and New Zealand on invasive species, ecological and cultural impacts. These presentations gave context and basis for discussion during the second part of the workshop, which was dedicated to the biosecurity challenges in French Polynesia (Figure 4).

The presentations by Dr Jean Yves Meyer and scientist Fred Jacq highlighted that numerous cultivated and traditionally important species are affected by exotic invasive species in French Polynesia. While the impacts of animals (e.g. rats, pigs) and invasive plants (e.g. *Miconia*) are well known by the scientists and the local population, the role of microorganisms in plant diseases is poorly investigated.

What was learnt during the discussions that followed the presentations is that implementing border protection against the introduction of exotic pests and diseases in French Polynesia is very challenging. The main reason is the number of islands to monitor, which are scattered across that part of the Pacific (120 islands). Adding to the geographic challenges are the limited funds, and the lack of structures and workforce to prevent and manage invasive species incursions in each of these islands. Currently, most of the environmental conservation projects are run by local NGOs, groups and associations with very little money from the government. It was agreed by all the attendees that inter-island commercial trade and travellers are probably the main vectors of biosecurity incursions.

Considering the issues posed by the increased incursions of invasive exotic species, attendees suggested that adequate human and financial resources to be made more available to improve biosecurity in French Polynesia. Training of more staff among the local population of the islands was mentioned as key to addressing the issue of ineffective inter-island biosecurity. Tourism represents the main source of income in these islands, and it is important to communicate that it might also carry biosecurity risks. It was also suggested that inter-island biosecurity could be enhanced by implementing a citizen science surveillance programme based on new technologies to detect and locate both endemic and invasive species. This was also supported by the fact that most of the people have a mobile phone and that internet access is now available everywhere including in remote islands. Additionally, forming closer partnerships among governments, research institutes and indigenous communities from the different Pacific countries was seen as an effective enforcement element to increase border defences and protection against various pests and diseases.

It was also discussed that in the Pacific, traditional ways of managing the environment were proven to be more effective than governmental or commercial programmes. For example, sustainable coastal fishing was successfully achieved for hundreds of years by the Polynesian people by the establishment of the rahui', a traditional practice of restricting access to an area or resource as a way of conserving it. Similar rahui' are still used nowadays elsewhere in the Pacific, including in New Zealand and New Caledonia (tabou), to protect some of the endangered kauri forests. This highlights a common and strong feeling of guardianship and protection of the environment among the different indigenous people of the Pacific.

Figure 4. Biosecurity workshop in Papeete, 13 March 2020. From top left to bottom right: Fred Jacq presenting his work on Tiare' apetahi; workshop roundtable; Jean-Yves Meyer presenting about invasive species and impacts; group photograph, from left to right: Jean Kape, Alby Marsh and Jean Yves Meyer.

4.3.4 Cultural exchanges

Cultural exchanges and discussion around indigenous collaboration in the Pacific were made with two cultural representatives from Moorea (Hinano Murphy) and from the Tuamotus islands (Jean Kape), as shown in Figure 5. Hinano Murphy is President of Te Pu Atitia (a local NGO dedicated to documenting, promoting, and preserving Polynesia's biocultural heritage) and the Associate Director of Administration & Outreach at US Berkeley Gump Research Station in Moorea. Jean Kape is the president of the academy of Pa'umotu, an institute which aims to safeguard and study indigenous language as part of traditional knowledge from French Polynesia. The conversations with the two cultural representatives highlighted that people from the islands are worried about plant disappearances from their environment and from their traditional knowledge. It is important that collaboration between the communities and the science world are reinforced to share the knowledge about biological incursions and impacts on traditional usage and ways of interacting with the environment. Ways to enhance the collaboration between communities from the Pacific were discussed, and included sharing our project in the local journal (Bulletin de la Société des études océaniennes) and shared visits between countries.

Figure 5. Koha exchanges with Hinano Murphy (left) and Jean Kape (right) following cultural exchanges.

Alby Marsh met with Romy Tavaeari'i, chair of the Tuihana Association, a voluntary group dedicated to the protection of the Tiare Apetahi flower (Figure 6). The tiare apetahi is a rare flower that can only be found in the Tahitian island of Ra'iātea. Now endangered, the emblematic flower of Ra'iātea is heavily protected; however, it is being affected by a rust disease.

Romy Tavaeari'i shared a traditional Ma'ohi korero of the flower and its spiritual connection to Māori. In Māori tradition it is believed that when their spirits leave from the north in Te Rerenga Wairua, the souls descend beneath the waters and resurface at Ra'iātea in Tahiti. At the break of dawn when the tiare apetahi pods open, their spirits are finally released to the heavens.

"When those of Tahiti, Māori, Rapa Nui or Hawaiian descent dies, their soul comes to Mount Temehani. It is said that when the soul is coming back here to Temehani, they will be able to take one tiare apetahi to keep their heart beautiful forever," explains Tavaeari'i.

Thousands of apetahi flowers once covered the Temehani plateau in Ra'iātea, a beacon to returning souls that they are nearly home. Today there are only twenty apetahi left. A law was established in 1995 that bans people from picking or cutting the flowers and transporting them elsewhere. Anyone who picks, kills or attempts to transplant an apetahi flower risks a prison sentence and a fine of one million Pacific francs, or $NZ14,500: https://www.teaomaori.news/endangered-tahitian-flower-connected-maori

Romy Tavaeari'i was also able to share with Alby Marsh the historical connection Ra'iātea has to the Māori people of New Zealand. This was portrayed in the visit to Taputapuatea, the sacred mārae at Opoa on the south-east coast of Ra'iātea. It is widely believed that the great Māori migration originated in Hawai'iki, and this is where their spirits return. Ra'iātea is believed to be Hawai'iki Nui, Hawai'iki Roa, Hawai'iki Pāmāmao.

Taputapuatea Mārae, believed to date from about 1000AD, is a site of great significance to the people of the Pacific and was believed to be an important religious and political centre for the Polynesian people. Alby Marsh was welcomed onto the mārae by Romy Tavaeari'i with a traditional Mā'ohi welcome, acknowledging the connection of people, culture and place. Romy Tavaeari'i also acknowledged the history of Taputapuatea and its spiritual links to atea (gods) and our ancestors.

Alby Marsh responded acknowledging his hosts' hospitality, their mountains, the ocean that provides the connection, the waka that voyaged to Aotearoa/New Zealand, and atea and ancestors common to both cultures. For Marsh, this was a very moving experience.

The welcome and response was conveyed using the traditional languages of Ra'iātea and Aotearoa/New Zealand.

Alby Marsh's journey to Ra'iātea and TaputapuateaMarae is best summed up with the whakatauki (proverb) "E kore au e ngaro, he kākano i ruia mai i Rangiātea." I shall never be lost, I am a seed sown from Rangiātea (Rangiātea is the Māori name for Ra'iātea): https://www.ancient-origins.net/ancient-places/taputapuatea-marae-0011864

Figure 6. Taputapuatea Mārae (source: http://geminisunset.space/marae-taputapuatea/) and group photograph from left to right: Romy, Alby and Tahi at Taputapuatea Mārae (right).

5 Benefits

The benefits of this research were to increase capacity to recognise cultural knowledge and management practices that enable an appropriate response for those dependent on indigenous forest resources. The knowledge gained and exchanges between these Pacific communities has strengthened the indigenous knowledge networks, and protection of culturally valued species. Ongoing relationships built during the research will enable continued pathways for learning and responding to myrtle rust and to future disease threats to Pacific Island nations.

By using a co-development planning process, the individuals and communities involved will be able to understand and manage the effects of myrtle rust with the resources available to them. The ability to identify and prioritise critical impacts, and develop means of mitigating them, will be supported through the experiences of the research team in a New Zealand setting. A culturally sensitive approach to working with the spiritual, collective and ecological values of indigenous people will ensure tools and approaches are appropriate to the traditional contexts of their unique places.

Developing knowledge and cultural exchange networks between these three islands will prevent the loss of biodiversity and minimise impacts on food, fibre, medicine and cultural uses of plant species (Figure 7). Communities will be empowered both to understand and to act using culturally relevant practices for intervening when new plant diseases are discovered. Scientific knowledge of the diseases will be integrated with cultural practices to support preventative and mitigating actions to minimise disease spread and impacts.

Figure 7. Sharing traditional knowledge and traditional usage of plants in New Caledonia with Subama Mapou (top) and in Tahiti with Dr Jean Yves Meyer (bottom).

6 Examples of unknown pathogens affecting culturally important plant species

Along with our visits to and discussions with the scientific and local communities, we discovered that a certain number of threats possibly caused by unknown pathogens are affecting native trees in French Polynesia. An expedition to Mt Aorai and Mt Te Mehani with our local partners gave us the opportunity to see how these threats were affecting culturally important native shrub species.

6.1 Dieback of *Metrosideros collina* var. *collina* and *Metrosideros collina* var. *temehaniensis*

Metrosideros collina (Myrtaceae, common name “pua rata”) is a variable species native to some mountainous islands of the south Pacific, including the Society islands. On Mt Aorai, Tahiti's third highest mountain, the native population of *Metrosideros collina* var. *collina* is affected by an unknown disease. The symptoms are characterized by a progressive defoliation that will eventually lead to tree death (Figure 8). According to Jean Yves Meyer’ own observations, it can take up to several months or years for the trees to die. Some of the trees we saw were still showing some epicormic growth at the base of the trunk before drying out and die. Tree death has been spreading throughout the *M. collina* population of Mt Aorai and it is unknown if the species will be able to survive in this area. While the precise cause of the tree death is still unknown, specialists who previously visited the site think it is not due to rapid ‘Ōhi‘a death pathogens (*Ceratocystis lukuohia*, *C. huliohia*) or to the myrtle rust pathogen (*Austropuccinia psidii*). The cause of death among this population of *M. collina* should be investigated, to determine if it is due to an unknown pathogen that could potentially represent a biosecurity threat for the other *Metrosideros* species in the Pacific.

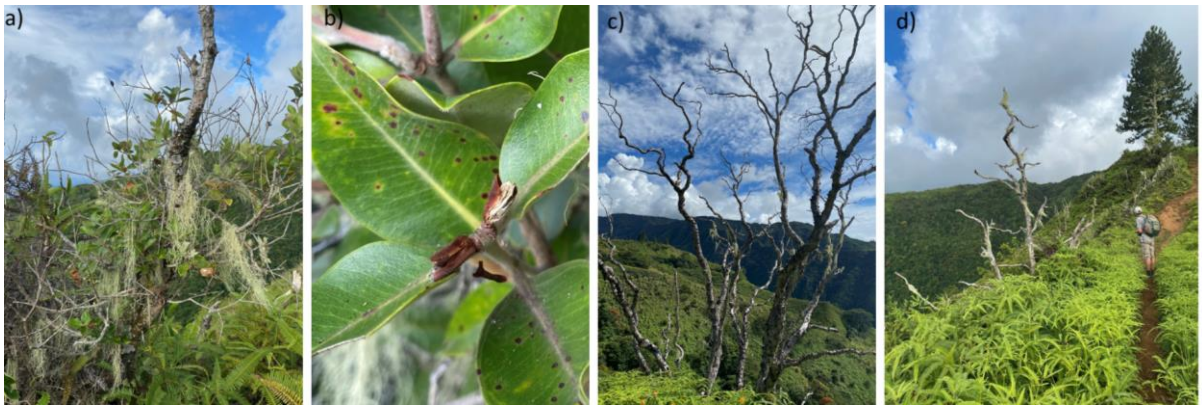


Figure 8. Dying *Metrosideros collina* var. *collina* on Mt Aorai (Tahiti): a) severe defoliation; b) necrosis of leaves buds; c-d) dead trees.

On Mt Te Mehani in the heart of Ra’īatea island, the endemic *Metrosideros collina* var. *temehaniensis* was showing dieback symptoms on the young apex growth (Figure 9). While no tree deaths were observed at the time of the visit, the dieback was quite widespread among the population observed on Mt Te Mehani. The cause of this dieback is unknown, but severe drought and insect damage (psyllids) were observed on some of the shrubs.

Figure 9. *Metrosideros collina* var. *temehaniensis* on Mt Te Mehani (Raʻīatea): a-c) dieback on young apex foliage; d) insect damage on young leaves.

6.2 Dieback on Tiare apetahi

Apetahia raiateensis (Campanulaceae, common name “Tiare ‘apetahi”) is an emblematic flowering plant of the volcanic highlands of the island of Raʻīatea. This small shrub is one of the rarest species in the world and is critically endangered. It is also the symbol of the endangered endemic flora of French Polynesia, and one of the most important plants in Tahitian culture as explained earlier in this report (Section 4.2.4). According to Fred Jacq’s presentation during the workshop organized in Papeete, a ten-year survey of this species showed a high rate of extinction (81%). Several factors are responsible for deaths within the remaining population of *A. raiatensis*, including the impacts of rats, illegal picking by humans, and an unknown disease causing branch wilt, rot and viscous orange dropping from the stem (Figure 10).

Figure 10. Disease symptoms on Apetahia *raiateensis.*

A research programme is currently on going in Raʻīatea to try to identify phytopathogens on 28 species from Te Mehani, including those potentially affecting *Metrosideros collina* var. *temehaniensis* and *Apetahia raiateensis*. Results from this study will be very valuable to the wider Pacific countries where diseases affecting native tree species are poorly investigated.

7 Challenges

Meetings with the science and research community in New Caledonia proved to be quite challenging for one of their former colleagues. There is a definite cultural difference in the way research is conducted, with little to no appetite for involving community or more specifically indigenous communities in their research. Working with communities is regarded as a distraction or unnecessary, as the “pure” research undertaken has no real relevance or outputs that would include them. It will be a major obstacle for us to involve or even work with them if the research is to continue.

Another challenge for the team was the COVID-19 pandemic and the shift of the virus into the southern hemisphere. Prior to our arrival in French Polynesia, there were no confirmed cases of COVID-19 in the region or any of the islands. One of the requirements of our travel was to produce a doctor’s certificate confirming we were COVID-19-free. Both Alby Marsh and Julia Soewarto were able to do this.

Unfortunately, during our visit, cases of COVID-19 were confirmed by a returning national who had been visiting France, followed shortly after by a passenger of a cruise ship. The day after the cruise ship passenger’s confirmation, two more cruise ships arrived at the port of Papeete. These arrivals signalled the end of our adventures exploring Papeete and the surrounding area, as we did not want to risk being exposed to the disease. It was one of our biggest disappointments; however, it was necessary in the very challenging circumstances.

8 Recommendations

The team believe this is the beginning of a journey – a journey that reconnects cultures and values shared by all indigenous people across the Pacific, and an outcome that has been welcomed by all involved. This sentiment was echoed by all participants involved, from the Kanak people of the north and south in New Caledonia to the Ma'ohi of Tahiti, Mo'orea and Ra'īatea in French Polynesia. It has also been a refreshing reconnection with the environment for many, especially learning about the impacts new and invasive pests and diseases are having on the native flora and fauna harboured within.

It was agreed by all whom we visited that this connection should not be the one and only time we meet. There is much enthusiasm to continue to forge connections, and reciprocal visits should be arranged. The purpose would be to learn how to identify the host species and the pathogens and to develop a programme of work to contribute to the long term health of the environment.

The disappointment for our host in New Caledonia, Subama Mapou, was that she was not aware of what myrtle rust was, and that it was present in New Caledonia. She was surprised to learn of the devastating effect it was having on native Myrtaceae and it had the ability to "wipe" them out altogether.

What we learnt is that the definition of biosecurity varies between countries. The term "biosecurity" is a relatively new concept, in New Zealand and Australia it includes a set of measures designed to protect the country's exports and natural environments from entry and spread of pests and diseases. In both New Caledonia and French Polynesia, the term biosecurity was understood for different purposes by different groups. While specialists considered it was covering the prevention of invasive alien species, people in the local community were referring to threats towards agricultural crops only or to the risks of introduction and release of genetically modified organisms (GMOs).

We realised that the biosecurity threats that pathogens represent for the unique islands' biodiversity was underestimated in the management policies. In New Caledonia, a list of more than 250 invasive alien species (IAS), which has been established in the country, is used as a reference for the implementation of territory-wide management strategy. This list comprises many vertebrates (mammals, birds, reptiles, Amphibians, Fish), invertebrates and plants. Microorganisms, and in particular pathogens of cultivated and native plants, were not addressed despite the recent introduction event of the notoriously known myrtle rust disease. In French Polynesia, a list of 52 invasive alien species was considered to pose a threat to the native biodiversity, again these only comprise animals and plants, but no microorganisms were included.

It was highlighted in both New Caledonia and French Polynesia that implementing biosecurity measures and managing invasive alien species are limited by many challenges including the inter-island trades and people movement in the Pacific archipelagos that contribute to the movement of invasive species. In both countries the lack of money and infrastructures do not allow deployment of enough biosecurity agents or control barriers. Often the local population is not aware of the potential danger of moving plant or animal species, therefore better communication is necessary to limit the introduction of invasive species through this pathway.

It is the intention of the team to reapply for funds from the French Embassy to continue the relationship and extend the purpose for our connection. The hope is to invite our colleagues from both French Polynesia and New Caledonia to Aotearoa/New Zealand, for a number of purposes. The first is to extend our hospitality to them, to experience our culture, to witness the similarities and the invisible connections we have as the indigenous communities of the Pacific. The second is to demonstrate and highlight the impacts new and invasive incursions are having on our natural ecosystems and native species. This will be done by visiting some of the most affected regions of New Zealand. The third purpose will be the opportunity to share the mode in which the indigenous communities of Aotearoa/New Zealand work with and interact with the science community. This is a recent and interesting development and one that still has wrinkles in it; however, the indigenous/researcher relationship will improve with increasing familiarity with how to work with one another. This is a way of working which can be shared across the Pacific particularly for the protection of culturally significant plants and safeguarding against the loss of cultural knowledge.

The challenge of the third purpose will be to foster a relationship with non-indigenous researchers in the Pacific to increase their understanding of the need to include the people from the communities whom have an intimate knowledge and connection to the environment. Improving these relationships will promote inclusive programmes and foster cohesive collaborations for the mutual benefit of all. Published indigenous and non-indigenous researchers from Aoteroa/New Zealand will be encouraged to participate to help foster and guide participation at workshops and collaborative connections.

Associated with the preceding piece of work will be a fourth focus on the revitalisation of the Apetahi flower. It would be a tragedy to lose this iconic flower of great significance. Research is already being undertaken by Plant & Food Research in New Zealand on ornamental plants and this expertise could be applied to techniques employed to ensuring the survival of the Apetahi flower. This research could potentially be used as an example to strengthen the use of both western and indigenous methods to improve knowledge and outcomes. This partnership would ensure both IP and germplasm ownership would be retained by the Mā'ohi partners.https://www.telegraph.co.uk/films/moana/tiare-flower-symbol-of-polynesia/

9 Acknowledgements

This work was supported by the Pacific funds of the French Ministry of Foreign Affairs, Plant & Food Research, the Agronomic Institute of New Caledonia, Délégation à la recherche de la Polynésie Française, the association Dayu Biik and IKAPALA.

We acknowledge and thank Dayu Biik and particularly Josine Tiavouane for helping us organise the biosecurity workshop in Hienghene and facilitating our visit to New Caledonia.

We acknowledge and thank IKAPALA and particularly Subama Mapou for guiding us through the customary ceremonies in New Caledonia and sharing her knowledge with us.

We thank the members of the Kanak customary senate for allowing us to conduct our research in New Caledonia.

We acknowledge and thank Dr Jean-Yves Meyer (Délégation à la recherche de la Polynésie Française) who greatly facilitated our visit to French Polynesia and for sharing his knowledge.

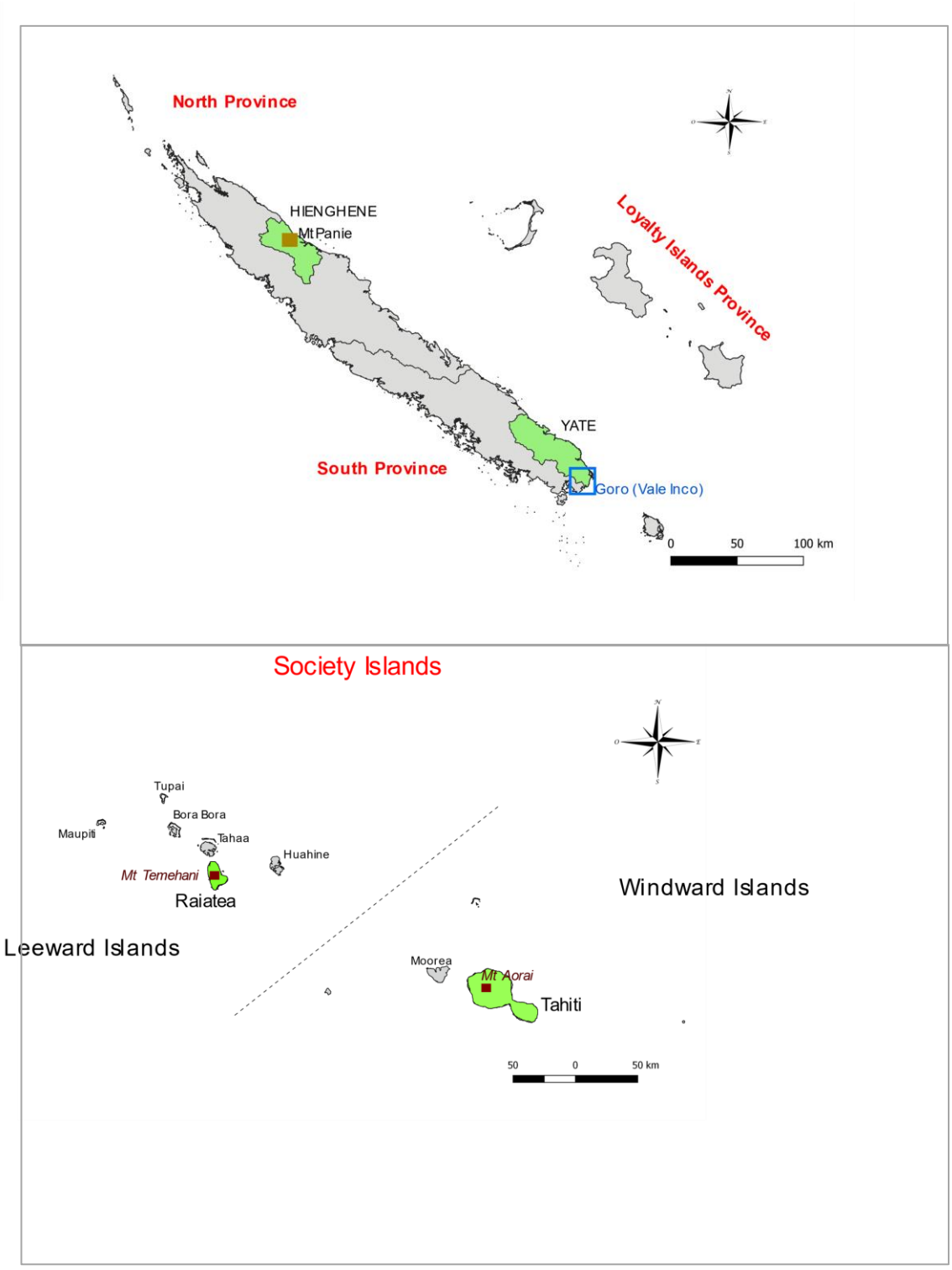
We are very grateful to Fred Jacq and Thierry Laroche for hosting us on Raʻīatea island and taking us up to the mountain. Thank you for sharing your knowledge and your passion in protecting native species.

We acknowledge and thank Romy Tavaearii for hosting us on Raʻīatea island and for sharing his culture.

We would like to acknowledge the support for the project provided by Scion and Plant & Food Research.

Appendix 1. Itinerary maps

Green represents the areas where relationships with the local communities have been initiated.



Appendix 2. New Caledonia biosecurity workshop responses

Question 1: What exotic invasive species do you know about?

Class	Scientific names	New Caledonia's priority invasive species list
amphibians	Frog – no scientific name available	
animal	*Platydemus manokwari*	yes
arthropod	*Rhipicephalus microplus*	yes
bird	*Anas platyrhynchos*	
bird	*Acridotheres tristis*	yes
bird	*Pycnonotus cafer*	yes
fish	*Oreochromis mossambicus*	yes
fungus	*Austropuccinia psidii*	
insect	*Polistes olivaceus*	yes
insect	*Wasmannia auropunctata*	yes
insect	*Periplaneta australasiae Fabricius, Blatella germanica*	
insect	*Apis mellifera mellifica*	
insect	*Termites*	
insect	*Orchidophilus aterrimus*	yes
insect	*Diptera, Tephritidae*	
mammal	*Rusa timorensis*	yes
mammal	*Sus scrofa*	yes
mammal	*Rattus* spp.	yes
mammal	*Oryctolagus cuniculus*	yes
mammal	*Felis silvestris*	yes
mammal	*Canis lupus familiaris*	
mollusca	*Lissachatina fulica*	yes
plant	*Sphagneticola trilobata*	
plant	*Syzygium cumini*	yes
plant	*alguae*	
plant	*Mimosa pudica*	
plant	*Leucaena leucocephala*	yes
plant	*Albizia lebbeck*	yes
plant	*Pinus caribaea*	yes
plant	*Eucalyptus* spp.	
plant	*Opuntia ficus-indica*	yes
plant	*Furcraea foetida*	yes
plant	*Nymphea* sp.	
plant	*Pterocarpus indicus*	
plant	*Brachiaria mutica*	
plant	*Tillandsia usneoides*	
plant	*Stachytarpheta cayennensis*	
plant	*Urochloa mutica*	
plant	*Spathodea campanulata*	yes
plant	*Crystostegia grandiflora*	yes
plant	*Phyllostachys flexuosa*	yes
plant	*Mimosa diplotricha*	
plant	*Lantana camara*	yes
plant	*Acacia farnesiana*	yes
plant	*Tecoma stans*	yes
virus	*Banana bunchy top virus*	

Question 2: What are the impacts of these exotic invasive species on your life, wellbeing, work, traditions?

Responses	Type of impacts	Comment
Yam dieback, or anthracnose of water yam (*Colletotrichum gloeosporioides*)	-	impacts on yams production, reduced tuber yields
	-	impacts on tradition and customary ceremonies
Little red fire ant	-	economic impact
	-	slow down agricultural production
Cultivation of ornamental plants	+	positive impact on economy, source of income for families
	-	promotes the dispersion of invasive alien species including plants and pathogens
	-	loss of interest in resource plants for food and medicine, such as coconut trees
	-	promotes development of mosquitoes
Banana bunchy top virus	-	negative impacts of the environment, loss of diversity
	-	negative impact on agriculture, reduced banana yields
Snails	-	substantial impacts on agriculture
Bamboo	+	useful as construction wood
	-	negative impacts on agriculture, invasive species in the fields
Wild pigs, rusa deer	+	increased hunting rates and evolution of hunting techniques
	+	source of food for the people
	+	positive effect on the economy, as it is a source of income for families
	-	modification of food habits
	-	negative impacts in the fields, damages
	-	negative impacts on traditions
	-	negative impacts on forest regeneration
	-	negative impacts on water resources
	-	negative impacts on people's private gardens
	-	negative impact on the environment
	-	vector of diseases
	-	negative impact on tradition and customary ceremonies
Caribbean *Pinus*	+	timber wood, useful for the economy
	-	negative cultural impacts on traditions
	-	loss of traditional knowledge like the usage of native woods
	-	causing substantial damages in the environment

Responses to question 3: What would be the cultural impacts of native species disappearing?

Responses	Comment
Yams	loss of cultural value, species especially important for customary ceremonies and usage
Notou (*Ducula goliath*)	totem species, loss of spiritual values
Niaouli (*Melaleuca quinquenervia*) and Kanak poplar	loss of traditional medicinal knowledge
	loss of wood for traditional construction
Sea turtles	threaten by overhunting; if the species disappears it will culturally affect Kanak clans and tribes living close to the sea, loss of connection, loss of patrimonial species
Yams, taro, plantain banana	used as gifts in customary ceremonies, loss of traditions
Kanak poplar (*Erythrina variegata* var. *fastigiata*) disappeared because of an unknown reason	impact on traditional knowledge; this species was used in traditional medicine
New Caledonia flying fox (*Pteropus vetulus*) and notou (*Ducula goliath*)	important for Kanak tradition and identity, but threatened by overhunting and source of income

Responses to question 4: What kind of impacts should be prioritized in management plans against invasive species? (impacts on traditions, ecology or economy)

Each group had different opinions:

- Two of the groups thought that management plans should not prioritize invasive species only based on one type of impact. The economy, people's wellbeing and cultural traditions, and the environment are all connected. Everything should be considered, not only the economical or environmental impacts.
- One group thought that impact on the native species and forests should be prioritized in terms of management because all the other resources (food, water, traditions, economy) depend on forest health.

Appendix 3. Invitation flyer sent to workshop attendees in French Polynesia

Présentation du projet :

Réseau de Biosécurité des Communautés Autochtones du Pacifique
Pacific Indigenous Biosecurity Network

Alby MARSH, Maori Relationship Manager, Plant and Food Research, Nouvelle-Zélande
Dr. Julia SOEWARTO, Postdoctorante, SCION, Nouvelle-Zélande

Les peuples autochtones du Pacifique Sud ont en commun une relation complexe, holistique et interconnectée avec la nature et ses ressources. Ce lien traditionnel et ancestral les rend particulièrement vulnérables aux invasions biologiques (animaux, végétaux et micro-organismes), dans certains cas cela peut se traduire par des changements de modes de vies, la perte des pratiques et de savoir-faire traditionnels pour les générations futures. L'ampleur de ces impacts socioculturels est souvent méconnue et rarement prise en compte dans l'élaboration des plans de gestion des espèces invasives. Initié par Alby Marsh, représentant Māori pour la biosécurité en Nouvelle-Zélande et membre de Te Tira Whakamātaki réseau de biosécurité Māori, ce projet représente une opportunité pour le peuple Māori de renforcer les liens existants avec les autres communautés du Pacifique. L'objectif de ce réseau est de favoriser la résilience des peuples du Pacifique et de promouvoir l'intégration des considérations culturelles, écologiques, sociales de ces peuples dans les procédures – actuelles ou à venir – d'étude d'impact et de gestion des espèces invasives.
Au cours de cette présentation, nous introduirons les participants de ce workshop à la culture et au savoir traditionnel Māori (Mātauranga). Nous aborderons également les enjeux et l'intégration de la vision Māori dans la gestion des espèces invasives en Nouvelle Zélande.

Alby Marsh est chargé de relations au sein de l'institut de recherche Plant and Food Research, il est le lien entre la communauté Māori et le monde scientifique. Son rôle en particulier est de promouvoir les aspirations sociales, environnementales, économiques et culturelles Māori en développant des programmes de recherche qui favorisent les relations mutuellement bénéfiques avec un réel impact pour les Māori. Avec un intérêt tout particulier pour la protection des ressources en Nouvelle Zélande et son expérience dans la biosécurité, Alby est leader de plusieurs projets dont "Te Ao Māori - Myrtle Rust" commissionné par MPI (Ministry of Primary Industries), "Engagement for Resilience in Indigenous Communities" soutenu par l'Australian Plant Biosecurity Collaborative Research Centre, "Réseau De Biosécurité Des Communautés Autochtones Du Pacifique" un projet du Fond Pacifique, ainsi que de "Māori solutions to to biosecurity threats and incursions to taonga species" financé par Biological Heritage National Science Challenge.

Julia Soewarto est post doctorante au sein de l'équipe Forest Protection à l'institut de recherche SCION. Originaire de Nouvelle-Calédonie, elle a mené son doctorat au sein de l'Institut Agronomique néo-calédonien sur les impacts écologiques de la rouille des Myrtaceae (myrtle rust) et sur le développement de marqueurs génétiques liés à la résistance. Julia poursuit sa recherche sur la rouille des Myrtaceae en Nouvelle Zélande, en se focalisant plus particulièrement sur l'évaluation des niveaux de susceptibilités des espèces natives face à différentes souches du pathogène.

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