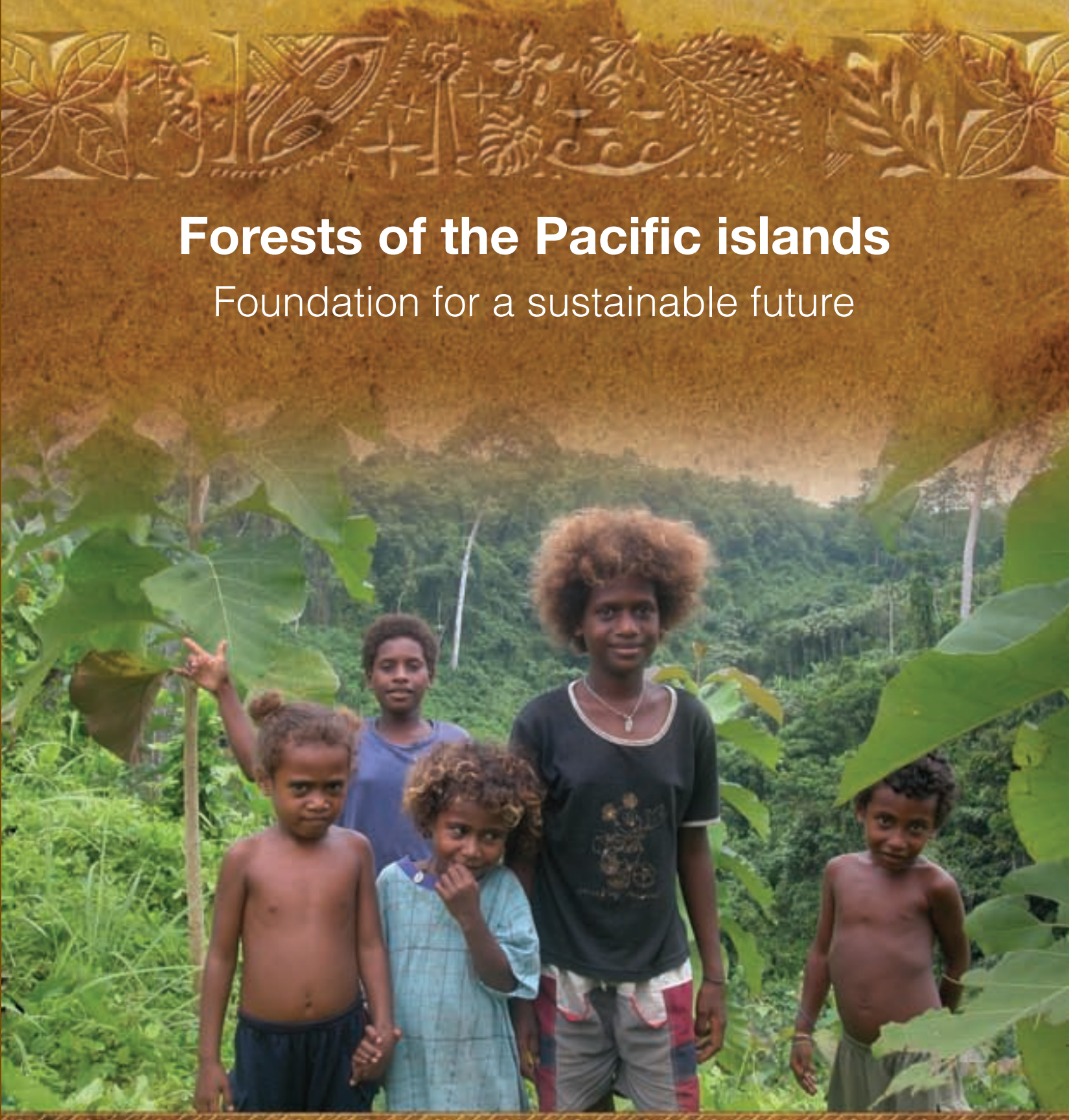
Forests of the Pacific islands

Foundation for a sustainable future



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Map of the Pacific

PACIFIC OCEAN

NORTHERN MARIANA ISLANDS
Saipan
Hagatna
GUAM
FEDERATED STATES OF MICRONESIA
Koror
PALAU (BELAU)
Palikir
MARSHALL ISLANDS
Majuro
Tarawa
KIRIBATI
NAURU
Yaren
INDONESIA
PAPUA NEW GUINEA
Port Moresby
SOLOMON ISLANDS
Honiara
TUVALU
Funafuti
TOKELAU
Honolulu
HAWAII
WALLIS & FUTUNA
Mata Utu
SAMOA
Apia
Pago Pago
AMERICAN SAMOA
VANUATU
Port Vila
FIJI
Suva
NEW CALEDONIA
Nouméa
Alofi
NIUE
Nukualofa
TONGA
Avarua
COOK ISLANDS
Papeete
FRENCH POLYNESIA
PITCAIRN ISLANDS
Adamstown
AUSTRALIA
NEW ZEALAND

130°E 140°E 150°E 160°E 170°E 180° 170°W/O 160°W/O 150°W/O 140°W/O 130°W/O 120°W/O
20°N 10°N 0° 10°S 20°S 30°S 40°S

Forests of the Pacific islands

Foundation for a sustainable future

Edited by Anne Moorhead

Supported by:

giz

On behalf of

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

of the Federal Republic of Germany

JICA

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Front Cover photo: Solomon Islands *Bronwyn Clarke*

Preface

The year 2011 is the International Year of Forests, with the theme 'Forests for People'. Like nowhere else on Earth, the Pacific islands illustrate this theme. Remote and isolated, the islands' forests have been the primary resource from which people have sought their practical, cultural and spiritual needs for thousands of years. This continues today, with an estimated three-quarters of Pacific islanders living a rural, traditional lifestyle.

Pacific islanders have mostly lived in harmony with the forests. They have built their homes from trees, and furnished them with mats and baskets woven from fronds and leaves. They have used the different woods for carving bowls, utensils, tools, ornaments and weapons, and for making canoes, their main form of transport. They have woven fishing nets from bark, roots and fronds, and made garlands from flowers and fruits. Their diet has been enriched by fruits, nuts and leaves from the forest, and their ailments treated with the many medicinal plants found there. The forest also provided a rich hunting ground for animals and birds, and the fuel with which to cook them.

Over the last few centuries, Pacific island forests have also been commercially exploited. Valuable trees like sandalwood were harvested and exported, sometimes to local extinction of the species. On many islands trees have also been felled over large areas to make way for development, commercial agriculture and pastureland. At the same time plantation forests of coconut, mahogany, teak and pine have been established.

These are just some examples of the ways people have used and changed Pacific island forests. Mostly, the forests have been seen as a resource, whether for local or commercial use. Of at least equal importance, however, are the ecological services that the forests provide. Again like nowhere else, islands illustrate the critical role of forests in providing services such as soil, watershed and coastal protection, animal and plant habitat, and clean water. When deforestation causes these services to break down, the impacts are very soon felt on small islands.

The ecological services provided by forests have at best been taken for granted, and at worst been sacrificed in pursuit of short-term economic gains. Today, the critical importance of these services is much better appreciated, placing forests at centre stage of international discussions on biodiversity, desertification and climate change. The message is, and has been for the last two to three decades, that we now need to develop forest management systems that preserve the ecological role of forests – in other words, sustainable forest management.

For us in the Pacific, it is time to take stock of our islands' forests and plan for their sustainable future. We do this at a critical time in the history of our planet, when we are facing uncertainty on a massive scale. Climate change, unprecedented population growth and vulnerable small island economies are some of the issues setting the scene for the future. In light of these challenges, more than ever before we need effective ways to integrate the diverse demands on forests, and to build sustainable and workable forest management systems that will support the people and economies of the Pacific islands into the future. Current international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC) are creating opportunities for new investments into forestry through mechanisms like REDD (Reducing Emissions from Deforestation and Forest Degradation) and REDD+, and Pacific island countries must take advantage of these to provide resources for the implementation of activities towards the sustainable management of their forests.

This book aims to contribute to the goal of the International Year of Forests by raising the profile of Pacific forests and celebrating their important contributions to the well-being of the people of the Pacific. It presents information on the forests of 22 Pacific island countries and territories. For each country or territory, it describes the current status of the forests. It identifies the main roles that forests are understood to play for the country's people and its environment, and also the key threats that the forests face at this point in time. The final part of each country chapter looks to the future, and presents a vision for the country's forests. This visioning is deliberately optimistic – there are many challenges to be overcome, but the forests of the Pacific islands are so vital to the people, culture, environment and economies of the islands that there is no alternative but to find more sustainable ways to manage them.

The book is not meant to be a technical publication nor purports to contain all the information about forests in all of the Secretariat of the Pacific Community (SPC) 22 member countries and territories. It is an introduction only, but one which we hope will provide sufficient information for a better appreciation of the value of Pacific forests and the issues and challenges faced by our people in managing these vital resources in a sustainable manner.

The idea for the book was proposed to and supported by participants at the Heads of Forestry Meeting held in Fiji in September 2009, and endorsed by the Heads of Agriculture and Forestry Services Meeting, also held in Fiji, in September 2010, as one of the regional activities to be organised by SPC towards the celebration of the International Year of Forests in 2011.

This mammoth task would not have been possible without the support and assistance of so many people from within and outside SPC, including the member countries and territories and their heads of forestry.

In particular we would like to thank Dr Randy Thaman, Dr Dick Watling and Dr Patricia Kailola for reviewing the manuscript. Ms Anne Moorhead performed the role of main editor for this book and also undertook the task of supporting and mentoring the individual country authors.

Our partners, GIZ (Deutsche Gesellschaft für Internationale Zusammenarbeit) on behalf of the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and the Japan International Cooperation Agency (JICA) provided the necessary support that ensured the satisfactory completion of the book. Their generous contribution is gratefully acknowledged.

Last, but not least, the country authors, in the face of many challenges, made excellent contributions which have ensured that this book is really one that is written and published by the Pacific for the Pacific.

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INTERNATIONAL YEAR OF FORESTS • 2011

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Introduction

Anne Moorhead and Randy Thaman

The forests of the Pacific islands

The 22 Pacific island countries and territories include more than 20,000 islands dispersed over some 29 million square kilometres of ocean. With very few exceptions, the natural vegetation of the islands is tropical forest. Without human impact, almost all of the islands would be completely under forest.

Forest types

In the Pacific islands, the main forest types are montane rainforest and cloud forest, tropical lowland rainforest, tropical dry forest, swamp forest, coastal forest, mangrove forest, agroforest and plantation forest. The extent and nature of these different forests on each Pacific island depends on factors including island type, elevation, location within the ocean and climate.

The islands can be roughly divided into high and low islands. High islands, rising to mountainous peaks, are mostly of volcanic origin but also include islands of ancient continental origin, such as the main islands of Papua New Guinea and New Caledonia. Low islands include low-lying limestone atolls formed over sunken volcanoes, which rise no more than 4 metres above sea-level; and raised limestone islands, many of which are quite large and rise to much higher elevations.

The origin and geology of an island influences the types of soils found there, and the soil influences the type of forest. Very generally, continental islands have a great diversity of soils ranging from very poor soils to rich volcanic and alluvial soils; high volcanic islands have fertile soils but they are prone to erosion on the steep slopes; the soils of raised limestone islands are alkaline, porous and fertile, but often shallow; and atolls have very shallow, alkaline, sandy soils with very low fertility.

The older nutrient-poor soils of continental islands often support only dry forest of savanna vegetation (scattered trees in grassland or scrubland) at lower elevations and rainforest at higher elevations. Volcanic soils and the

The Yela forest on Kosrae in the Federated States of Micronesia. *Eva Gonnerman*

Anne Moorhead is a science writer and editor. Randy Thaman is Professor of Pacific Islands Biogeography at the University of the South Pacific.

Coastal forest in Kiribati. *Randy Thaman*

limestone soils of the raised limestone islands generally support dense, species-rich rainforest; whereas the very poor soils on the low-lying atolls support mainly coastal and mangrove forest made up of widespread ocean-dispersed species.

Topography is also reflected in the different types of forest. Tropical lowland rainforest is usually the tallest forest and has the greatest diversity of species of trees and other plants and animals. It is also one of the most vulnerable to human impact, because land at lower elevations is in high demand for uses such as agriculture, pasture, settlements and urban development. As a result, very little original tropical lowland forest remains in the Pacific islands.

Montane rainforest is found higher up the mountainsides, while cloud forest is found on the peaks of the highest islands. In coastal areas, salt- and wind-tolerant ocean-dispersed species form coastal forests; while saltwater-tolerant mangrove species form mangrove forests in estuaries and protected coastal areas. Different species again are found in low-lying freshwater swamps.

Climate is another key factor influencing the type of forest. Much of the Pacific region has high rainfall year round, and tropical rainforest predominates. Near the equator, however, there is a dry zone and forests and vegetation are dominated by more drought-resistant species. On the larger high islands the mountains act as a barrier, and rainforest usually grows on the wetter windward side while the natural vegetation on the drier leeward side is usually tropical dry forest or more open woodlands and savanna vegetation.

Tree species

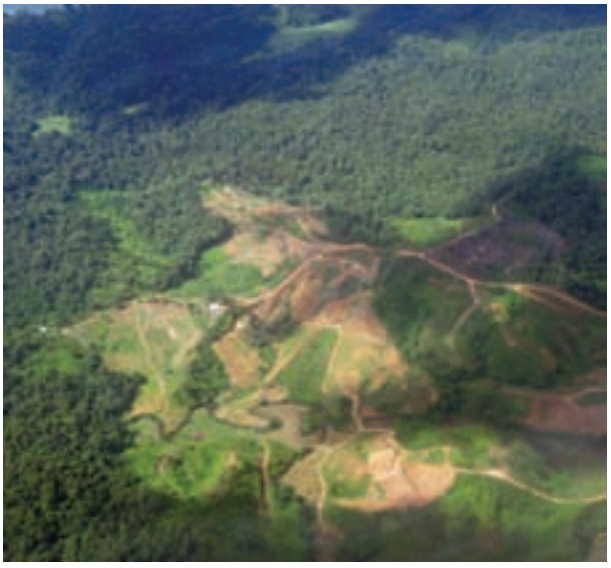
While distinct forest types are recognised across the region, the tree species within the forests vary. Each island has its own unique mixture of indigenous or native species that have established and developed there over hundreds of thousands of years. Some of these species may be found on almost all islands across the Pacific region, while others may be unique to a single island or group of islands. These unique plants are called endemic species. Generally speaking, the number of indigenous species is low on the smaller and more isolated Pacific islands and much higher on the larger islands of the western Pacific (e.g. Papua New Guinea and New Caledonia).

Human impact

These many variables explain the diverse natural forest types and indigenous species we find in the Pacific islands. However, the forests we see today are influenced by one final and overriding factor – people. Here, the islands have fared very differently. Some smaller islands have remained uninhabited, and their forests undisturbed. Many other islands have had centuries of low- or high-density habitation, with the accessible forest providing for the people's needs. People also brought fire to the islands, which has had a profound effect on the forests of some islands.

Impacts accelerated after the arrival of Europeans, especially from the 19th century. These include the conversion of most lowland and atoll forest and some

Human habitation has changed the forests of the Pacific islands. *Matt Capper*



Impacts on the forests accelerated after the arrival of Europeans. *Richard Markham*

agroforest and mangrove forest into coconut plantations to supply the copra trade. Other areas were cleared to grow crops like cotton and sugarcane.

People have also introduced new, non-indigenous trees and other plants and animals to many of the islands. Some, such as breadfruit, banana, other fruit trees, kava, pigs, dogs and chickens were carried by the early Pacific island settlers in their canoes. Other plants, such as exotic timber trees (pine, mahogany and teak), new food plants, ornamental plants and weeds, and animals such as cattle, goats and horses, have been introduced since the time of European contact with the islands. Many of these introduced species are now integrated into the Pacific island forests and agroforests. Others have become invasive, outcompeting indigenous species and replacing or degrading the natural forests.

The importance of Pacific island forests

Social and cultural importance

From the arrival of the first settlers, forests have played a central role in the lives of the Pacific islanders. For many centuries they have built their lives and cultures around the forests and trees. Today, the majority of the inhabitants of the Pacific region continue to live traditional lifestyles, and the social and cultural role of the forest is still paramount – forests and trees are a foundation for food and productive security. For example:

- Forests are a source of foods – both staple foods (such as coconut, breadfruit and wild yams) and food supplements (nuts, fruits, leaves and spices)
- Forests are a source of medicines – many trees have medicinal properties and traditional knowledge of their use has been passed down through generations

The traditional lifestyle of many islanders depends heavily on the forests. *Matt Capper*

Mat weaving in Solomon Islands. *Randy Thaman*

- Forests provide materials for building homes, furniture, boats, fencing, bowls and utensils, tools, weapons, fishing gear, mats and baskets, cloth (tapa), and many other products
- Forests provide fuel and illumination
- Many trees feature in the cultural traditions and religions of islanders, for example in ceremonies, folklore, songs, dances and poems.

Economic importance

As the world economy expanded in the 19th and 20th centuries, the economic role of the Pacific island forests came to the fore. On many islands valuable trees were felled and exported, while others were planted to supply international markets such as the copra trade. More recently, many Pacific island governments have chosen to use their country's forest resources to generate cash income and foreign exchange as a basis for modern economic development. Developing the forestry sector not only delivers economic returns, but also creates jobs and infrastructure.

Examples of economically important products and services of Pacific island forests are:

- Timber
- Added-value wood products, such as sawn wood, veneer and furniture

Wood carving brings income to communities. *SPC*

- Copra
- Carved or woven handicrafts
- High-value non-wood products such as virgin coconut oil
- Niche market foods, such as nuts and fruits
- Tourism, particularly ecotourism.

Coconuts have long been a source of income for the Pacific islands. *Richard Markham*

Ecological importance

In more recent years, the ecological value of forests has begun to be better appreciated. Forests provide many ecological services on which healthy island environments depend. These services include watershed and soil protection, maintaining soil fertility, coastal and riverbank protection, reef protection, protection from saltspray, clean water, and conservation of biodiversity through the provision of habitat and breeding sites for other plants and animals. Island forests also hold carbon, an ecological service of global relevance in this time of global warming.

In the country chapters, the key roles that the forest plays for each country and its people are described. For all countries ecological services are critical, however because they are generally the same for all countries they are not repeated in each chapter. Instead, the box on page 6 describes the ecological role of island forests in more detail.

From ridge to reef, ecosystems are linked. *Matt Capper*

Clean drinking water is an ecological service of healthy forest ecosystems. *Matt Capper*

Striking a balance

The key to the future will be to strike a balance between the economic, cultural and ecological roles of the forests. The difficulty will be to ensure that the cultural and ecological roles of trees and forests are not neglected as development pressures for cash income and foreign exchange increase in the Pacific islands. Recognising that these roles are interlinked is a useful first step. Economic development, for example, increasingly depends on the ecological services of healthy forests. In addition to commercial forestry, tourism and nearshore fisheries are examples of key economic sectors that are increasingly dependent on healthy forests. Similarly, failure to protect the cultural role – particularly the diverse non-cash income that trees and forests provide for rural communities – will have significant negative economic implications for countries.

The social, cultural and economic roles of forests can be enjoyed while at the same time preserving the ecological services. This is the basis of sustainable forest management, and is where the future must lie for Pacific island forests. There are however threats and challenges to the forests that will need to be addressed.

Ecological services provided by Pacific island forests and trees

Every island in the Pacific Ocean, even the smallest atoll with the most limited vegetation, benefits from ecological services provided by forests and trees. Ecological services are complex, and are best provided by established and intact ecosystems; however even degraded systems provide many services. Some of the most important of these services, described in very simple terms, are:

- Coastal protection – Mangroves and coastal forests play an extremely important role in keeping coastlines stable and protecting them during events such as king tides, storm surges and tsunamis. This is a purely physical function of the trees, their structures both above and below ground acting as a barrier against sea and weather.
- Watershed protection – Particularly on high islands, this is a critical ecological service provided by trees and forests. Most high islands have very high rainfall, and intact watersheds collect and channel the rainwater cleanly down to the sea. Where trees have been removed, soils are no longer protected by the canopy, leaf litter and roots, and heavy rain starts to erode the soils and riverbanks. Lower down the valley, this contributes to siltation and flooding.
- Marine and reef protection – This is linked to watershed protection, and captured in the 'ridge to reef' approach to sustainable system management. Healthy nearshore marine ecosystems depend on healthy inland forests. When watershed forests are damaged or removed, soils are washed down from the mountains and silt up estuaries, lagoons and coral reefs, damaging their ecosystems.
- Conservation of biodiversity – Isolated from major land masses by many thousands of years and many kilometres of ocean, island forests have evolved unique (endemic) species and communities found nowhere else on the planet. Because they are often found on only one or several islands, these species and communities are highly vulnerable to extinction. It is estimated that the Pacific islands are home to a quarter of the world's threatened species – and most of these are found in the forests.
- Clean drinking water – Healthy forest ecosystems are a vital component in water cycling and filtering on both high and low islands.
- Carbon sequestration – As elsewhere, forests and trees in the Pacific islands sequester (hold or store in their wood, leaves and other parts) significant amounts of carbon. Interestingly, there is some evidence that mangroves sequester proportionally more carbon than inland forests (see page 58).

Competition for land use, particularly on the coastal plains, poses a threat to the forests on many islands. *Richard Markham*

Forests under threat

Like forests worldwide, Pacific island forests are under threat. The causes are mostly linked to human activities, and a failure to regulate and manage these (with the notable exception of cyclones, which regularly damage Pacific island forests). It is in our power to change these activities, and to remove many of the threats.

The greatest threats fall under four main headings: population growth, the drive for economic development, global environmental change, and invasive species. The challenge posed by limited resources and capacity compounds these threats.

Population growth

Rising populations on many Pacific islands multiplies human impacts that may have been sustainable in the past when population densities were lower. Removing timber trees to build new homes in a village is unlikely to damage the forest in the long term; removing all the large trees in a single operation, for large-scale construction, will destroy the forest very quickly. To feed larger populations there is increasing emphasis on commercial agriculture and grazing, and less land available for traditional shifting agriculture. With little attention to soil health, this is declining, weeds and pests increasing, and farmers are being forced to clear new areas of forest on steeper and higher land. Also with population growth comes increased competition for land for urban and commercial development.

Economic development

Most islands have limited options for competing in the global economy, and it is not surprising that those countries that have extensive forests should choose to use them to drive economic development. However, the desire for rapid development has often meant that harvesting has proceeded in an unsustainable manner, without effective regulations and monitoring systems in place. Papua New Guinea and Solomon Islands in particular face the threat of unsustainable logging in the coming years, in their pursuit of economic development. In many places, forests are also being cleared for more 'lucrative' land uses, such as agriculture.

At the same time, economic development brings opportunities for better forest management. With development comes better education and raised awareness of environmental issues, as well as more financial resources with which to address them. However, modern education can also mean the loss of traditional knowledge about the importance and sustainable use of forests.

The pursuit of economic development can lead to unsustainable logging. *SPC*

Global environmental change

Global environmental change, including climate change, is a significant threat to forests and indeed to all ecosystems. Although there is uncertainty in the projected changes, and the impacts these changes will have, there is clear evidence of rising average temperatures and rising sea levels. More intense and more frequent extreme weather events are also predicted, in a part of the world where cyclones or hurricanes already cause significant damage to forests. These changes pose a direct threat to coastal forests and mangroves, and to agroforestry systems near the coast, but they are also an indirect threat as people are displaced from coastal areas inland, or from low islands to high islands, and then clear new forest areas. It remains to be seen exactly how the climate will change in the Pacific region, but it will change, and at relatively rapid rates. Forest adaptation is a little-researched area, but it seems likely that these complex ecosystems will struggle to keep pace with rapid environmental change. Environmental change will exacerbate the threat already posed by pests, diseases and introduced invasive species. Healthy trees and forests are usually resilient to these hazards, while trees and forests under stress are much more vulnerable.

Global environmental change will add to coastal erosion problems. *Ministry of Agriculture, Tuvalu*

The African tulip tree, conspicuous by its red flowers, is an introduced species that is outcompeting native tree species on many Pacific islands. *SPC*

Invasive species

Island forests are particularly vulnerable to invasive species. When highly adaptable plant species or generalist predators arrive on small islands, island species that previously faced little or no competition – and have nowhere to retreat to – are easily overwhelmed. Examples of introduced trees which have invaded island forests displacing native species include the African tulip tree, guava, *Leucaena leucocephala* and *Miconia calvescens*. Introduced predators, feral animals, insects and diseases have caused the extinction of many native birds, snails, insects and other plants and animals from the islands' forests and agroforests.

Resources and capacity

These threats need not spell disaster for the forests of the Pacific islands. We know how to manage forests sustainably, even in the face of growing populations and

the drive for economic development. There are many components to sustainable forest management, and each country will have to choose appropriate ones for its own circumstances. But for all countries, implementing sustainable forest management practices requires financial, technical and human resources.

Many island countries have limited financial resources, and forest management is often underfunded. With many other pressing needs, forestry may be given low priority by governments that may not yet fully appreciate the value of their country's forests. The long-term commitment needed for sustainable forest management is also highly challenging. Developing a forest policy is a vital first step that provides the basis for long-term commitment to good forest management, however many countries have not yet been able to do this. Those that have now face the much bigger challenge of turning policy into practice. In many cases, this will be compounded by the complex land ownership arrangements in much of the Pacific region (see box).

This is an outline of the threats facing Pacific island forests. Each country chapter focuses on the top three or four current threats to its forests. Although climate change is identified as a key threat to all Pacific island forests, because this threat is currently largely undefined it is included in the country chapters only where impacts are already being felt or where islands are particularly vulnerable. The threat posed by cyclones, with or without climate change, is also not repeated in each chapter, but is acknowledged as a significant threat that is best managed by maintaining the integrity and with it the resilience of the forests. And the threat posed by limited financial, technical and human resources is similarly stated here as a general challenge across the island nations, and not repeated in each chapter.

Looking to the future

What lies ahead for the Pacific islands and their forests? The threats associated with environmental change, rapid population growth and economic development loom large, while at the same time governments face difficult choices with limited resources. The importance of forests now and in the future is clear, and most agree that sustainable forest management is the way forward – but what does this actually entail and how can it be realised, against this backdrop of challenges?

New approaches to forest management are needed, that build on traditional systems while at the same time using the latest scientific knowledge available, to realise new economic opportunities while conserving essential ecological services and traditional roles of trees and forests. There are already projects under way that are showing how this can be done.

Community-based forest management provides a promising starting point. This builds on traditional community-based natural resource management, and introduces new ways of working for the 21st century. The Drawa Sustainable Forest Management project in Fiji provides a model (see page 21).

Small-scale, diverse agriculture and agroforestry are part of the tradition of the Pacific islands. Now, as population pressure builds on many islands, these systems need to be updated, drawing on the very best science available, to ensure that yields are high, soil quality is maintained, and pests, diseases and invasive species are kept under

Customary land ownership

In many of the Pacific island countries and territories, the majority of the land is under customary community ownership. This means its inheritance is governed by traditional custom rather than by modern legislation. This system reflects the strong cultural attachment Pacific islanders have to their land.

Customary ownership has traditionally allowed the benefits from land resources to be shared fairly within communities. However, with new land use and income options, growing populations and rural–urban migration among other trends, the limitations of customary land ownership are being revealed, often through heated conflict.

Several of the Pacific island countries are looking to reform their land tenure systems. The reforms most likely to work will be simple reforms that balance the interests of landowners and land users. They will reflect local needs and circumstances, and will work with the customary system rather than simply replacing it. However, the process of reform is likely to take a long time – perhaps decades.

Customary land ownership makes it difficult to develop land use plans, and to implement sustainable forest management over large areas. However there are examples where landowners and communities are working together with other stakeholders to manage their land sustainably. These include the Sovi Basin project in Fiji (page 20), the Drawa Sustainable Forest Management project in Fiji (page 21), the efforts to conserve the Yela forest in the Federated States of Micronesia (page 58), and the forest conservation work in Samoa (page 132). These examples can serve as models for developing sustainable forest management within customary land ownership systems.

The beautiful Pacific islands have a global comparative advantage for tourism and ecotourism, if the natural environment can be maintained. *Matt Capper*

control. High-value trees can be part of such systems, adding an economic element. With such systems, many islands can be self-sufficient for much of their food, energy and other needs, despite increasing populations. Community-based agroforestry action plans can form the basis of new, revitalised systems (see page 71).

Economic opportunities are changing, and the Pacific island countries and territories must identify those that they can realistically and sustainably address. Because of their remoteness and limited resources, most of the island countries cannot compete in world markets for most manufactured goods or services. There are however new opportunities for high-value niche products which some islands can capitalise on – and many of these come from the forests. Canarium nut (see page 43) and sandalwood (see page 50) are two examples.

For those countries that have been exporting round logs, it is now essential to increase value adding in the country, in other words to convert raw timber to products such as sawn wood, veneer, furniture and flooring. This is a vital step in the move towards sustainable forest management, as it directly addresses poverty and development issues. Jobs are created, income is generated, and the need to overexploit the forest is reduced. Fiji is making strides

in this direction, and Solomon Islands and Papua New Guinea should follow suit.

One economic opportunity where the Pacific islands have a global comparative advantage is tourism. The rise of ecotourism in particular offers opportunities in sustainable forest management. Many of the countries are beginning to develop ecotourism activities; enabling policy and support from governments are needed.

Climate change, though a dire threat, also brings opportunities. Islands with significant amounts of forest or land where plantation forest can be established will be able to take part in REDD+ schemes (Reducing Emissions from Deforestation and Forest Degradation). These will bring economic benefits to these countries, as well as environmental benefits locally and globally.

These and other promising approaches need to be promoted through national forest policies and plans. Developing a national policy on forests and their management is a first step for Pacific islands to manage the transition to sustainable forest management. Policies should be developed with broad consultation among stakeholders, as well as with expert guidance, so that they reflect the real situation on the ground while drawing on the best available knowledge to address the issues. Countries that have recently developed such policies include Fiji, Tonga and Vanuatu. It is important that forest policies be integrated with other national policies and plans, especially those on land use.

The following chapters describe the forests of the Pacific islands, their importance for the people of the Pacific region, the threats they face, and the future they hope to see.

Community-based forest management offers a promising way forward. *SPC*

Canoes that pass in the night: A cautionary tale from Yap

Yap, in the Federated States of Micronesia, has just over 100 km^2 of land. Today, there are multiple demands for Yap's very limited timber resources.

A typhoon in 2004 felled or damaged many big trees. Typhoon recovery assistance brought in many chainsaws to clear the debris. These chainsaws remained behind and are now being used to cut living trees.

A Baptist church also brought in a sawmill and began milling lumber. This inspired a number of local people to obtain sawmills and, with no regulations in place, there are now more sawmills than the forest resources can sustainably support.

Typhoon recovery assistance also funded the construction of many traditional men's houses, which required the cutting down of more large trees.

The island is also experiencing a resurgence of interest in traditional navigation and canoes, which has added to the demand for large trees.

A 1988 survey provided data on timber volume but did not address sustainable harvesting. A more recent forest inventory, in 2009–10, also gathered a large amount of data but also did not include recommendations relating to sustainable harvest.

Each group involved in assessing and using the island's tree resources had good intentions but didn't look beyond their own short-term project and address the long-term future of the island's forests. They are like 'canoes that pass in the night', and so the opportunity for Yap to retain the materials needed for the expression of Yapese culture (such as canoes), and for outside groups to assist in the sustainable development of Yap, is lost.

Matt Capper

Melanesia

Fiji. *SPTO*

Fiji

Samuela Lagataki and Anne Moorhead

Fiji at a glance

Number of islands: 332 (approx. 110 inhabited)

Total land area: 18,273 km^2

Forest cover: 60% (includes plantations and mangroves)

Population: 847,793

% population urban/rural: 51/49

GDP per capita: US$3,499

Main drivers of economy: Tourism, sugar, agriculture, fish, timber, mining

The rainforests of Viti Levu. *Matt Capper*

Summary

Fiji has extensive forests, both natural and planted. Plantations of mahogany and pine, planted on the larger islands since the 1960s, are now being harvested and hold significant export value for the coming years. However, as the timber industry develops, there is a critical need to balance it with sustainable management in all of Fiji's forests, in order to safeguard the country's biodiversity, to protect its soils, watersheds, coasts and reefs, and to supply the rising demand for ecotourism. Fiji's 2007 Forest Policy provides a framework for integrating these different needs for a sustainable future

Fiji's forests

Fiji has an estimated 60% forest cover, of which about 86% is natural forest and 14% plantation forest, mainly introduced mahogany (*Swietenia macrophylla*) and Caribbean pine (*Pinus caribaea* var. *hondurensis*). Although today very little of the natural forest remains undisturbed by people, it still hosts many unique species of plants and animals.

The largest island, Viti Levu, has slightly more than 50% of Fiji's land area. The mountainous interior acts as a rain barrier, so that the windward southeast of the island receives high rainfall and has extensive areas of tropical

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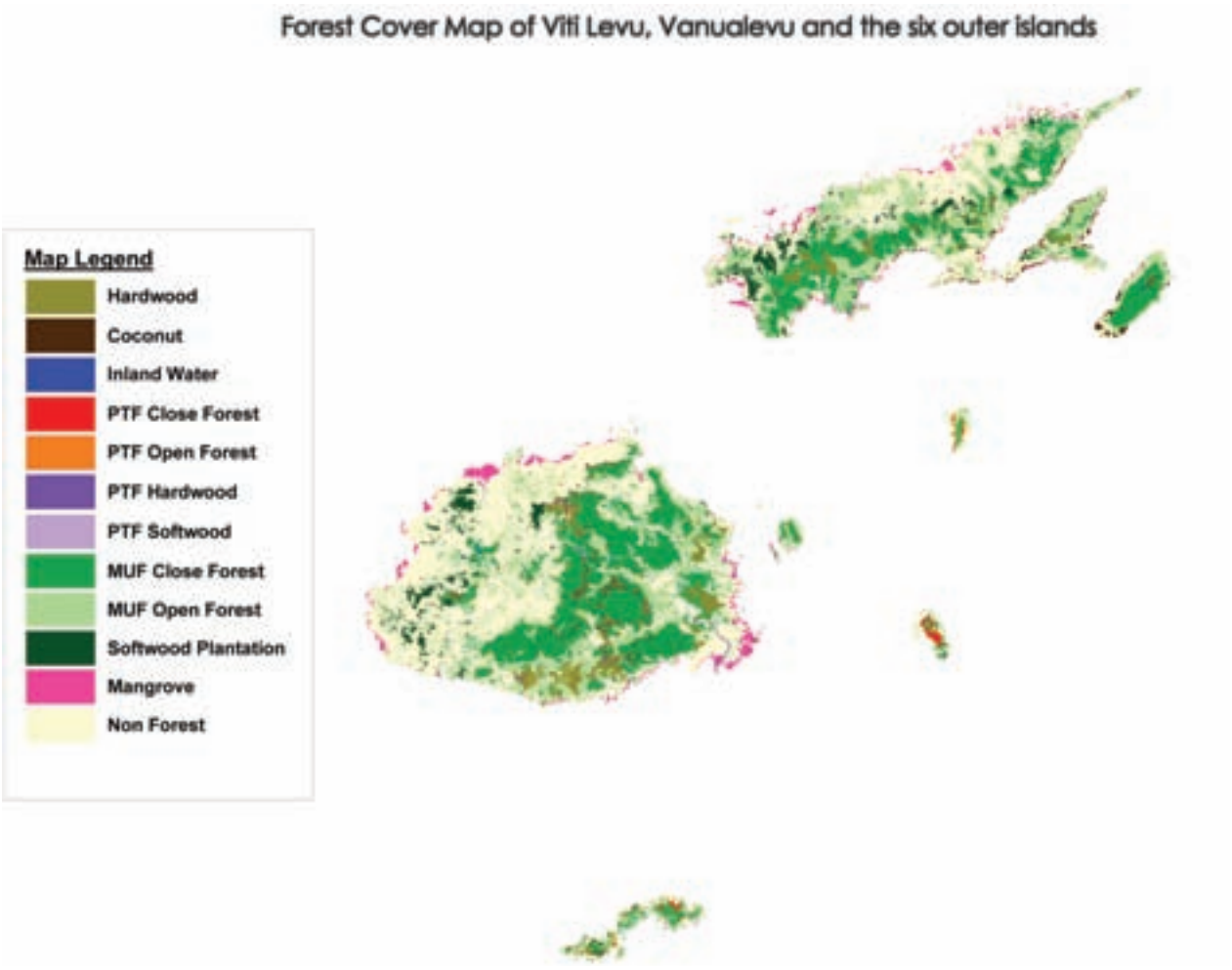

rainforest, while the leeward northwest is much drier and has tropical dry forests. However, much of Fiji's tropical dry forests have been lost due to repeated burning, and replaced by degraded grasslands, shifting agricultural gardens, pastureland and pine plantations.

Common trees in the lowland rainforest include *kauvula* (*Endospermum macrophyllum*), *vesi* (*Intsia bijuga*), calophyllum or *damanu* (*Calophyllum* spp.), *yasiyasi* (*Syzigium* (*Cleistocalyx*) spp.), *kaudamu* (*Myristica* spp.) and the conifers Pacific kauri or *dakua* (*Agathis macrophylla*) and *Podocarpus* spp. Cloud forest is generally found above 1,000 m, but on exposed ridges can be found as low as 600 m.

Vanua Levu, the second largest island with about 30% of Fiji's land, has similar topography and climate to Viti Levu. The wetter southeast is also mainly covered by secondary rainforest, while dry forests in the west exist only as remnants. Vanua Levu's dry forests were notable for sandalwood (*Santalum yasi*), but most of these trees were removed at the height of the sandalwood trade in the early 19th century.

Taveuni and Kadavu, the third and fourth largest islands, are considerably smaller. However, both have significant amounts of natural forest. Many of the smaller islands also have natural forest and significant areas of agroforest and village tree groves, though some have been completely deforested.

Coastal forests on the main islands have been almost completely cleared primarily for agriculture (mainly sugarcane and coconuts), but also for infrastructure and housing, and today little remains. There is however a notable patch of coastal forest growing on sand dunes near Sigatoka on Viti Levu, with species that normally grow further inland. Fiji also has significant mangrove forests – an estimated 3% of its forests are mangroves.

Western Viti Levu, where much of the natural forest has been replaced by grasslands. *Matt Capper*

A brief history of Fiji's forests

Before the arrival of Europeans, the main impact on Fiji's forests was from slash-and-burn agriculture. Rainforest was able to regenerate after such clearing, but with repeated burning the dry forest began to be replaced by grassland. This habitat destruction, as well as hunting, led to the extinction of some forest birds and other animals.

Impacts on the forests were much greater with the arrival of Europeans. The sandalwood trade brought the first Europeans to Fiji in the 18th century, and most sandalwood was gone by 1820. Planters followed, and cleared large areas of forest on the main islands to grow cotton, sugarcane and coconut.

Harvesting of timber from natural forests increased in the early 20th century to supply Fiji's expanding towns.

Tahitian chestnut

Tahitian chestnut (*Inocarpus fagifer*) is found across most of the Pacific island region. It has been cultivated for centuries in agroforestry systems for its edible nut, which is an important seasonal staple food in many traditional cultures. The nut must be cooked to make it edible – it can be roasted, grilled, boiled or baked. Traditional dishes include lap lap in Vanuatu, koko in Fiji and masimasi in western Solomon Islands.

The tree is usually found in lowland forest, along shorelines and rivers, and in agroforests and homegardens. It is a medium size evergreen tree, growing to about 20 m. It can grow in many types of soil, but is particularly adapted to waterlogged soils. It is also salt-tolerant. It is valuable for soil stabilisation because of its dense network of lateral roots. It is a legume and an important nitrogen-fixing tree.

Ripe fruits are harvested from the tree or from the ground. The fruit is split open to reveal the edible nut inside. The wood is also used, for carvings and tools, for canoes, and occasionally as timber for flooring. It is also a good fuel wood. The tree also has medicinal properties. In Solomon Islands, for example, the bark is mixed with coconut milk and used to treat urinary tract infections.

Richard Markham

Sugarcane was introduced to the two main islands of Fiji as a cash crop in the 19th century. *Vinesh Prasad*

Without any control, supplies in easily accessible areas began to be depleted. In response, the government set up the Forestry Department in 1938 to manage the exploitation of the forests. In 1950, a Forest Policy was endorsed by the government which set the scope and direction for forestry in the country. This was replaced in 2007 by a new Forest Policy.

The 1960s saw a major change, with the decision to establish forestry plantations to relieve pressure on natural forests. Caribbean pine was the main species planted in the drier areas in the west, which had mostly been reduced to degraded grasslands at this stage. Mahogany was planted in the rainforests after logging of native species.

Harvesting in the pine plantations began in the late 1980s, and mahogany began to be harvested in 2003. Today both are producing timber, for export and for the domestic market.

Forest ownership and management

About 90% of Fiji's forested land is communally owned, with the remainder privately or state owned. The iTaukei Land Trust Board (TLTB) administers the communally owned land on behalf of the land-owning groups or *mataqali*.

In recent decades forests have mainly been managed for timber extraction. This is done in partnerships between landowners, logging companies and the Forestry Department. The Forestry Department issues logging licences after agreement is reached between logging companies and landowners (via the TLTB).

In recent years the need for more sustainable forest management has been recognised. This prompted the new Forest Policy, which was developed between 2005 and 2007 with wide consultation among stakeholders. The Policy's goal is "sustainable management of Fiji's forests to maintain their natural potential and to achieve greater social, economic and environmental benefits for current and future generations". A National Forest Program has been developed alongside the Policy, covering 2010–2012, and clarifies the roles and responsibilities of the many different partners and provides an action plan towards sustainable management of Fiji's forests.

Importance of Fiji's forests

Conservation of biodiversity

Fiji has an unusually high number of endemic species of plants and animals, most of which are found in the rainforests. Of the approximately 1,600 native plant species, over half are endemic. For example, of 26 native palm species, all but one are endemic. Fiji also has an endemic family of primitive trees, the Degeneraceae, distantly related to magnolia.

Twenty-eight bird species are endemic to Fiji. The Fiji ground frog (*Platymantis vitianus*) and the Fiji tree frog (*P. vitiensis*) are endemic amphibians, while endemic reptiles include two species of iguana. Fiji's only native mammals are its six species of bat, of which the Fiji

The Fiji crested iguana (*Brachylophus vitiensis*), an endemic species of the dry forest, is in danger of extinction. *Matt Capper*

The orange fruit dove (*Ptilinopus victor*) is found in the forests of just a few islands in Fiji. *SPC*

flying fox (*Mirimiri acrodonta*) is found only in the cloud forests of Taveuni. There is limited information about the insects of Fiji, but surveys between 2002 and 2006 found 285 new species and 15 new genera. One insect – the Taveuni long-horn beetle (*Xixuthrus terribilis*) – is famous as the largest beetle across the whole of Australasia.

Many of Fiji's endemic species are seriously threatened as their forest habitat is being degraded or destroyed. Others are known to have already gone extinct, for example, Fiji has lost three bird species since the arrival of Europeans (the whistling tree duck, the grass owl and the barred-wing rail) and another seven prior to this time.

Timber

Fiji's forests have been a source of timber, both for use in the country and as an export commodity, for many years. The Caribbean pine plantations started in the 1960s are currently delivering increasing amounts of wood, mainly for export as wood chips. The mahogany plantations in particular have great economic potential in the coming years. With effective value-adding in-country, this could be a significant driver of development for Fiji. At the same time natural forests continue to be logged for useful species, mainly for use within the country.

Tourism

Tourism is one of Fiji's biggest revenue earners, and this looks set to continue, with ecotourism becoming increasingly important. Fiji's visitors come mainly for the beaches and reefs, and keeping these healthy is therefore critical to the success of the industry. Intact inland forests are an important part of this.

There is also great potential to develop inland tourist attractions based on the natural forests, agroforests and rivers. Currently, a relatively small amount of Fiji's forests is managed for recreation or tourism purposes. On Viti Levu, Colo-i-Suva Forest Park covers about 250 ha close to the capital Suva. The Koroyanitu National Heritage Park, on the west side of the island, is an ecotourism project that protects montane and cloud forest and at the same time provides income to the villages within the park. Also on Viti Levu, the Sigatoka Sand Dunes National Park includes the associated coastal forest. On Vanua Levu, Waisali Rainforest Reserve protects 116 ha of rainforest; while on Taveuni the Ravilevu Nature Reserve, the Taveuni Forest Reserve and the Bouma National Heritage Park together protect over 16,600 ha.

Value to rural communities

Approximately half of Fiji's people live in rural areas, and they depend heavily on the natural forests and agroforests for many things, from food and medicines to building and weaving materials. Forests are also of economic importance to the rural communities, through royalties from logging and also sales of carvings and non-wood forest products outside the villages.

There is great potential to expand ecotourism in Fiji. *Matt Capper*

Threats to Fiji's forests

Expanding agriculture

Fiji's population has increased from around 200,000 in the 1940s to more than 800,000 today. Feeding the people is taking its toll on Fiji's forests, as more areas are cleared for agriculture. Both subsistence farming and

The timber industry is gaining momentum in Fiji. *SPC*

commercial agriculture are encroaching on the forests. The booming demand for the root crop taro for export to Australia and New Zealand is also putting pressure on forests in Taveuni and parts of Viti Levu. Expanding monoculture of crops such as taro and cassava has led to the neglect of the species-rich agroforestry systems and the loss of many useful trees within them.

The timber industry

As the timber industry gains momentum, much of the knowledge and resources needed for sustainable forest management are not yet in place, and regulations are difficult to enforce. Risks include unsustainable harvesting and poor logging practice.

Land ownership

The majority of Fiji's forests are under communal ownership. This poses a significant challenge to forest management as it requires consensus across large numbers of people who may have different interests and needs.

Looking to the future

In the past, the economic value of Fiji's forests has generally taken priority over their environmental and cultural roles. Now, however, it is recognised that these different needs must be balanced through sustainable forest management. This is clearly stated in the current Forest Policy, which reflects the views of many and diverse stakeholders.

The Policy hopes to create a thriving forest industry supported by sustainably managed forests. High-quality wood and non-wood forest products for which Fiji has a comparative advantage will form the basis of the industry. Adding value to products within the country, and where possible within rural communities, will boost the economy at different levels. There are already promising moves

The Sovi Basin project

The forests in and around the Sovi Basin on Viti Levu comprise the largest remaining area of rainforest in Fiji, most of which is relatively undisturbed. The forests provide habitat for some of Fiji's rarest plants and animals, including the long-legged warbler (*Trichocichla rufa*) and the ancient gymnosperm, *Acmopyle sahniana*. In the early 2000s the Fiji Forestry Department and local partners, supported by the National Trust of Fiji and Conservation International, joined forces in a unique project to ensure that this very special area is not lost.

The project area covers more than 20,000 ha, and is owned by 13 land-owning groups or *mataqali*. The challenge was to develop a mechanism that would provide economic incentives for the landowners to put their land into conservation instead of allowing it to be logged, and to ensure this would remain in place over the long term.

The Sovi Basin project team worked with landowners and other stakeholders to get support for the project, to overturn a logging concession in the basin, to agree to a 99-year lease on the land which is held by the National Trust of Fiji, and to develop a management plan for the conservation area. The management plan was developed with full participation of the landowners, to meet both conservation and livelihood needs. Under the plan, landowners may use the protected area for traditional gathering and fishing purposes, which was an important stipulation to secure landowners' support. The landowners are also involved in the implementation of the management plan.

The partners also developed the Sovi Basin Trust Fund to finance the project. The Trust Fund covers lease premiums, compensation for lost timber royalties, community development opportunities, any costs associated with implementation of the management plan, and other project costs. The Fiji Water Foundation was the main contributor to the Trust Fund.

Matt Capper

in this direction, for example value-added mahogany products, virgin coconut oil and other coconut products, and sandalwood.

Today, very little of Fiji's forests is managed sustainably (but see the boxes for promising projects). To begin addressing this, the Policy advocates the establishment of 'permanent forest estates'. Within these designated areas, forests will be managed sustainably for different purposes. Plantations will be managed for production of wood and wood products, while protection forests – forests with important environmental, cultural or historical significance – will be minimally disturbed. A third category, multiple use forests, will be sustainably managed for a range of products and uses, including for timber.

Sustainable forest management will only work if it involves rural communities and landowners, and if they see immediate and significant benefits. A first step is raising awareness among communities of sustainable management options under the new Policy, and the opportunities they offer. The local conservation organisation NatureFiji-MareqetiViti recently began an awareness campaign to address this.

Fiji's significant area of forests means that the country has a part to play in efforts to mitigate global climate change. In the future, REDD+ (Reducing Emissions from Deforestation and Forest Degradation) projects will also form part of such community-based forest management. While the international community works to clarify mechanisms for REDD+ projects, Fiji is laying the groundwork – a REDD+ policy was recently endorsed by the government.

Sustainable forest management must involve communities. *SPC*

The Drawa Sustainable Forest Management Project

A project in Vanua Levu has shown how sustainable forest management can be implemented through a community-based approach, and how this can work with land under customary ownership.

SPC

The Drawa project area covers 6,345 ha and belongs to 11 land-owning groups or *mataqali*. The project began in the late 1990s, and first sought to establish commitment from the landowners. The Landowners Association of Drawa (LOAD) was set up to oversee activities, and the Drawa Landowners Forest Management Co-operative Limited (DraFCo) was set up to carry out and manage timber operations. A forest inventory was undertaken, and based on this a 10-year forest management plan was drawn up for the period 2005–2015 (to be reviewed and revised every 10 years). The plan identifies areas appropriate for sustainable harvesting, protected areas where timber cannot be harvested and other activities are limited, and areas for non-timber activities such as cultivating crops. All in the landowning groups signed the plan, agreeing that they would respect the designated areas. Community monitoring bodies were set up to ensure compliance with the plan. Implementation of the plan is directed by traditional decision-making processes, including for conflict management and mitigation.

The project carried out capacity building at different levels, and this strengthened the commitment of individuals and groups to the project. An impact assessment in 2008 found landowners diligently following the land use plan and applying sustainable land management practices.

New Caledonia

Philippe Bourgine and Van Duong Dang

New Caledonia at a glance

Number of islands: 21 (11 inhabited)

Total land area: 18,576 km^2

Forest cover: 60% (includes scrub forest, mangrove forest and plantations)

Population: 254,525

% population urban/rural: 63/37

GDP per capita: US$37,993

Main drivers of economy: Nickel mining, French financial support, tourism

South-west Grande Terre. *Carla Appel*

Summary

New Caledonia has extraordinary biodiversity, with many endemic plants and animals in its forests, particularly on the largest and main island Grand Terre. Among these are 44 conifers – the largest number of conifer species by area in the world – and 18 of these belong to the ancient family Araucariaceae. Nickel mining on Grande Terre has damaged much of the montane and scrub forest, while fire has destroyed most of the dry tropical forests. New environmental policy aims to balance economic demands on the country's resources with good environmental management. Sustainable forest management, including fully protected areas of special biodiversity, is the goal. As part of this plan, a breeding program for native pines from the Araucariaceae family is under way, and plantations are being developed that will supply timber as well as conserving these unique trees.

The forests of New Caledonia

New Caledonia comprises one large, high continental island called Grande Terre and 20 smaller low islands. These include the raised limestone islands of the Loyalty Islands (Îles Loyauté) to the east of Grande Terre and the Isle of Pines (Île des Pins) to the south.

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Grande Terre is an ancient continental island that was connected to Australia some 80 million years ago as part of the ancient southern super-continent Gondwana. At more than 16,000 km^2, Grande Terre has 90% of New Caledonia's land. The island is elongated, and is approximately 350 km long and 70 km wide at the widest point. It has a central mountainous ridge running the length of the island which has average elevation of about 1,000 m, with peaks rising above 1,500 m.

The western side of the island is in the rainshadow of the mountains. Here, tropical dry forests once dominated, but these are now almost completely gone, due to bushfires and clearing for cattle farming and agriculture. Much of this area has been colonised by the more resilient *niaouli* (*Melaleuca quinquenervia*). Moving up into the mountains, the natural vegetation is montane rainforest or scrub forest, depending on the soil and other factors. Scrub forest grows on soils that are rich in metals that are toxic to many plants. These forests have been very disturbed over recent decades by open-cast mining for nickel, which has also caused serious soil erosion further down the slopes. Cloud forest occurs on the highest peaks, and is less disturbed because of its inaccessibility. The eastern side of the island has mainly rainforest-covered steep slopes. Small areas have been cleared for subsistence agriculture, while some valleys have been cleared for commercial coffee growing.

New Caledonia has been designated a global 'biodiversity hotspot'. Because of its origins as part of ancient Gondwana, its isolation, and also its great diversity of habitats, soils and topography, Grande Terre has a very high number of plant and animal species for its size, many of which have evolved here and are endemic to the island. The rainforest has an estimated 3,670 plant species of which 82% are endemic; the scrub forest has 1,140 plant species, 89% of which are endemic; and the dry forest – now only found as remnants – has 230 species of which 56% are endemic. Among the endemic species are 44 conifers – the largest number of conifer species per unit area in the world. These include 18 species from the family Araucariaceae (see box on page 28).

The natural vegetation of the Loyalty Islands is lowland rainforest and coastal forest. The Isle of Pines was named by Captain Cook for its tall native pine trees, now called Cook's pine (*Araucaria columnaris*). The centre of

The Isle of Pines. *SPC*

the island is a plateau (150 m above sea level) on which the natural vegetation was scrub forest, but this has now been replaced mainly by pine plantations of introduced Caribbean pine (*Pinus caribaea* var. *hondurensis*). Caribbean pine plantations are also found on Grande Terre, and smaller plantations are found on some of the other islands.

Mangroves are most abundant on the west coast of Grande Terre, but are also found on the east coast and on some of the other islands.

A brief history of New Caledonia's forests

New Caledonia's extraordinary biodiversity stems from its ancient origins as part of Gondwana. The islands separated from Australia and the super-continent many millions of years ago, and were then isolated in the Pacific Ocean. Many of New Caledonia's unique plants still show this ancient ancestry, for example, *Amborella trichopoda*, a small tree with primitive characteristics that link it to the very earliest flowering plants.

The islands were first settled by humans about 3,000 years ago. Traditional life was based on subsistence agriculture, hunting in the forests, and fishing in the ocean. The forests also provided a wealth of useful products, from building materials to medicines. During this period, the major impact on the forests was burning, and the dry tropical forests declined as a result.

The arrival of Europeans started a new era for New Caledonia and its forests. Sandalwood (*Santalum austrocaledonicum*) was the first product to be exploited and exported, beginning in the 1820s. Over the years, thousands of tonnes were exported to Australia, China and Europe. Today, very few isolated stands of sandalwood remain, mostly on the Isle of Pines and the Loyalty Islands.

In 1853 New Caledonia was annexed by France. Over the following decades, the French administration sold off large areas of land to European settlers who cleared much of the land, for example to set up cattle ranches on the west coast of Grande Terre and coffee plantations on the east coast.

The discovery of nickel on Grande Terre in 1865 led to a mining industry that grew slowly until the 1950s and then expanded rapidly during the 1960s. The nickel deposits are found in the central ridge of mountains above about 400 m, with the richest deposits on the high ridges. The nickel is mined from open-cut mines, and requires the stripping away of the vegetation before mining. There are further impacts from the dumping of waste earth which washes down into lower waterways and into the sea, silting up and damaging these ecosystems. The building of roads to reach mining areas has also contributed to soil erosion. A slowing of demand for nickel has led to the closing of many mines since the 1970s, however demand is increasing again and mining is set to continue.

Nickel mining began on Grande Terre late in the 19th century. *Randy Thaman*

From the beginning of the 20th century up to the 1940s, an Australian company logged and exported a species of kauri, *Agathis lanceolata*, from the forests in the south of Grande Terre. This led to near extinction of the species.

Forest ownership and management

There are three forms of land ownership in New Caledonia: public land owned by the national or provincial government; privately owned land; and customary land. On Grande Terre, about 60% of the land is public land, about 20% is privately owned, and about 20% is customary land. In the Loyalty Islands and the Isle of Pines, more than 95% is customary land and the remainder is public land.

The first national Forest Policy was drawn up in 1910, with the aim of regulating logging and burning of the natural forests. Its objectives were to protect water resources and watersheds, and to prevent slope erosion.

A national Forest Service was set up in 1947. Its roles include controlling logging in the natural forests, and managing plantations. Between 1973 and 1998 the country's forests were inventoried, and this was followed by the drawing up of a logging plan. The plan identifies 15,000 of 400,000 ha of rainforest that can be logged,

following approved practices. There are currently two logging permits in place, one on the Isle of Pines and the other on Grande Terre.

On customary-owned land, the landowning communities have the right to use products from the forest for their daily needs. They can also apply to the provincial authorities for a logging permit and then log the forests following Forest Service regulations.

Importance of New Caledonia's forests

Conservation of biodiversity

New Caledonia is recognised as one of the most important areas of biodiversity in the world. About 14% of its plant genera and 80% of the species are endemic, including five complete families (Amborellaceae, Oncothecaceae, Papracrypyiaceae, Phellinaceae and Strasburgiaceae). Among the many conifer species is the only known parasitic conifer (*Parasitaxus ustus*). Another unusual tree, *Sebertia acuminata*, accumulates nickel in its sap. The ancient lineage of many of these plant species makes them particularly interesting and important from a botanical point of view.

In addition to the diverse and unique flora, more than 5,000 animal species have been identified, about 80% of which are endemic. Sixty of the 68 lizard species are unique to New Caledonia – these include the world's largest gecko (*Rhacodactylus leachianus*) and the world's largest skink (*Phoboscincus bocourti*), although this latter may now be extinct. More than 150 endemic land snails have so far been identified, and it is believed there are many more yet to be found.

Of New Caledonia's birds, seven species are endemic. These include the national bird, the cagou or kagu (*Rhynochetos jubatus*), which is the only surviving species in the ancient family Rynochetidae. A flightless bird, the cagou is found in the rainforest and shrub forest of the mountains of Grand Terre.

Tourism

Tourism is New Caledonia's second largest industry after nickel mining. Around 100,000 tourists visit the country each year, not including those who visit briefly by cruise ship. People come for diving on the barrier reef, relaxing on the beaches, and to experience the biodiversity of the islands. Two national parks on Grande Terre showcase

Plaines des lacs, an important wetlands in the south of Grande Terre. *Randy Thaman*

New Caledonia's national bird, the forest-dwelling cagou, is endangered. *SPC*

the country's forests. The Parc de la Rivière Bleue covers 19,000 ha of scrub and montane forest and is home to the country's largest kauri tree (40 m tall and 11 m girth), as well as many rare plants and animals. The Parc des Grandes Fougères covers 4,500 ha of montane forest.

Timber

New Caledonia's forests currently supply some 10% of the country's timber needs, and this percentage will increase over the coming years as the Caribbean pine plantations, which were established from the late 1960s, come into full production. There is also a project under way to develop native pine plantations to provide for domestic timber needs; and another to plant introduced drought-tolerant timber species such as eucalypts (*Eucalyptus* and *Corymbia* spp.) in the dry southwest of Grande Terre.

Non-wood forest products

A significant non-wood forest export is sandalwood oil. This is produced on the Isle of Pines and on Maré in the Loyalty Islands. Annual production is about 1,500 kg, which is worth more than half a million US dollars to the country. Sandalwood oil from New Caledonia is sold mainly in France, Germany and the US. The waste is dried and sold to the Asian market where it is again distilled, then crushed and used for making incense sticks.

Threats to New Caledonia's forests

Mining

New Caledonia is believed to have 25% of the world's nickel. Although nickel mining has declined since the peak years of the 1960s, it remains important to the national economy, and recent investment in the industry makes it likely that mining will continue for the coming years. Today, before extensive new mining is permitted an impact study must be carried out. Good practices must also be followed during mining to reduce environmental damage. However, mining remains damaging to the forests, and is controversial, with opposition from environmental groups and many local people.

Fire

Fire is one of the biggest threats to New Caledonia's forests. Most fires are started illegally, sometimes to aid deer hunting, as the deer are attracted to the new growth following the fire. Fires are a problem particularly on the drier side of the islands and during the dry season. For example, a fire in December 2005 destroyed 5,000 ha of scrub and rainforest, while in October 2010 a fire on the Isle of Pines destroyed 1,800 ha of mainly Caribbean pines.

Fire is one of the biggest threats to New Caledonia's forests. *Jipé Le-Bars*

Invasive species

One of the most damaging introduced species is the Java deer (*Rusa timorensis*) which was brought to Grande Terre from Indonesia about 100 years ago. A highly adaptable animal, it is found in all habitats from the mangroves at the coast up to the highest ridges. Numbers on the island are now estimated to be more than 250,000. The deer graze on tree seedlings and also trample young plants. Deer hunting, which is encouraged to try and control the numbers, also has significant negative impacts on the

Sandalwood

Several species of sandalwood are found in the Pacific, including *Santalum austrocaledonicum* in New Caledonia and Vanuatu, *S. yasi* in Fiji, Niue and Tonga, *S. insulare* in Polynesia and *S. macgregorii* in Papua New Guinea. The tree grows naturally in tropical dry forest. Like Indian sandalwood (*S. album*), these trees are highly prized for their scented wood, which is carved or used to extract essential oil. In the 1800s large numbers of sandalwood trees were felled and exported, changing forever the natural sandalwood forests of the islands. Today, sandalwood in the Pacific islands exists as remnant populations and in some small plantations.

In nature, sandalwood usually grows as a shrub or small tree in relatively open forest, as the saplings cannot tolerate shade. The tree is a hemi-parasite, which means it needs a host plant in order to survive. The sandalwood tree grows root extensions that link with the host's roots, and it obtains water and essential nutrients in this way. Only certain tree species are suitable hosts.

Thus, propagation of sandalwood is not straightforward. Nonetheless, because of its great economic potential, efforts are being made to promote replanting of sandalwood. Trees take between 25 and 40 years before they can be harvested, but they provide very good economic returns. They are also being promoted for planting in environmentally sensitive areas so that communities can derive benefits from the forest by felling just a few high-value trees, limiting disturbance to the forest.

SPC

forests, particularly through burning to attract the deer to new growth. Wild pigs and the little fire ant (*Wasmannia auropunctata*) are also a threat to biodiversity in New Caledonia.

Looking to the future

New Caledonia will strive to balance economic demands on the country's resources with good environmental management to ensure the future of its forests. Environmental policies to guide these efforts have recently been developed at the province level. Conservation of biodiversity, management of natural resources, prevention of pollution and the control of invasive species are the main themes of the policies. Community participation is a key feature.

Logging of natural forests will stop within the next 5 years. Forest management will switch to controlling invasive species, controlling hunting, and preventing illegal harvesting.

More forests will be managed for recreation or as biodiversity sanctuaries. A new forest reserve status will be created, as a framework for sustainable forest management. Within these areas, ecosystems of special interest will be identified and fully protected. Other sustainable management options will be explored outside these protected areas.

Regulations on mining activities are tightened in the new policies. For example, forest cannot be cleared on slopes of more than 30°, over 600 m elevation, or within 10 m of a riverbank unless a permit is given. An impact study is required if the area to be cleared is more than 30 ha. Management of mining waste is also addressed in the policies.

Endemic Cook's pine in a plantation on Grande Terre. *Christian Harbulot*

Regulations for timber harvesting have been revised and are included in the new policies. In the future, timber will come from the existing and new plantations. As the Caribbean pine plantations come into full production, they will supply a larger proportion of the country's timber. There are also plans to develop 300–400 ha of new plantation each year with a variety of introduced and native species (see box). These include two species of kauri (*Agathis lanceolata* and *A. moorei*), two araucarias (*Araucaria columnaris* and *A. nemorosa*), sandalwood, gaïac (*Acacia spirorbis*), mahogany (*Swietenia macrophylla*), calophyllum (*Calophyllum neocaledonicum*) and Caribbean pine. Areas in the southwest of Grande Terre are also to be replanted with drought-tolerant species such as eucalypts, which will provide timber within 25 years.

A sandalwood plantation on the Isle of Pines. *Charles Holué*

Working with native species – the Araucariaceae

Philippe Bourgine

The Araucariaceae is an ancient family of conifers found only in the southern hemisphere. There are just two genera – *Agathis* and *Araucaria* – and 40 species. Of these, 18 species are found only in New Caledonia. Recognising that it is important to conserve these trees, and that they are well adapted to the conditions of New Caledonia, the Forestry Service is developing several of the species for timber plantations and for restoration of mining sites.

Cook's pine (*Araucaria columnaris*) is the most adaptable species and is found across Grande Terre as well as on the Isle of Pines and the Loyalty Islands. A breeding program is under way to genetically improve Cook's pine for better growth and straighter trunks. When completed, this will be one of the main plantation species. Another species of *Araucaria*, *A. nemerosa*, is currently rare and endangered. This is also being grown in plantations, contributing to its conservation. Two other species, *A. rulei* and *A. muelleri*, are being used for restoration of mining sites. They are very slow growing trees but they are tolerant of poor soils and high winds, conditions often found at mining sites.

Trees of the genus *Agathis* are known as kauris. They are mostly very large trees, and therefore favoured for timber. Three species of *Agathis* are being used in plantations – *A. lanceolata*, *A. moorei* and *A. ovata*. *Agathis lanceolata* and *A. moorei* are also undergoing a breeding program. Once seed has been produced and multiplied, these trees will be widely planted. *Agathis ovata*, which grows naturally in the scrub forest, is also being used for mining site rehabilitation.

Despite their slow growth, these native pines have several advantages over introduced pines. They are very familiar to the local communities, who have made use of them over the centuries. They are better adapted than introduced trees to the extreme weather that New Caledonia occasionally experiences, such as cyclones. They are also proving easy to grow in nurseries, with nearly 90% of seedlings being successfully planted out.

Papua New Guinea

Ruth Turia, Dambis Kaip and Fay Duega

Northern Region of mainland PNG. *Richard Markham*

Summary

Papua New Guinea (PNG) has great diversity of island types, extensive forests, and extraordinary biodiversity. The vast majority of PNG's people have a traditional lifestyle and rely heavily on their natural forests and on the diverse production of agroforestry systems, while export of timber is a major earner for PNG. However, unsustainable logging poses a huge threat to the forests and their biodiversity. Timber is usually cut by Asian logging companies in remote locations, and monitoring and regulating their activities is extremely difficult. To secure the future of PNG's forests, the government must take serious steps to tackle this problem; a recent ban on the export of round logs from new timber concessions is an important first step. Other promising initiatives include developing local industries that produce high-value forest products, both wood and non-wood; putting logging and sawmilling into the hands of the local communities; building the ecotourism industry; and developing REDD+ (Reducing Emissions from Deforestation and Forest Degradation) projects.

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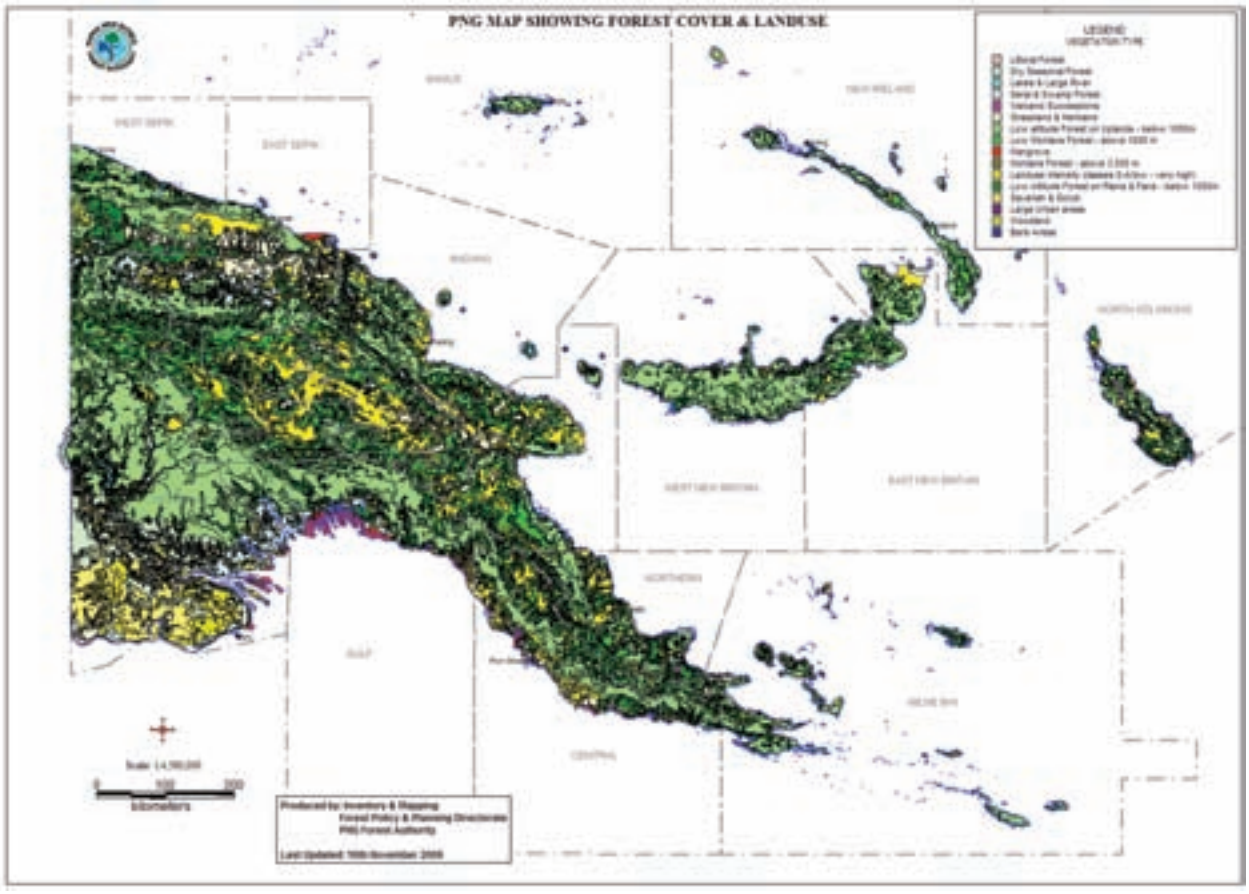

Papua New Guinea's forests

Papua New Guinea (PNG) is by far the largest of the 22 Pacific island countries and territories. It also has by far the largest area of forests, and within them some of the richest biodiversity on Earth.

The country includes the eastern half of the island of New Guinea (the 'mainland'), and several groups of smaller islands offshore. There are four regions: the central, mountainous Highlands Region; Momase (or the Northern Region) to the north of the mountains; the Southern Region; and the New Guinea Islands Region. The highest point is Mount Wilhelm on the mainland, which rises to just over 4,500 m. The main islands are of ancient continental Gondwana origin while some of the smaller eastern islands are younger volcanic islands. There are also atolls in the far east.

The mainland has extensive tracts of montane, lowland and coastal rainforest. Much of the terrain is rugged and difficult to access, and large areas remain to be explored and documented by science. There are believed to be many species of plants and animals yet to be scientifically described.

The Highlands Region is mostly covered with dense montane rainforest, up to elevations of about 3,000 m. Sub-alpine grasslands are found above this elevation. Typical trees of the montane rainforest include araucaria pines (*Araucaria* spp.), trees of the beech family (Fagaceae) such as *Castanopsis acuminatissima* and *Lithocarpus* spp., and more than 10 species of southern beech (*Nothofagus* spp.). Conifers and trees of the myrtle family (Myrtaceae) dominate at higher elevations.

Momase has montane rainforest as well as extensive tracts of lowland rainforest and freshwater swamp forest around the Sepik and Ramu river basins. The Southern Region also has lowland rainforest and swamp forest associated with the Fly and Purari river plains and other smaller rivers. Extensive areas of mangroves are also found, particularly around the river deltas. With 33 mangrove species, PNG has the highest mangrove diversity in the world.

The offshore islands of PNG which make up the New Guinea Islands Region include New Britain and New Ireland, the Admiralty Islands, and Bougainville. The islands have proved more vulnerable to human impact than the mainland, with large areas cleared over the

Native araucaria pines. *Fay Duega*

years for coconut, oil palm and cocoa plantations, or logged for timber.

New Britain and New Ireland are the two largest islands of the Bismarck Archipelago. Both are high volcanic islands, and the inaccessible interior of the islands remains covered with montane rainforest. There are also large areas of lowland rainforest on both islands, with characteristic trees including araucarias, *Lithocarpus* spp., *Castanopsis acuminatissima*, *Syzygium* spp. and *Ilex* spp. Beech and oak trees are found on New Britain as well as on the mainland, but not on New Ireland. The high-elevation forests of New Ireland are dominated by *Metrosideros salomonensis* (Myrtaceae).

The Admiralty Islands are also part of the Bismarck Archipelago, but have flora that is distinct from New Britain and New Ireland. The largest island is Manus, which rises to 700 m. The island's main vegetation is lowland rainforest, with dominant trees *Calophyllum* spp. and *Sararanga* spp. Some of the smaller islands and the atolls, such as the atolls of the Carteret group in the far east, have mainly coastal forests as their natural vegetation, but much of this has been completely converted to coconut plantations.

Bougainville is part of the Solomon Islands archipelago, and shares many species of plants and animals with this island group. A high volcanic island, Bougainville has montane rainforest as well as lowland rainforest, freshwater swamp forest, coastal forest and mangrove forest.

Throughout PNG, most communities have extensive areas of agroforest within walking distance of their villages. These forests include many deliberately planted or protected multi-purpose trees, such as the native nitrogen-fixing casuarina (*Casuarina equisetifolia*) that is planted and protected to improve soil fertility and provide valuable fuel.

Currently PNG has just over 62,000 ha of forest plantations, mostly planted with native species. These include *Acacia mangium*, *Araucaria cunninghamii* and *A. hunsteinii*, *Eucalyptus deglupta* and *Terminalia brassii*. Teak (*Tectona grandis*), which was introduced in the early 1900s, is also grown. Plantations are mostly on the mainland, and on New Britain and New Ireland.

A brief history of PNG's forests

The first inhabitants of PNG are believed to have arrived from the Indonesian archipelago about 50,000 years ago. Because New Guinea's terrain is extremely rugged and difficult to traverse, different cultural groups developed in virtual isolation from each other. The people derived almost all their material, cultural and spiritual needs from the forest, agroforests, rivers and the sea but their impacts were limited to small areas of forest around settlements. Thus, until the arrival of Europeans seeking trade, the majority of PNG's forests were largely undisturbed.

The arrival of European settlers from the late 19th century had greatest impact on the smaller islands and the accessible coastal and lowland areas of the mainland. Forest was cleared to make way for commercial crops such as coconut, cotton, coffee and rubber.

Around this time, forests also began to be logged for timber. Commercial exploitation of the forests for timber has had the greatest impact in the history of PNG's forests. Since the early 20th century, the PNG government has attempted to regulate timber harvesting through policy

There have been high rates of deforestation in PNG over the last few decades. *Richard Markham*

Deforestation contributes to soil erosion. *Richard Markham*

and legislation. However, harvesting has continued at a high rate, for timber products as well as to make way for agriculture projects such as oil palm, contributing to high rates of deforestation over the last several decades.

PNG saw much fighting during the Second World War, as the islands changed hands between the Australians, the Japanese and the Allied forces. Immediately after the war there was a period of reconstruction, which drew on the country's forest resources. The timber industry expanded over the following decades, reaching a peak in the 1980s in terms of number of companies operating. During this period, forests increasingly became a main source of income for landowners, logging companies and the government.

Cutnut

Cutnut (*Barringtonia procera*) is a member of the Brazil nut family, and is grown for its edible nut. It has long been a part of the traditional agroforestry systems of PNG, Solomon Islands and Vanuatu. Found naturally in the lowland rainforest, people have for centuries protected the trees in the forest, and also planted them in homegardens.

The nuts are usually eaten fresh, or occasionally boiled or roasted. In the western Solomon Islands they are roasted and baked in a pudding with hibiscus spinach and coconut cream. The nuts are mostly traded locally, but Vanuatu has developed a small export trade in dried and bottled nuts. There is potential to further develop cutnut as an export commodity, but this will need a domestication program and good farmer organisation to develop a reliable supply of quality nuts.

The leaves and bark are used medicinally for various ailments, for example sap from the bark is used to treat ciguatera poisoning. The timber is poor quality and therefore mostly used as firewood.

Randy Thaman

One of PNG's many native orchids. *Richard Markham*

Commercial forest plantations were started in the 1960s. Native pines (*Araucaria hunsteinii* and *A. cunninghamii*) and other introduced pines such as Caribbean pine (*Pinus caribaea* var. *hondurensis*) and *Pinus patula* were some of the earliest plantation species.

Since 1991, the government has set an annual limit of 3.5 million m^3 of wood to be cut from the forests. In 2010 the government introduced a ban on the export of round logs from new timber concessions, in an effort to increase value-adding in the country and to boost economic returns on the forest resources.

Forest ownership and management

About 97% of the land in PNG is owned by local community clan groups. All decisions on forest management are made in agreement with these customary owners. In order to carry out any forest operations, such as harvesting of timber, development of plantations or reforestation, extensive consultations must take place between forest authorities and the landowners.

Current forest policy and legislation dates from 1991. The PNG Forest Authority (PNGFA) was established in 1993 under the 1991 Forestry Act. Within the PNGFA, the National Forest Board advises on policy and legislation; provincial forest management committees provide a forum for consultation and coordination of forest management; and the National Forest Service is the implementing body.

Importance of PNG's forests

Conservation of biodiversity

PNG's biodiversity is among the richest on Earth, and is a result of the ancient geological origins of the islands as well as their complex topography. New Guinea was once linked to Australia and the ancient southern super-continent of Gondwana. From ancient shared species, in the isolation of PNG's rugged interior, many new and unique species of plants and animals evolved.

There may be as many as 20,000 plant species in PNG, and half of these may be endemic. There are thought to be about 2,000 tree species, including araucaria pines and southern beeches, which are links to ancient Gondwana flora. It is estimated that there are more fern species on the mainland of New Guinea than in the rest of the world, and PNG is famous for having one of the richest orchid floras on Earth, most of them found in the forest.

Nearly 500 bird species have been recorded in the forests, including almost all the known species of bird of paradise. There are many pigeons and parrots – an estimated one-sixth and one-seventh of the world's species, respectively. The largest birds are flightless cassowaries, which again represent a link to ancient Gondwana.

Mammals include marsupials, among them tree kangaroos, possums and the cuscus, which is related to the possum. Many of these are endemic.

There are also many amphibians and reptiles. Over 320 frogs and toads have so far been identified, with tree frogs one of the most diverse groups. There are 13 species of turtle, two crocodiles, nearly a hundred snakes and several hundred lizards, with probably many more to be discovered. Similarly, the known insects are probably a fraction of those existing. Several hundred butterfly species have so far been recorded, including the famous bird-wing butterflies, so sought after by collectors.

Bird-wing butterfly. *Richard Markham*

The offshore islands were never linked to New Guinea and Gondwana, and have evolved different floras and faunas to those of the mainland. Each island group has its own unique community of plants and animals and endemic species. The Admiralty Islands in particular, because of their isolation, have many endemic species of plants, birds, bats and other animals.

PNG's agroforests are also known to have among the richest agricultural biodiversity on Earth, with many important food plant varieties, such as varieties of sugarcane and banana, having been developed there. These agroforests, if protected, will continue to serve as 'gene banks' for agrobiodiversity.

Economic value

Export of timber is a major revenue earner for PNG. The timber industry in PNG is mainly log export oriented. Logs are exported to Asia, with about 80% currently going to China, while processed wood products are mainly exported to Australia, New Zealand, and other countries in the Pacific. Rural communities also make money by selling timber on their land to the timber companies.

Value to communities

PNG's forests, including agroforests, have played a crucial role in the lives and livelihoods of people since they first arrived in the country. The trees have provided staple foods, fruits and nuts, medicines, building materials, fuel, and a wealth of other products and services. Many forest plants and animals have immense spiritual value and served as ancestral totems. The vast majority of PNG's people still have a traditional lifestyle and rely heavily on the forests. The importance of this tradition is recognised in the PNG Constitution as a defining feature of PNG society that should be protected into the future.

Threats to PNG's forests

Unsustainable logging

Unsustainable logging is currently the greatest threat to PNG's forests. About 120,000 ha of forest are estimated to be logged annually. Plantation development is lagging far behind with a total of approximately 62,000 ha planted so far.

Timber is usually cut by Asian logging companies in remote locations, and monitoring and regulating their activities is extremely difficult.

Land tenure

Customary land ownership is a significant challenge to developing sustainable forest management. Any forest management activities require the consensus of large numbers of people who may have different interests and needs from their land. Because of this land tenure system, PNG has not been able to develop a national land use plan. All decisions on land use must be negotiated on a case-by-case basis with the landowners

Natural forests are being cleared to grow oil palm, a valuable cash crop. *Richard Markham*

and the authorities. As an indication of the challenge this poses, very few conservation or protected areas have been established in PNG.

Competing land use

Forest is under threat in some areas from other land uses such as large-scale agriculture projects, oil, gas and mining exploration, and urban development. Without land use plans, decisions on clearing forest are made on an ad hoc basis, and often without due attention to environmental impact. The government's recently approved National Agriculture Development Plan (NADP) is a particular threat as it paves the way for the clearing of both natural forests and agroforests for cash crops such as oil palm.

Looking to the future

PNG must overcome enormous challenges to achieve sustainable forest management across the country. But the importance of the forests – at local, national and global level – means the country must find ways to do this. There are already some promising projects and initiatives which can be built on, as well as many lessons that can be transferred from other countries.

The banning of round log exports in 2010 from new timber concessions is an important first step towards improving sustainability in the forest sector. Processing and adding value to wood and wood products means the country, and its people, will achieve much better economic returns on the forest resources that are harvested, reducing the volume needed for the same return. The PNG government is also in the process of promoting permanent forest estates in line with objectives under its Vision 2050.

PNG has the lowest GDP per capita of the Pacific island countries and territories. As the cash-based culture of the 21st century reaches rural communities of PNG, creative ways will be needed to protect the forests and trees from being sold off for immediate cash returns. There are many more sustainable ways for rural communities to make money from their forests, and these will need to be developed within the PNG context and scaled up to make a difference. Awareness raising on the longer term value of forests, and the opportunities they offer, will be an important parallel activity.

A pine nursery in Bulolo, Morobe Province. *Fay Duega*

One way is to develop local industries producing high-value forest products, both wood and non-wood. A balsawood project in East New Britain provides a good example (see box). Other high-value products could include traditional medicines from the forest, nuts, spices, essential oils, and butterfly farming. Certification of products, for example by the Rainforest Alliance, can also help by improving access to high-value niche markets outside the country.

Another option is to put logging and sawmilling into the hands of the communities. With small, portable sawmilling machinery, communities can manage and control logging at a sustainable level in their forests. Eventually, a mixture of community and private company logging is envisaged.

PNG, with its amazing biodiversity, has huge potential as an ecotourism destination. Again, there are many challenges to overcome in realising this potential – security issues, accessibility, and infrastructure, for example – but the returns to local communities combined with the conservation of the forest ecosystems make this a very attractive opportunity to pursue.

REDD+ (Reduced Emissions from Deforestation and Forest Degradation) schemes also hold great potential as a mechanism to protect PNG's forests. PNG was instrumental in setting up the Coalition for Rainforest Nations, which brings together developing countries with significant rainforest to seek ways to reconcile economic development with sustainable forest management.

Balsa in East New Britain

Balsa (*Ochroma pyramidale*) is native to South and Central America. Its potential as a high-value wood commodity led to trials in PNG in the 1980s. Balsa grows quickly into a large tree, making it an attractive option for landowners and a good alternative to cash crops such as cocoa and copra. Trials were particularly successful in East New Britain, and a balsa project began there in 1994. Objectives were to improve the institutional and organisational effectiveness of the balsa industry, improve silvicultural management, and improve smallholders' income with an emphasis on extension and training, and better planting materials. Ten years later, project achievements included the establishment of the Balsa Growers Association, improved balsa planting materials and corresponding increased yields, and a balsa manual. Today, the PNG Balsa Company employs more than 2,000 workers and purchases balsa from 600 growers. The company exports balsawood products to Asia, Europe, the USA and Australia, and its share of the world balsa market is about 15%. Demand for balsa composites is increasing, especially for use in the wind turbine blade industry, and the company is aiming to increase production to keep up with demand.

Lex Thomson

Solomon Islands

Basil Gua, Terence Titiulu and Gideon Bouro

Coastal forest in Western Province. *Lex Thomson*

Summary

Solomon Islands' natural forests are very biodiverse, with as many as 4,500 plant species, more than 14,500 insect species and 200 birds. Most rural Solomon Islanders depend on their traditional agroforests for food and productive security. The country also has a major timber industry on which the country's economy depends, but it is this industry that poses the main threat to the forests. The industry is extremely inefficient, with large amounts of money lost by failure to monitor exports, tax evasions by logging companies, and corruption at various levels. Volumes of wood cut are currently far above sustainable levels. Sustainable forest management in Solomon Islands will depend on scaling back of the logging industry and a complete overhaul of remaining logging operations. Managed sustainably, the forests of Solomon Islands can be of immense economic value to the nation and to landowners forever, while the current situation is rapidly diminishing their value and potential.

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The forests of Solomon Islands

Ecologically, Solomon Islands can be divided into two regions. The southeastern Santa Cruz islands share much of their flora and fauna with Vanuatu, and are part of the 'Vanuatu rainforest ecoregion'; while the remaining islands have distinct flora and fauna which they share with the islands of Bougainville and Buka of PNG – they comprise the 'Solomon Islands rainforest ecoregion'.

The Santa Cruz islands are mostly smaller volcanic or raised limestone islands, and the main forest type is lowland rainforest. Common tree species include *Campnosperma brevipetiolata*, *Calophyllum vitiense*, whitewood (*Endospermum medullosum*) and Pacific kauri or *duro* (*Agathis macrophylla*).

Guadalcanal is the largest of the Solomon Islands, and the highest island, with mountains rising to over 2,000 m. Other large islands are, from north to south, Choiseul, Isabel, New Georgia, Malaita, Makira and Rennell. The main forest types of these and other islands of the Solomon Islands ecoregion are mangrove forest, coastal forest, freshwater swamp forest, lowland and montane rainforest, and on Guadalcanal only, tropical dry forest.

The coastal areas of all islands have coastal and mangrove forest, with coastal forest being the dominant natural vegetation on the smaller atolls. The atoll and coastal forests are dominated by widespread coastal trees such as pandanus (*Pandanus* spp.), coconut (*Cocos nucifera*), calophyllum (*Calophyllym inophyllum*), cordia (*Cordia subcordata*), milo (*Thespesia populnea*) and tree heliotrope (*Tournefortia argentea*). Many of these trees are among the most valuable trees for wood carving and other uses, but they are seriously threatened in highly populated areas.

There are two distinct types of mangrove forest – a low forest dominated by *Rhizophora apiculata*, and a taller forest dominated by *Rhizophora* spp. and *Brugiera* spp. Freshwater swamp forest includes typical trees such as *Campnosperma brevipetiolata*, *Terminalia brassi*, sago (*Metroxlyon salomonense*), and pandanus. In the lowland rainforest, common trees are *Calophyllum* spp., *Dillenia salomonensis*, *Elaeocarpus sphaericus*, whitewood,

The forests of Guadalcanal have been greatly impacted over the centuries. *Richard Markham*

Parinari salomonensis, *Maranthes corymbosa*, tava (*Pometia pinnata*), *Gmelina mollucana*, *Schizomeria serrata*, *Terminalia calamansanai* and *Campnosperma brevipetiolata*. Higher up the mountainsides, the montane forests are lower in height and include species of *Syzygium*, *Metrosideros*, *Ardisia* and *Ficus*.

Tropical dry forest is found on the seasonally dry north of Guadalcanal. These forests consist of mixed deciduous forest and grassland where the forest has been cleared. Trees include tava, *Vitex cofassus* and *Kleinhovia hospita*, and deciduous species *Pterocarpus indicus*, *Antiaris toxicaria* and *Ficus* spp.

On all islands there are also extensive areas of diverse agroforest that supply most of the needs of local communities, including cash from the sale of products such as copra, cutnut (*Barringtonia procera*) and canarium nut or *ngali* (*Canarium* spp.).

There are forest plantations on several islands; planted species include *Gmeliana arborea*, *Campnosperma brevipetiolatum*, *Eucalyptus deglupta*, *Terminalia calamanasai*, *T. brassii*, *Acacia* spp., mahogany (*Swietenia macrophylla*) and teak (*Tectona grandis*). In 2005 the area of plantations was estimated at 28,000 ha. The two main plantations are on Kolombangara and Viru, in the west.

A brief history of Solomon Islands' forests

Low population densities meant that the early inhabitants of Solomon Islands had relatively little impact on the forests. They depended on their agroforest gardens and nearby forests for most of their needs. The first major impacts came with the arrival of Europeans and the conversion of large areas of coastal forest and agroforest to coconut plantations, and later to cocoa plantations and other crops such as oil palm. However, by far the greatest impact has been commercial logging of the rainforests over the last 50 years.

Commercial logging began in 1924, when an Australian company began cutting Pacific kauri in the Vanikoro Islands. A small number of overseas companies developed logging operations over the following decades. The islands of north New Georgia, for example Gizo and Kolombangara, were extensively logged for useful species during this time. The government issued logging licences for either government-owned land or customary land they had leased from the landowners.

In the early 1980s, commercial logging moved into a new and much more damaging phase. Asian logging companies negotiated logging licences with the government and began cutting and exporting increasing amounts of timber, mostly from customary owned land. In 1998 an estimated 609,000 m^3 of round logs were

Pacific kauri

The Pacific kauri (*Agathis macrophylla*) is one of the largest and longest living trees of the Pacific islands. Found in Solomon Islands, Vanuatu and Fiji, trees can grow up to 40 m tall with a 3 m diameter, and can live as long as 1,000 years. Pacific kauri grows in lowland and lower montane rainforest, and the mature trees provide a distinctive structure to the natural forest.

Pacific kauri is traditionally used for building houses, making furniture, boats and carving. Its resin is used for glazing pots, lighting fire, glue and in torches. The smoke from the burning resin is used as a hair dye and for tattoos. Its high-quality wood has also made it a valuable commercial species for export, and over the years it has been extensively logged from the forests.

Today, there are very few natural stands remaining. While the tree itself is not currently endangered, it would be tragic to lose these unique Pacific island forests, and conservation efforts are therefore vital. Pacific kauri is also recommended to be replanted in degraded forests for their rehabilitation, and to be used in agroforestry programs.

Randy Thaman

exported; in 2004 that figure was 1,403,000 m^3; while estimates for 2010 are in excess of 1,600,000 m^3. The calculated sustainable yield from the country's forests is 220,000 m^3 per year. Corrupt government officials, ineffective legislation, and a failure to monitor exports have contributed to the excessive logging. Very few reforestation activities have been carried out over these years.

The government set up a Forestry Department in 1952, and developed a Forest Policy 5 years later which focused on reforestation on logged-over areas. The Policy was subsequently broadened to include the protection of forests and their sustainable management. However, actual forest management practice today falls far short of this ambition.

Forest ownership and management

An estimated 87% of the land is under customary ownership in Solomon Islands. The national constitution guarantees the customary owners control over these lands and their forests.

The Commissioner of Forest Resources is custodian of the Forest Resources and Timber Utilisation Act.

The Ministry of Forestry and Research has four divisions. Forest Industries and Utilisation deals with logging operations, including licensing and monitoring. The Forest Resources and Management Division is responsible for forest resources information as well as forest legislation and policy. The Forest Development and Reforestation Division is the largest, with 45 forest offices and 56 village-based forest extension officers posted throughout the country. The fourth division is the National Herbarium and Botanical Gardens.

The cuscus is a native forest dweller. *Ian Markham*

The government is dependent on the timber industry for about 66% of its foreign exchange earnings. *Lex Thomson*

In 2010 the national parliament enacted the Forest Reserves Act, allocating certain areas as permanent reserves.

Importance of Solomon Islands' forests

Conservation of biodiversity

Solomon Islands has a rich biodiversity associated with the forests, with many endemic species. There may be more than 4,500 plant species, including about 230 orchids. Of the 47 mammal species, 26 (17 bats and nine rodents) are unique to Solomon Islands. There are around 200 bird species, about 90 of which are endemic or near-endemic. These include several white-eye species, each found only on one island, and several species of monarchs, warblers, parrots and fruit-doves. There are more than 20 species of frog, 85 reptiles, and 14,500 insect species described so far, with likely many more of each of these groups yet to be discovered by science.

Economic importance

Selling timber concessions to logging companies brings in about 15% of government revenue and 66% of foreign exchange earnings, so that the economy is highly dependent on the timber industry.

The two main plantation forests on Kolombangara and Viru are owned by private companies and contribute about 5% of the total revenue from round log exports. Both have Forest Stewardship Council (FSC) Certification, and receive premium prices available for sustainable forestry products.

Aerial view of a commercial logging concession. *Richard Markham*

With support from the Ministry of Forestry and Research, many villages have established small forest plantations, some just a quarter of a hectare. Communities are encouraged to plant high-value species such as teak, mahogany and eucalyptus. To date, about 12,421 ha have been established, and this is expected to increase.

Threats to Solomon Islands' forests

Commercial logging

At present, by far the greatest threat to indigenous forests is poorly managed and unsustainable commercial logging. The country's economy is dependent on income from log exports, however the industry is extremely inefficient, with much money lost by failure to monitor exports, tax evasion by logging companies, and corruption at various levels. Volumes of wood cut and exported have been increasing far beyond sustainable levels, and some estimates say that all accessible lowland rainforest will have been logged of useful species by 2015.

Mining

The Solomon Islands are rich in minerals including copper, gold, lead, nickel and zinc. Apart from one gold mine, these have not been exploited. Exploration is however under way, with mining likely to begin in the next few years, for example for nickel in Isabel Province and the Shortland Islands in the Western Province. Mining may provide an alternative income source for the government to replace timber, but there are significant risks to the environment that must be addressed before mining begins.

Commercial agriculture

The expansion of commercial agriculture in the form of monocropping of cash crops, such as oil palm, coconut and cocoa, and of grazing land, are also a threat to both indigenous forests and species-rich agroforests.

A teak plantation. *Lex Thomson*

Looking to the future

Turning around the timber industry to make it sustainable is a huge challenge for Solomon Islands in the coming years. However it is essential in order to save the country's forests, to protect their biodiversity, and to guarantee the continued provision of useful products and vital ecosystem services for Solomon Islanders in the future. Managed sustainably, the forests of Solomon Islands can be of immense economic value to the nation and to landowners forever, while the current situation is rapidly diminishing their value and potential. A scaling back of the logging industry, and a complete overhaul of remaining logging operations, are urgently needed.

A first step is a revision of forest legislation, to provide a legal basis for sustainable forest management. Current legislation is outdated, ineffective and unenforceable. A new reforestation policy is another essential measure, to restore the depleted forests. Reforestation plans should be developed at the provincial level, with participation and ownership by the people. REDD+ (Reducing Emissions from Deforestation and Forest Degradation) schemes could help to fund reforestation activities. Local communities should also be encouraged to protect their species-rich traditional agroforestry systems, which contain so many useful trees and, just like natural forests, provide so many useful products and ecological services.

The sustainability of the timber industry will depend on supply from forest plantations and private woodlots. The Forestry Department has been promoting reforestation with teak, a high-value wood, and local farmers are taking up the challenge and planting this tree in small woodlots across the country.

Processing of wood to add value inside the country can offset losses from scaled-back sales of unprocessed logs. Efforts must be concentrated to develop value-adding businesses from which landowners and small-scale producers can benefit. Certification that wood and wood products come from sustainably managed forests is important. Australia and New Zealand already have the requirement that all wood from Solomon Islands is certified before it enters these countries. The authorities are working to develop an appropriate certification scheme for the country's timber.

High-value non-wood products can also be developed on a commercial and sustainable basis, to bring economic returns to landowners. For example, a small industry is developing based on canarium nut (see box).

FSC-certified teak, ready for export. *Lex Thomson*

Agroforestry systems have not been used widely in Solomon Islands, but have potential for developing sustainable food systems and contributing to rural livelihoods. To realise this potential, support to develop appropriate systems for the different agroecozones will be needed. Ecotourism is another possible area for

expansion, which would bring economic returns to the country.

The future of Solomon Islands' forests depends mostly on a change of mindset at the highest levels, to see the longer term value of the forests rather than their immediate economic value, and to recognise the disaster that will befall the country if the forests are not managed sustainably.

Acknowledgements

Thanks to the SPC LRD team in Solomon Islands, especially Dr Shane Tutua, former Commissioner of Forests Mr Daniel Kwanairara, and Ross Cassells, for their contributions to this chapter.

Canarium nuts – a high-value non-wood forest product

Canarium nuts have been identified as one of the most promising export market opportunities from Melanesia. As well as the edible nut, the nut oil can be used to make body care products. However, a reliable supply of good quality nuts has not been available. A Honiara-based enterprise called Maraghoto Holdings is working to overcome this problem and to develop the industry.

To assist Maraghoto Holdings, a project has been helping to select the best canarium varieties from old trees and trees growing in the wild. The project has already identified some promising varieties that produce high yields in as little as 3–4 years. Seeds are being made available to interested communities who can then grow them in small plantations, or integrated into agroforestry systems. The communities will then supply the company with nuts for processing.

The company has, with assistance, invested in processing equipment including a solar dryer and a nut press to extract the oil. It has also developed attractive packaging and other branding elements. Maraghoto Holdings is now poised to begin processing the nuts, with plans to begin exports in 2012.

Richard Markham

Vanuatu

Livo Mele

Natural forests and coconut plantations in Vanuatu. *Richard Markham*

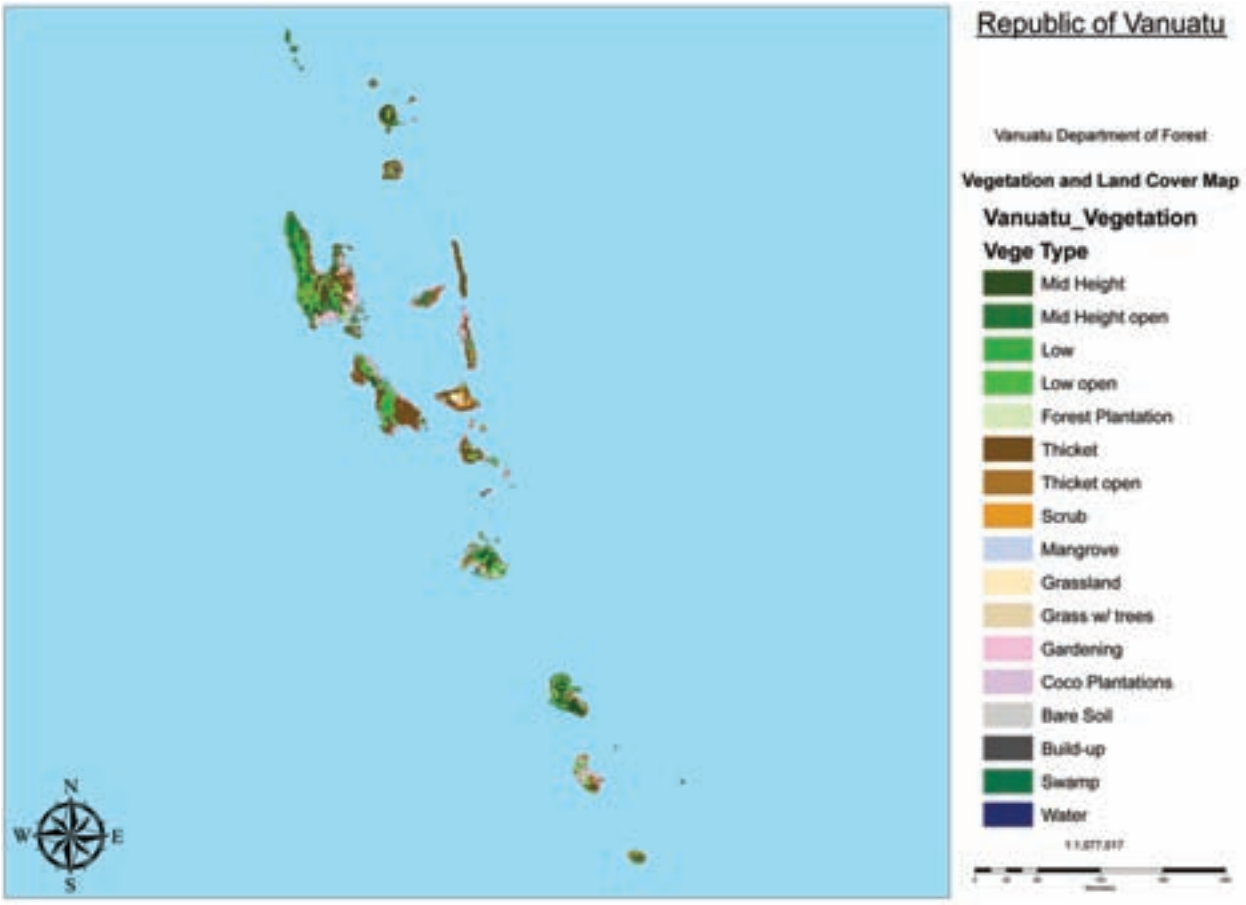
Summary

Vanuatu has natural forests that are still largely intact on its smaller islands, and even on the larger and more densely populated islands some of the inland and mountain forests are relatively healthy. However useful timber species have been overharvested, and today Vanuatu imports most of its timber needs, and no longer has a significant export industry. A threat to the forests is expanding agriculture, especially pasture for cattle grazing. Vanuatu has recently developed a new Forest Policy that promotes sustainable forest management. A major replanting program is also under way; many of the new plantings are on woodlots and agroforestry plots established by communities. One of the first trees to be exploited in Vanuatu – sandalwood – today holds promise again with efforts to build an industry to supply overseas markets with oil and other high-value products.

Vanuatu's forests

Vanuatu is an archipelago of more than 80 islands, stretching about 1,300 km from north to south. The larger islands are mostly volcanic, with steep hills and peaks cloaked in rainforest.

Livo Mele is Director of Vanuatu's Department of Forests.



On many of the smaller islands, the natural forests are still largely intact. There is more significant disturbance on the more populated islands of Efate, Espiritu Santo, Malekula and Tanna, due to coconut plantation development and the expansion of commercial agriculture, but even on these islands some of the inland and mountain forests are relatively healthy.

Common forest trees include whitewood (*Endospermum medullosum*), calophyllum (*Calophyllum inophyllum*), *Calophyllum neo-ebudicum*, canarium nut or *nangai* (*Canarium indicum*), vesi or *tora* (*Intsia bijuga*), milk tree (*Antiaris toxicara*), *Castanospermum australe*, *Pterocarpus indicus*, *Bischofia javanica*, *Gyrocarpus americanus*, *Acacia spirorbis* and tropical almond (*Terminalia catappa*). Pacific kauri (*Agathis macrophylla*) was once common on Aneityum and Espiritu Santo, but has been overharvested and now only remnant stands are found. On Erromango a reserve protects 3,200 ha of Pacific kauri. Sandalwood (*Santalum austrocaledonicum*) has also been depleted, although it is still found in small numbers on several of the islands, and is being promoted for replanting (see box on page 50).

Espiritu Santo is Vanuatu's largest island, accounting for one-third of the country's land. The island rises to the country's highest peak of 1,879 m. The natural vegetation is tropical rainforest on the wetter southeast of the island and tropical dry forest in the drier west (although most of this has now gone). Much of the coastal area is covered with coconut plantations and cattle pasture, while some of the inland forest has been cleared to grow food crops and kava.

Malekula is the second largest island. Again, the low coastal plain is largely under coconut plantation and pasture, with the inland forests mostly intact.

Tanna and Efate are the most densely populated islands, and their coastal areas have been mostly cleared for agriculture, pasture and urban development. Erromango, Maewo and Vanua Lava are much less populated and their coastal lands are still mostly forested.

A type of forest scrub densely covered with lianas is the most widespread forest type on some of the northern islands. It is reportedly related to cyclone disturbance.

Mangroves cover an estimated 2,500 ha, notably on the east coast of Malekula but also in smaller areas on Hiu, Ureparapara, Vanua Lava, Motalava, Epi, Emae, Efate and Aniwa. There are 10 mangrove tree species, including several *Rhizophora* species, *Bruggiera gymnorrhiza* and *Sonnetaria caseolaris*.

Most communities have extensive areas of agroforest in which they have a very wide range of culturally useful trees and other plants and animals. In some areas programs are under way to plant indigenous timber trees, such as whitewood, within these traditional cropping systems.

Forest plantations are found on several of the larger islands – species planted include sandalwood, whitewood, canarium nut, tropical almond and mahogany (*Swietenia macrophylla*). The total area of plantations was estimated at 4,800 ha in 2006.

In the rainforest on Espiritu Santo. *Randy Thaman*

A brief history of Vanuatu's forests

Before European contact, the main impact on the natural forests was from slash-and-burn agriculture. The dry forests on the western sides of the larger islands gradually disappeared after repeated clearing in this way, and some species of plants and animals became extinct. Settlers also brought new species into the forests.

Exploitation of forest resources for export began in the early 1800s, when sandalwood traders arrived. They were followed by planters who began the coconut plantations on the coastal plains of the larger islands. Cotton, coffee, cocoa and banana were also grown for export from the 1800s, displacing the natural forest in the lowland coastal areas.

Commercial logging of timber species from natural forests began around the 1960s on Aneityum, Erromango and Espiritu Santo, and later on Efate and other islands. The timber was mostly exported. Logging was not effectively controlled, and easily accessible areas of forest were soon degraded.

Shortly after independence in 1980 Vanuatu enacted a Forestry Act. This legislation was, however, largely based on European-style forest administration and did not really suit the circumstances or the communal forest ownership situation in Vanuatu.

The Department of Forests was established in 1988. One of its first tasks was to carry out a national forest inventory. Based on this, a sustainable yield of 52,000 m^3 per year was established.

In 1993, the Government issued licences to several foreign logging companies allowing a total harvest of over 300,000 m^3 per year. In mid-1994, landowners on Erromango disrupted a planned log shipment due to their concerns about the process that had been used to gain landowner consent for logging operations. As a result the Government of Vanuatu banned the export of logs. Processing facilities were established in Vanuatu so that higher value wood products could instead be exported.

Vanuatu's first Forest Policy was endorsed in 1998, and a Code of Logging Practice was approved the same year.

Between 1990 and 2004 an average of just over 30,000 m^3 of wood was harvested each year. Whitewood and milk tree were the two main species. In 2004, the industry was scaled back because of dwindling supplies, and many of the major logging companies ceased activities.

In 2001 a new Forestry Act and Regulations were approved by parliament. The Forest Policy was reviewed and revised in 2010 using a participatory consultation process, and the current Policy was endorsed in 2011.

Forest ownership and management

All land in Vanuatu is traditionally owned by communities rather than by the government. However, today some of the coastal land is being sold off for private development, usually linked to tourism.

The people of Vanuatu greatly value the forests and their natural environment, which the majority rely on for most of their daily needs. This is reflected in the country's constitution – Article 7 states that every person has the responsibility to safeguard the country's natural wealth, resources and environment in the interests of

the present generation and of future generations – and in the government's commitment to sustainable forest management.

The Department of Forests oversees the management of forest resources in Vanuatu. It leads the implementation of the national Forest Policy and implements and enforces forestry legislation. The Department works with logging companies and sawmill operators, issuing licences and monitoring activities to ensure compliance with the Code of Logging Practice. The Department also works with landowners to promote tree planting and agroforestry at the community level.

Vanuatu has four protected areas: Erromango Kauri Reserve which covers 3,205 ha of kauri rainforest; Big Bay Conservation Area on Espiritu Santo which has 2,300 ha of primary rainforest and an additional 2,000 ha of coastal limestone terraces; Loru Protected Area also on Espiritu Santo which has 150 ha of primary rainforest; and Nagha mo Pineia Area on Malekula, which is a landowner initiative covering 1,056 ha of which 600 ha is forest.

Importance of Vanuatu's forests

Conservation of biodiversity

About 1,300 plant species have been recorded in Vanuatu, of which 10% are endemic to Vanuatu. There are 79 bird species in Vanuatu, of which about 30 are endemic.

There are 19 native reptile species, and 11 species of bats, three of them endemic to Vanuatu.

Tahitian chestnuts on sale in the market in the capital, Port Vila. *Anne Moorhead*

Many rural communities rely on wood as their main fuel. *Matt Capper*

Value to rural communities

A National Agriculture Census carried out in 2006 concluded that up to 90% of households rely daily on wood and wood products from forests and agroforests. Besides wood, the majority of households collect food, medicines and other non-wood products from the forest and agroforests for their day-to-day use.

Timber

Processed timber was an important export commodity for Vanuatu until 2004, when the industry was scaled back because of dwindling resources. However, the active planting program means that, when plantations become productive, the export market may again become a significant money earner for the country. Timber for the domestic market has also declined in recent years, with the majority now imported. Again, this should change with the maturing of plantations.

Non-wood forest products

Non-wood forest products such as nuts, seeds and orchids are gaining importance in the domestic and international market. The Forestry Department is helping private investors to establish processing facilities to utilise these resources. The sandalwood industry is also expanding, with government support (see box on page 50).

Tourism

Tourism is a mainstay of Vanuatu's economy, with about 197,000 visitors in 2008. Tourists come for the natural beauty of the islands, and the biodiversity of the sea and

reefs, all of which depend on healthy inland and coastal forests.

Threats to Vanuatu's forests

Expanding agriculture

The biggest threat to the forest in Vanuatu is expanding agriculture, especially pasture for cattle grazing. Almost half of Efate is currently under agricultural leases for cattle grazing, for example. Vanuatu's beef is considered some of the best in the world and is in high demand both within the country and overseas. High local demand for kava is also resulting in clearing of forest to grow this lucrative crop.

Forests are being cleared to make way for cattle grazing. *Randy Thaman*

Land tenure issues

All land in Vanuatu is traditionally under communal or customary ownership, although this is slowly changing as land is leased or sold to private owners. Communal ownership poses a challenge to forest management because of the conflicting economic interests on the use of the land. Private leaseholders also pose a challenge to forest management because the leaseholders want to make quick returns on the land before the lease expires and forestry is not a good option for this.

Invasive plants

In many areas of secondary vegetation, introduced exotic weeds have taken hold. The grasslands of the southern and central islands are an example of a degraded ecosystem largely dominated by exotic weeds. The fast growing climber *Merremia peltata* is an important

Whitewood

Whitewood (*Endospermum medullosum*) is an important timber species in PNG, Solomon Islands and Vanuatu. It is harvested from the natural forest, and also grown in plantations and agroforestry systems along with food crops, to supply both domestic and export timber markets. The wood is medium density and easy to saw and machine, and is mostly made into furniture or used for light construction. Whitewood grows naturally in lowland rainforest, usually after a disturbance creates a space in the canopy, as the seedlings are intolerant of shade. It grows rapidly, and reaches 40 m in height.

Randy Thaman

Merremia peltata is an invasive weed that smothers the natural vegetation after the forest has been disturbed. *Matt Capper*

The Forest Policy recognizes the importance of indigenous knowledge and rights. *SPC*

weed problem. It rapidly covers vegetation where the forest has been damaged, for example by tree removal or cyclones, and it impedes the natural regeneration of native tree species.

Looking to the future

The new Forest Policy presents a vision and strategy for the country's forest resources. The goal is to manage these in a sustainable way, so that they provide wood and non-wood products as well as environmental and social services, and contribute to economic growth.

One of the first priorities is to undertake a forest resources assessment, and the Policy recommends this be repeated every 10 years. Economic analyses of wood and non-wood forest production and services are also urgently needed.

The Policy recommends that traditional and cultural practices be incorporated into sustainable forest management activities. Indigenous knowledge and rights should be recorded, protected and their use encouraged.

The Policy discourages the conversion of natural forest to other land uses, and especially prohibits its conversion to commercial forest plantations. It promotes forest plantations on other lands in order to supply the country's timber and rebuild the export industry. It aims for 20,000 ha of plantations by 2020, which will include large-scale plantations, community plantations and small woodlots.

The Policy advocates working with communities on forestry and agroforestry initiatives. It recommends developing model farmer-based and community forest plantations and woodlots; incorporating conservation of forest genetic resources into the activities of farmers and communities; and promoting trees, crops and agroforestry farming systems that are adapted and resistant to climate change and that can help to take pressure off Vanuatu's natural forests. In terms of the planting of timber trees within agricultural systems, Vanuatu is perhaps the most advanced country in the region, having successfully planted selected varieties of sandalwood, whitewood, *Flueggea flexuosa*, *Alphitonia zizyphoides* and tropical almond in woodlots and agroforests.

The Policy also addresses conservation, with the objective of formally protecting 30% of the natural forests. This is an example of working with traditional practices and culture – some of the areas would be protected by traditional taboo, and others as community conservation areas, with chiefs responsible for enforcement.

The Policy anticipates integrating climate change mitigation with forestry planning and activities, and developing REDD+ initiatives in the future.

Finally, the Policy addresses forest industries. It aims to increase production from plantations and agroforestry, and promotes domestic processing and value adding. It recommends seeking new niche markets for products, promoting a Vanuatu brand, and encouraging certification and eco-labelling.

Acknowledgements

Thanks to Hannington Tate, Principal Forest Officer for the Vanuatu Forestry Department, and Mr Tony Bartlett of the Australian Centre for International Agricultural Research (ACIAR) for their help with this chapter.

The Forest Policy advocates domestic processing and value adding. *SPC*

Building a sandalwood industry

Recognising the potential for a sandalwood industry, and the benefits this would bring to rural communities, the Vanuatu government developed a Sandalwood Policy in 2003 to direct development of the industry. The industry is still developing today, and some believe it has the potential to become a major export for the country.

Because of the substantial profits, landowners are very interested in planting sandalwood. But they must be supported through supply of good quality seedlings, training, technical information and extension services. Both community and private nurseries have been set up to supply seedlings, and in 2010 more than 62,000 seedlings were distributed. There are currently an estimated 300,000 sandalwood trees growing in plantations, in small woodlots and in agroforestry systems. Trees are already being harvested, and the government has supported the development of processing facilities, so that the industry can supply markets in Europe and Asia with oil, carvings and other high-value products. The industry is also being supported through research into genetic improvement, using elite genetic materials collected from the natural forests. A next step is to develop standard labeling of sandalwood products for export.

Cenon Padolina

Micronesia

Randy Thaman

The Federated States of Micronesia

Margie Falanruw and Anne Moorhead

The FSM at a glance

Number of islands: 607 (approximately 65 inhabited)

Total land area: 701 km^2

Forest cover: 87% (includes agroforests and mangroves)

Population: 111,364

% population urban/rural: 22/78

GDP per capita: US$ 2,183

Main drivers of economy: Funds from the US, tourism, fisheries

Natural forests of Kosrae.

Summary

The islands of the Federated States of Micronesia (FSM) have considerable natural forests which hold significant biodiversity. Inhabited islands also have much agroforest. However, people are moving away from traditional lifestyles, resulting in neglect of some agroforestry systems and loss of traditional controls on natural resource exploitation. Clearing for infrastructure and agriculture, wildfires, and relocation of people because of sea level rise also threaten the forests. The FSM has committed to the Micronesia Challenge, which includes a pledge to conserve 20% of its land ecosystems by 2020. The FSM recently completed a Statewide Forest Resources Assessment and Resource Strategy (SWARS), which defined priorities for forest management in the coming years.

Forests of the Federated States of Micronesia

Four island groups comprise the four states of the Federated States of Micronesia (FSM); from west to east, these are Yap, Chuuk, Pohnpei and Kosrae. Yap State

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includes mainland Yap, which is a cluster of four high islands with highest point 173 m; a raised limestone island (Fais); and low-lying limestone islands and atolls spread over some 250,000 km^2 of ocean. Chuuk consists of a series of high volcanic islands within the Chuuk lagoon, with highest point 443 m, and surrounding atolls. Pohnpei comprises a high island, highest point 791 m, and several atolls. The state of Kosrae consists of the single high volcanic island of Kosrae, which rises to 629 m.

This diversity of island type, size and topography, combined with variations in climate (the western islands have a more pronounced dry season) and soils, is reflected in the diverse forest types found across the FSM. These include lowland and upland rainforest, cloud forest on the two highest islands of Kosrae and Pohnpei, tropical semi-dry forest on the drier western islands, palm forest, agroforest, swamp forest, mangrove forest, limestone forest, and coastal and atoll forest.

In total, the FSM has an estimated forest cover of 87%, however this varies by state, from Kosrae with 97% to Yap with 70%. Kosrae and Pohnpei have much remaining natural forest, with many endemic species. Chuuk, which is the most densely populated state, has converted the majority of its forests to agroforests and secondary vegetation.

Each state of the FSM has its own outstanding forest features. Kosrae has magnificent swamp forests dominated by endemic *Terminalia carolinensis* (known as *ka*) and *Horsfieldia nunu* trees, and mangroves with tall *Sonneratia alba* trees covered with epiphytes. The cloud-covered peaks of Pohnpei and Kosrae have unique mossy forests, and Pohnpei has the most endemic species in the FSM. The islands of Chuuk lagoon have some of the most endangered native forests in the FSM in the form of small patches of endemic species-rich forests on the ridges and mountaintops. Yap has the most diverse agroforests.

Mangroves are found along the coasts of all of the high islands. Pohnpei has the largest area of mangroves, while Yap has the highest number of mangrove tree species.

The outer islands of the FSM are scattered over a vast area of ocean. The raised island of Fais supports some limestone forest, while the inhabited low-lying islands have mostly agroforest mixed with atoll forest. The uninhabited

Cloud forest on Mount Tafeyat, Kosrae. *Carlos Cianchini*

Agroforestry on Pohnpei. *USDA-NRCS*

islands are sometimes visited to harvest resources, but are generally less disturbed. Some of these have unusual inland mangroves that make use of the fresh or brackish water lens in the interior of the island.

A brief history of the FSM's forests

Most of the forests of the FSM have been influenced by people. Some traditional agroforestry systems do not remove the forest cover, but cultivate crops among the trees, for example yams are often grown using living trees as trellises in Pohnpei. Other agriculture systems required clearing of the forest canopy. Areas of forest were also cleared for settlements. Wildfires also contributed to loss of forest, particularly in Yap, where there are now extensive areas of savanna.

The arrival of Europeans to the islands of the FSM in the 19th century resulted in more clearing of forests to support their ways of life and to plant coconut to supply the commercial copra trade. In the 20th century, the Second World War caused damage to some island forests, such as dieback of mangrove forests in Chuuk lagoon following oil spills after the bombing of a fleet of ships. Numerous plant and animal species were also introduced to the islands during and after the war, some of which became invasive.

In 1947 the FSM became a UN Trust Territory administered by the US. A period of infrastructure development began at this time, to support economic development, which continues to the present day. Today the FSM is in a Compact of Free Association with the US. At the start of the Compact, in 1986, funds were readily available

Mangrove species

The word 'mangrove' refers to many different species that are adapted to being submerged by seawater during high tide, but above water during low tide. They are normally found along protected coastlines and in estuaries, river deltas and internal back-beach tidal basins. Different mangrove species have a varieties of aerial or prop roots or peg- or snorkel-like raised bumps on their roots that help them to absorb oxygen, and leathery leaves and other ways of excreting salt. Worldwide, 22 plant families have evolved species that are defined as mangroves.

From west to east across the Pacific, the diversity of mangrove species declines, from 33 species in PNG to eight in Fiji and three in American Samoa, which is the eastern limit for mangroves in the Indo-Pacific region. Common species in the Pacific islands include red mangroves (*Rhizophora mangle*), stilt mangroves (*Rhizophora stylosa*), Oriental or large-leafed mangrove (*Bruguiera gymnorrhiza*), the red-flowered black mangrove (*Lumnitzera littorea*), the mangrove apple (*Soneratia alba*) and the blinding tree (*Excoecaria agallocha*).

Mangrove timber is traditionally used for house construction, boats, fish traps and tools such as fishing spears. The wood is also a favoured firewood. The fruits of Oriental mangrove are grated, cooked and eaten in Solomon Islands, Nauru and other parts of the western Pacific as an emergency food or delicacy. Its bark is also one of the main sources of dye for tapa cloth in both Fiji and Tonga. Some species have medicinal uses, for example red mangrove bark is used to treat angina, boils and fungal infections. Mangroves are also important to food security because most nearshore fish, shellfish and crustaceans (crabs and prawns) spend part of their life cycle in mangroves, and are gathered from these sites.

Mangroves also perform a host of environmental services that go largely unrecognised. They play a major coastal protection role, as shown by the fact that areas in Samoa with mangroves were much less damaged by the 2008 tsunami than those without vegetation. Mangroves are an important wildlife habitat for birds, bats, crustaceans, shellfish and fish. They also help maintain water quality by cycling nutrients and trapping sediment.

SPC

An endemic subspecies of fruit bat from Yap (*Pteropus mariannensis yapensis*). *Margie Falanruw*

from the US and these contributed to a change in lifestyle for many islanders, from traditional living to more westernised, urban living with increased dependence on imported food and other goods. This has resulted in reduced maintenance of the agroforestry systems on some of the main islands, and loss of traditional controls on natural resource exploitation. The US funding is now declining, and some people are returning to making their living by exploiting natural resources. However, with the disappearance of traditional controls, resources are at risk from overexploitation.

Forest ownership and management

Ownership of forested areas varies in the different FSM states. In Kosrae and Pohnpei, land is either privately or state owned. In Chuuk, most land is privately owned and acquired through inheritance, gift, or more recently, purchase. In Yap, almost all land is owned or managed by individual estates and is under traditional control. In all the states, land cannot be sold to non-citizens of the FSM.

The responsibility for environmental issues is shared between the FSM national government and the individual FSM state governments. To date there is no forest policy in any of the states. The FSM has however committed to the Micronesia Challenge, which pledges to sustainably manage 30% of near-shore marine areas and 20% of terrestrial habitats by 2020.

Importance of the FSM's forests

Conservation of biodiversity

The forests of the FSM are quite biodiverse with a high number of endemic species for such a small land area. The islands have over 1,200 species of ferns and flowering plants. There are five endemic species or subspecies of flying fox (fruit bats, *Pteropus* spp.), and a sheath-tailed bat (*Emballanura* sp.). Over 121 species of birds have been reported from the FSM, including at least 16 endemic forest birds. There are at least five endemic reptiles, and a rich invertebrate fauna including numerous land snails and over 50 species of ants on Pohnpei alone.

The coastal forests of the uninhabited islets and atolls are very important as seabird and sea turtle nesting areas and refuges for coconut crabs (*Birgus latro*). These islands also harbour relict populations of some endemic species, for example, several new species of gecko and a snake were recently described.

The conservation of native forests of the FSM is very important to the continued existence of this rich biodiversity heritage. A Blueprint for Conserving the Biodiversity of the FSM identified 53 conservation targets including 12 ecosystems, six communities and 29 species, and delineated some 130 sites of special biodiversity significance, as candidates for protection under the Micronesia Challenge.

Medinilla diversifolia, an endemic plant of the forest. *Carlos Cianchini*

Value to rural communities

An estimated 78% of the FSM's population lives in rural areas and depends heavily on agroforestry systems for food and other products. Many of those who live in urban areas also rely to some extent on these systems for some of their needs, such as food, medicines, building materials, garlands and perfumes.

Tourism

The tourism industry is currently small, but has the potential to expand. Each of the FSM states has initiated ecotourism projects. In Kosrae, an increasing number of tourists are visiting the magnificent Yela swamp, while on Yap tourists frequently trek the 3-mile Tamilyog Trail that crosses the island, passing through several forest types.

Threats to the FSM's forests

Changing lifestyles

Traditional island life depended directly on the forest and agroforest resources, and there were traditional controls to limit exploitation. Today, many people are living a westernised lifestyle and are losing touch with their natural heritage. There is a shift from a community-centred culture to a culture that promotes individual choice and profit. Natural resources are increasingly taken for granted, or worse, seen as a way to boost individual economic gain. Timber harvesting, for example, is proceeding at an unsustainable rate on the island of Yap, without safeguards in place to protect the forests. This effect is being made worse by declining funds from the US, so that people are having to seek new ways to make a living.

Clearing for infrastructure and agriculture

Accompanying the change in lifestyle is a demand for more roads and other infrastructure, which is leading to forest clearing.

Clearing for agriculture is also threatening the forests on some islands. For example, the natural forests on Pohnpei have declined dramatically over recent years, due to a combination of clearing for the cultivation of *sakau* (*Piper methysticum*, also known as kava), smothering vines and droughts.

Wildfires

Wildfires are a significant threat to forests in the states of Yap and Chuuk, and a lesser threat in Pohnpei and Kosrae. Yap has frequent droughts, and wildfires (mostly due to arson) often burn large areas of savanna and damage the forest edges. During an El Niño-related drought in the early 1980s, for example, about 20% of the island was burnt by wildfires. Yap and Chuuk experience wildfires most years, while Pohnpei and Kosrae are normally affected only during severe El Niño-related droughts.

Rising sea levels

Low-lying islands and coastal areas of high islands are already experiencing high sea levels and very high tides that come inland and inundate taro patches. Many people are already relocating because of this – inhabitants of low-lying islands are moving to the high islands, and coastal residents of high islands are moving inland. In both cases this represents a threat to the forests, as new areas are cleared for agriculture and settlements.

Looking to the future

As funding under the Compact of Free Association between the FSM and the US declines, there will be efforts to fill the economic gap through exploitation of the country's natural resources. This could easily result in higher levels of unsustainable exploitation of forest resources. Fortunately, the FSM's small forestry staff is being augmented by environmental NGOs. NGO-assisted efforts involving communities are developing, for example to conserve the Yela forest on Kosrae (see box on page 58). The Micronesia Challenge, supported by the Micronesian Conservation Trust, will also contribute to the sustainable stewardship of the FSM's forests.

Sustainable timber harvesting is a priority for FSM for the future. *USDA-NRCS*

The FSM recently completed a Statewide Forest Resources Assessment and Resource Strategy (SWARS) which defined priorities for forest management in the coming years. These include food security, biodiversity conservation, watershed protection, production and sustainable harvesting, coastal stabilisation, urban forestry and capacity building.

To improve food security, the FSM plans to enhance its agroforestry systems and also expand food production into upland areas where natural vegetation is already disturbed. Preserving agrobiodiversity is also a priority. On all of the high islands watershed protection is an important issue, and efforts are already under way to develop watershed reserves on Pohnpei and Kosrae.

All four states face problems of unsustainable harvesting of forest resources, and will try to address these in the coming years. The first step is to assess resources in order to define sustainable harvesting, so that controls can be put in place. Planting programs are also planned, to guarantee supply of timber as well as to preserve forest habitat.

Mangroves are under threat throughout the FSM; some states are beginning to address this by developing mangrove management plans. A team of scientists from the US Forest Service recently worked with Yap State forestry staff to measure carbon sequestration by Yap's vegetation. Preliminary results show that mangroves, comprising 12% of the island's vegetation cover, sequester some 34% of the carbon held by the island's vegetation. This knowledge should increase incentives to preserve mangroves, and in the future the FSM could contribute to climate change mitigation through REDD+ (Reducing Emissions from Deforestation and Forest Degradation) schemes that conserve mangroves and other island forests.

Finally, plans for urban forestry focus on building more community involvement for managing these important trees and forests.

Conserving the Yela ka forest

The Yela forest on Kosrae, which is dominated by endemic *ka* (*Terminalia carolinensis*) trees, is one of the most intact freshwater swamp forests in the Southeast Asia–Pacific region and the only large stand of ka trees in the world. This unique forest is threatened by a proposed road through the swamp. In response, individuals and groups – local and international, government and non-government – have joined forces to protect the forest.

As the Yela swamp forest is privately owned, one of the issues is that conservation of the forest would deprive landowners of income they could get from exploiting or developing the area. This is being addressed through the US Forest Service Forest Legacy Program. This program purchases land or development rights from landowners in order to allow the forest to be put into conservation. The legal agreement is known as a conservation easement.

The families who own the Yela forest are interested in conserving the area, and have formed the Yela Environment Landowners Association (YELA). The forest has been surveyed and its value for the purposes of the easement has been determined through a study funded by a LifeWeb grant through the Micronesian Conservation Trust. When this payment is accepted by YELA, the easement will come into force. This will be the first conservation easement in the FSM.

Eva Gonnerman

Guam

Belmina Ingalla Soliva and Anne Moorhead

Scrub limestone forest in northern Guam. *USDA-NRCS*

Summary

Guam's forests have been greatly damaged by invasive species, fire, and military activities during and after the Second World War. About 42% of the island is under forest today, but this is mostly highly disturbed forest with many non-indigenous species. The planned expansion of US military in Guam over the next 5 years, and the development that will accompany this, poses a serious threat to these remaining forests. The 2010 Guam Statewide Forest Resources Assessment and Resource Strategy (SWARS) proposes a 5-year management plan to support the conservation and recovery of Guam's forests in the face of this challenge. Strategies include working closely with the military to avoid unnecessary destruction of forest and to keep as many native trees and forest areas as possible in the development zones.

Guam's forests

Guam's natural vegetation has been greatly altered, from a mostly forested environment to a highly fragmented

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landscape. Forests are today estimated to cover 42% of the island, but very little of this is undisturbed natural forest. There is no primary forest left.

Guam's forests reflect the island's soils and topography. The northern half of the island is a limestone plateau. There is little surface water because of the porous nature of the limestone. Here, land that is not cultivated or urbanised is covered with degraded secondary limestone forest or scrub forest. Common tree species in the limestone forest include Pacific banyan (*Ficus prolixa*), vesi or *ifit* (*Intsia bijuga*), dugdug or Marianas breadfruit (*Artocarpus mariannensis*) and yoga (*Elaeocarpus joga*). The endemic small tree *Guamia mariannae* is common in the understory of many limestone forests, and there are a few remaining trees of *Serianthes nelsonii*. Scrub forest has some of these same native species, but is typically dominated by vitex (*Vitex parviflora*), an introduced species from the Philippines. Another common introduced tree is leucaena or *tangantangan* (*Leucaena leucocephala*), which is found in extensive dense thickets in the north and south.

The southern half of the island has rolling hills rising to mountains, and is drained by nearly a hundred rivers. Soils here are mostly volcanic and highly prone to erosion. Because of repeated burning, this area is now mainly covered by grassland and savanna, with forest fragments occurring only in sites such as gullies and ravines. These forest fragments contain non-native species such as betelnut palm (*Areca catechu*) and the invasive palma brava (*Heterospate elata*), as well as native species such as beach hibiscus or *pago* (*Hibiscus tiliaceus*), pandanus (*Pandanus tectorius*) and *Premna serratifolia*.

Guam has extensive abandoned coconut (*Cocos nucifera*) plantations along some of its coastal areas. It also has some coastal forest, with casuarina (*Casuarina equisetifolia*) often a dominant tree. There are also small areas of mangrove forest.

A brief history of Guam's forests

The most significant historical events affecting the forests of Guam were the arrival of people some 4,000 years ago, and more recently the Second World War and the economic and urban development that followed the war.

The arrival of the Chamorro people brought fire to Guam.

Grasslands and the coastal plain of southern Guam. *USDA-NRCS*

Fire has had a dramatic effect on the island's vegetation over the centuries. In modern times, fire is used as a hunting tool – animals are drawn to the new shoots that sprout following burning. Frequent fires prevent native trees from regenerating, and as a result grasslands have replaced forest on most of the southern part of the island.

Guam was captured and occupied by the Japanese in 1941, and recaptured by the US in 1944. During this period, military occupation and land battles had a direct impact on Guam's forests.

A major indirect impact of the Second World War was the accidental introduction of the brown tree snake (*Boiga irregularis*), which was brought in with military equipment just after the war ended. Without predators to control it, and with abundant prey, snake numbers increased dramatically. Many native species were affected, birds in particular. Today, as a result of predation by the brown tree snake, nine of 11 native forest-dwelling birds are no longer found on Guam. Five of these were endemic – of these, three are now extinct while two exist only in zoos. The snake is also a major threat to most of the islands' indigenous geckos, lizards and fruit bats.

The structure of the limestone forests is also changing due to the presence of Philippine deer (*Cervus mariannus*) and feral pigs (*Sus scrofra*) which browse on seeds and seedlings preventing native forest regeneration. Other introduced plants and insects are also making their mark on the remaining native forests. These are described below under 'Threats to Guam's forests'.

Forest ownership and management

Land ownership on Guam is split between private (53%) and public (47%) ownership. Guam is an unincorporated territory of the US, and roughly half of the publicly owned land is managed by the US military. Forest management therefore involves a range of public and private stakeholders.

The territorial body responsible for Guam's forests is the Forestry and Soil Resources Division. The agency works with stakeholders to promote healthy and productive forests, and works closely with the US Department of Agriculture (USDA) Forest Service, which provides technical and financial assistance.

The USDA Forest Service supported Guam's development of a Statewide Forest Resources Assessment and Resource Strategy (SWARS; see box on page 64) in 2010. There was a high level of stakeholder input to identify and prioritise the major issues and threats to Guam's forests and landscapes, and strategies to deal with them.

The impacts of military activities on Guam remain today. *USDA-NRCS*

Importance of Guam's forests

Conservation of biodiversity

The natural forests of Guam hosted a rich diversity of plant and animal species. Over 100 bird species have been documented on the island. Three native mammals were also known to Guam – the Marianas fruit bat (*Pteropus mariannus mariannus*), the Pacific sheath-tailed bat (*Emballonura semicaudata rotensis*) and the little Marianas fruit bat (*Pteropus tokudae*); the latter is now thought to be extinct. There are at least nine native reptiles (not counting sea turtles) including five skink species, one of them (*Emoia slevenii*) endemic to the Mariana islands. Several native tree snail species still exist in low numbers on Guam.

The forest degradation that Guam has suffered, along with impact of the brown tree snake and other introduced animal and plant species, have greatly reduced Guam's biodiversity. The remaining forest is all the more valuable for conservation of those species that have so far managed to survive. The Guam Comprehensive Wildlife Conservation Strategy, completed in 2005, identified 31 terrestrial species that are at risk, including six plant species, two species of bat, 13 birds, five lizards, three snails and two insect species. Restoration of forest habitats is an important part of the conservation strategy.

The Tarzan River in southern Guam. *USDA-NRCS*

Reef protection

Guam is surrounded by an extensive and species-rich reef system that provides many services including cultural and traditional uses, tourism and recreation, fisheries, and shoreline and infrastructure protection. Over 98 km^2 of shallow coral reef are found within 5 km of Guam's coastline.

The health of the reefs is directly linked to the health of inland forests. Coral reefs are degraded by sediment runoff from watersheds, particularly from the steep hillsides in southern Guam. Deforestation, fire, invasive species and poor land management practices all increase the sediment flux from the uplands to the mouths of rivers that empty into the fringing reef and bays. Coral reef health is in decline where these significant and chronic sediment plumes occur.

Threats to Guam's forests

Military build-up and associated development

Over the next 5 years, there is planned military expansion in Guam which is a significant threat to the island's environment, and particularly its forests. Actual numbers of military personnel are unknown, but estimates are that the population may temporarily increase by more than 50,000 by 2014. This will greatly increase development pressures for conversion of forestland into infrastructure such as housing, shopping centres and new roads.

The primary threat is the direct removal of forests for this development, but there will also be indirect effects on remaining forests. Forest fragmentation and degradation due to urbanisation decreases forest resilience, for

Vesi

Vesi (*Intsia bijuga*) is found throughout the western Pacific region. The tree has long been highly valued for its wood, but overexploitation without replanting means that it is becoming uncommon.

Vesi is a tall tree, growing up to 40 m and with trunk diameter up to 1 m. It has glossy light green foliage that makes it easy to pick out in the forest, and beautiful orchid-like flowers. The roots of large trees form buttresses that add stability and make vesi less likely to be uprooted in a cyclone.

A great advantage of vesi is its broad tolerance to a range of conditions. It is found in coastal and lowland forest and dry forest on limestone rock. It is also found at the edge of mangrove forest and in inland rainforest, up to elevations of 450 m. It can tolerate waterlogged soils as well as dry sandy and rocky limestone soils. It is very tolerant of drought, sea spray and saline soils.

Vesi wood is hard and durable and has low shrinkage, making it very useful for house building, furniture and canoes. It carves well, and is traditionally used to make kava bowls, weapons and wooden ornaments. The bark, stems and leaves are also used medicinally for a range of ailments including rheumatism, diarrhoea and asthma.

The tree fixes nitrogen, and also increases calcium in the soil. It can therefore help to regenerate degraded land. It is a good species for erosion control, and for coastal protection, particularly as a windbreak.

Randy Thaman

Wildfire has greatly altered the natural vegetation of Guam, and continues to be a major threat. *USDA-NRCS*

example to wind damage and invasive species. Where natural forests are cleared and ornamentals planted in their place, this changes the species diversity and seed source pool of native species, with unknown impacts on the health and resilience of Guam's remaining natural forests and resident animals. New roads also open up access to forests, which often leads to increased pests and burning, and more unmanaged removal of wood and other forest products.

Fire

Fire has played a large role in altering the native forest cover in Guam, and continues to be a major threat. Following fire soils are highly vulnerable to erosion, and Guam's volcanic soils are very fine and therefore easily washed away. The underlying material has poor structure and low fertility and it is very difficult for vegetation to grow back. Soil is washed down into river systems, causing sediment pollution and affecting domestic water supplies. It is also washed into the sea and contributes to the decline of the coral reef system.

Invasive species

Guam is a central hub for the transport of goods and people (including military operations) between Asia and North America, and is a local hub for Micronesia. Approximately 1.1 million people pass through Guam each year. This makes the island very vulnerable to the introduction of new invasive species, and this will be exacerbated by the planned military build-up in the next 5 years.

In addition to the brown tree snake, invasive species already posing a serious threat to Guam's forests include the Asian cycad scale (*Aulacaspis yasumatsui*) and the coconut rhinoceros beetle (*Oryctes rhinoceros*). The Asian cycad scale was detected in 2003 and has spread on ornamental cycads in urban areas and also to native species of cycads in forest and savanna areas. In 2005 another pest of cycads, the cycad blue butterfly (*Chilades pandava*), was also detected. Together these two pests may be killing up to 10% of cycads each year. The coconut rhinoceros beetle is thought to have been accidentally introduced into Guam in 2005. This affects palms, including coconut, betelnut and native pandanus species, and has caused widespread damage on other Pacific islands.

Invasive plants that are affecting the forests include mile-a-minute vine (*Mikania micrantha*), Siam weed (*Chromolaena odorata*), Koster's curse (*Clidemia hirta*) and giant sensitive plant (*Mimosa invisa*), while introduced trees such as the African tulip tree (*Spathodea campanulata*), vitex and leucaena are suppressing regeneration of native forests. Deer, feral pigs and water buffalo are also a major threat to the regeneration of native forest.

Looking to the future

The next 5 years will be critical for Guam's forests, as US military operations expand on the island. The Guam SWARS provides a framework for conserving and recovering Guam's forests in the face of this challenge. Based on wide stakeholder consultation, it presents a 5-year plan that addresses not only ways forward to

A restoration project underway on Anderson Air Force Base. *USDA-NRCS*

Tree seedlings in a nursery in Guam. A strategy for the future is to implement planting programs using native species. *USDA-NRCS*

manage the forest resources, but also practical ways to implement the plan, including essential capacity building and funding.

The six key challenges identified by the SWARS were:

- Issue 1. Wildfire and Public Safety: The threat of wildland fire on human life and infrastructure.
- Issue 2. Water Quality and Supply: The threat to water quality and quantity from human development and forest degradation.
- Issue 3. Population Growth and Urbanisation: The threat posed by an expanding population on important ecosystem services provided by Guam's forest resources.
- Issue 4. Deforestation of Native and Old Forests: The threat posed to unique forest environments on Guam.
- Issue 5. Urban Forest Sustainability: The threat posed to Guam's urban forest resources by development and other stressors.
- Issue 6. Degraded Lands: Identification of threats to ecosystem health posed by lands currently identified as being in a degraded condition.

The six strategies proposed for addressing these challenges are:

- Strategy 1. Implement highest priority plantings that meet multiple objectives.
- Strategy 2. Protect, conserve and restore forests on state, private and other non-military lands.
- Strategy 3. Work with the military to avoid deforestation and develop tree ordinance laws for new and old development zones.
- Strategy 4. Improve fire prevention, control, suppression and prescribed fire activities through organising, training and equipping staff and resources.
- Strategy 5. Implement tree planting and monitoring projects in developed areas, open space, and parks in communities (urban forestry).
- Strategy 6. Implement a forest health program: unify interagency efforts to prepare for the military build-up.

Acknowledgement

Thanks to Mr John 'Bart' Lawrence, Assistant Director of Field Office Operations at the USDA Natural Resources Conservation Services, Pacific Islands Area, for his help with this chapter.

Statewide Forest Resources Assessment and Resource Strategy (SWARS)

SWARS is a tool developed by the USDA Forest Service which aims to identify the highest priorities for forest resource management, and ways to address them. The Pacific island countries associated with the US – American Samoa, CNMI, the FSM, Guam, Marshall Islands and Palau – all carried out SWARS exercises and published SWARS reports during 2010.

There are two parts to a SWARS – the Forest Resources Assessment, and the Resource Strategy. The Assessment is an analysis of current forest conditions and trends, including threats and opportunities, and priorities for action. The Strategy is a five-year plan for tackling the identified priorities. The overall purpose of SWARS is to guide investment of US funds for maximum effectiveness.

The SWARS process is widely collaborative, involving all stakeholders to ensure that issues identified reflect the real situation, and that strategies are relevant and realistic. The process also aims to encourage stakeholders to work together in addressing the priorities.

Kiribati

Tearimawa Natake and Anne Moorhead

Kiribati at a glance

Number of islands: 33 (20 inhabited)

Total land area: 811 km^2

Population: 100,835

% population urban/rural: 44/56

GDP per capita: US$1,490

Main drivers of economy: Copra, fishing, tourism, foreign aid

Coastal forest on Butaritari in the Gilbert Islands. *Randy Thaman*

Summary

The poor atoll soils, highly saline conditions and dry climate of Kiribati allow relatively few plants to grow. Coconuts, pandanus, mangroves and coastal forest species are the most common trees on the atolls and form the basis of agroforestry systems on which most of the people depend. Copra is economically important and accounts for more than 60% of the country's exports. Rising sea level is a serious threat to the forests and the people of these low-lying islands. The country lacks a formal forest policy and future management of its forests and trees is uncertain. Development of a policy, and an accompanying plan of action, would be a valuable step towards sustainable forest management.

The forests of Kiribati

The Republic of Kiribati comprises 31 atolls located in three widely separated island groups, the Gilbert Islands, Phoenix Islands and Line Islands, plus a single raised limestone island, Banaba. Most of the population

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A houseyard garden in Kiribati. *Randy Thaman*

of Kiribati lives in the Gilbert Islands, with Tarawa Atoll the main urban centre. The Phoenix Islands are mostly uninhabited, while several of the Line Islands are inhabited. Kiritimati, in the Line Islands, is the largest atoll in the world in terms of land area and comprises more than 70% of the land area of Kiribati. The other islands include a number of classic atolls with a series of small reef islets surrounding a central lagoon, and a number of low-lying lagoonless limestone islands, such as Arorae and Tamana in the south of the Gilbert group.

The environmental conditions of the atolls of Kiribati, which lie in the dry equatorial climate zone, are among the harshest on Earth. Frequent prolonged droughts, lack of surface freshwater, extremely poor soils and high salinity seriously limit plant growth. As a result, in the Gilbert Islands for example, only about 300 plant species have been recorded, and of these only 83 are possibly native species. Almost all the native plant species found in Kiribati are widespread, ocean-dispersed salt-tolerant plants. There are no endemic plants.

As a result of expanding population and urban development and over a century of planting coconuts on most available land, few of the main inhabited islets have any intact natural forest. Most of the remaining small groves are found on some of the uninhabited outer atoll islets. The main vegetation types are remnant stands of inland atoll forest or woodland, coastal forest and scrub, mangroves, coconut plantations in various stages of maintenance, agroforests, excavated taro pit gardens and village and houseyard garden.

Coconut (*Cocos nucifera*), pandanus (*Pandanus tectorius*), mangroves and common coastal trees such as tree heliotrope or *te ren* (*Tournefortia argentea*), scaevola (*Scaevola taccada*) and pisonia (*Pisonia grandis*) are the most common trees on the atolls. Coconut is known as the 'King Tree' and pandanus the 'Queen Tree', because of their importance. Pandanus and coconut are the basis of agroforestry systems that also include breadfruit (*Artocarpus* spp.), bananas and native fig (*Ficus tinctoria*) and the traditionally important ceremonial staple root crop, giant swamp taro (*Cyrtosperma chamissonis*). This is the only root crop that can survive the harsh atoll conditions and salinity. The traditional system depends on the excavation of pits through the limestone bedrock to the freshwater table and intensive soil management using a wide range of leaves as composting and mulching material.

The natural vegetation of the Phoenix Islands is largely undisturbed. Several of the islands are treeless and dominated by small scattered shrubs; others have low scrub or coconut forest. The islands are home to huge numbers of seabirds – at least 17 species and more than a million birds – and are included in a protected area that covers more than 400,000 km^2.

Banaba, which has an area of 6.5 km^2, was mined for phosphate during the 20th century. Ninety percent of the vegetation was removed during these years, and there have been no efforts to date to restore the forests. Today the mined areas are covered with regrowth of some native species and the invasive species *Leucaena leucocephala*, plus scattered stands of flame tree (*Delonix regia*).

Four different mangrove species are native to the islands of Kiribati – *Rhizophora stylosa*, *Sonneratia alba*, *Lumnitzera littorea* and *Bruguiera gymnorrhiza*.

Mangroves on Butaritari – *Rhizophora stylosa*. *Randy Thaman*

Rhizophora stylosa is by far the most common and found on most of the islands of the Gilbert group. The largest area of mangroves is found on Butaritari.

A brief history of Kiribati's forests

The atolls of Kiribati were first settled between 4,000 and 5,000 years ago. The early islanders struggled in the harsh conditions, and some islands were abandoned. However, on the larger islands that had freshwater resources – usually an underground 'lens' or water table – people gradually established permanent villages and agroforestry systems.

In the early 19th century Europeans arrived in Kiribati. In 1892 the Gilbert Islands became a British protectorate and later a British colony. Soon afterwards, most of the Phoenix Islands and the Line Islands also came under British administration. The colonists developed coconut plantations on most of the inhabited atolls and on many of the uninhabited offshore reef islets and uninhabited atolls, to supply the copra trade.

During the Second World War the Gilbert Islands were occupied by the Japanese, and fought over in the Battle of Tarawa. Kiritimati Island was occupied by the Allies. The occupied islands suffered localised impacts on trees and forests, for example from the building of airstrips and housing.

The US had an interest in the Phoenix Islands, claiming sovereignty over Kanton and Enderbury islands with the intention of mining seabird guano that had accumulated for millennia under pisonia tree groves. During the war some islands were bombed by the Japanese. After the war, Kanton was developed as a seaplane landing site, and later as a refuelling station for trans-Pacific civilian and military aircraft.

During the 1950s and early 1960s, both the US and the UK conducted nuclear weapons testing on and near Kiritimati Island. During this time they established villages, roads and two airstrips. The island now serves as the main focus for the resettlement of people from the overpopulated atolls of the Gilbert group.

Coconut

Coconut (*Cocos nucifera*), widely known as the 'tree of life', is without doubt the most important tree in the Pacific region in terms of usefulness to the people. It provides food, drink, oil, timber, thatch, fibre, fuel, medicines and many other useful products. It is particularly valuable to communities on small remote islands who have very limited resources. It also plays an important role in coast protection, its dense fibrous roots stabilising the soil and reducing erosion. There are a range of varieties, including tall and dwarf varieties and varieties grown specifically for the size of their nuts, the quality and length of the fibre of the husk that is used to make rope, their medicinal properties or for their taste, oil quality or edible husk.

Coconut is thought to have originated in Southeast Asia, and perhaps in the Pacific region. It is likely that some useful varieties were brought into the region by settlers beginning some 4,500 years ago. Growing by or close to the coast, the nuts have also spread naturally on the sea – they can survive up to 120 days afloat, and germinate when they make landfall. Through these two dispersal methods, coconuts have now reached all tropical regions of the world.

Coconuts became a commercial crop in the Pacific region during the 1800s, when coconut oil began to be used for industrial-scale cooking and baking in the USA and Europe. Plantations were established on many Pacific islands to supply the international market. However, demand declined with the development of other vegetable oil industries, and disruption to trade caused by the Second World War. Today, new high-value markets hold potential for restoring the economic value of coconuts (see page 109).

Randy Thaman

A lesser frigatebird chick on Kiritimati Island. *Randy Thaman*

Forest ownership and management

Most land in the Gilbert Islands is under customary ownership, by family groups. Land inheritance and exchange is a complex process governed by customary laws. The Phoenix and the Line Islands are mostly owned by the government of Kiribati, although some land on Tabuaeran and Teraina atolls in the Line Islands has been sold to people who have been resettled from the Gilbert Islands.

There is no separate forestry department, and no formal forestry activities. There is also no national forest policy. Forest management and agroforestry fall under the Ministry of Environment, Lands and Agricultural Development.

Kiribati has a National Biodiversity Strategy and Action Plan, and a Development Plan, both of which recognise the importance of conservation of trees and forests. A nursery in Tarawa focuses on propagating local species, in particular those which are endangered or of particular medicinal or cultural value, such as threatened pandanus varieties.

Kiritimati has been designated a wildlife sanctuary and the island Development Committee has developed an integrated program of wildlife conservation and education. Part of it includes the protection of some of the most intact pisonia groves and seabird rookeries on the uninhabited islets within the extensive lagoon.

Importance of Kiribati's forests

Conservation of biodiversity

Biodiversity is very low in Kiribati, which makes its conservation even more important. The few plants that have shown themselves able to survive in this harsh environment are critical to the future of the islands and their people.

The Line and Phoenix Islands are very important seabird nesting sites and refuges for many migrating birds. Kiritimati Island has 18 breeding seabirds, and the world's largest populations of some of these, for example the Phoenix petrel (*Pterodroma alba*), the Central Pacific sooty tern (*Sterna fuscata*) and the Christmas shearwater (*Puffinus nativitatis*). McKean Island in the Phoenix group is home to the largest population of lesser frigatebirds (*Fregata ariel*) in the world.

Value to communities

The majority of the people of Kiribati derive many of

their everyday needs from trees, especially coconut, pandanus, mangroves and other indigenous tree species. All trees have a local name, many have multiple uses and all provide important ecological services in the harsh atoll invironment. The diverse uses include construction, boatbuilding, toolmaking, handicrafts, fuelwood, fish trap stakes, dyes, medicines, and leaves and flowers for making garlands and perfumes. The agroforestry systems provide staple foods such as giant swamp taro, breadfruit, bananas and figs as well as fruits, nuts and leaves to supplement the diet.

Economic value

Copra remains an important export for Kiribati, accounting for more than 60% of the country's exports in recent years. Today, the copra mills also produce coconut oil products including cosmetic products (body oil, soap, shampoo) and cooking oil, which are sold in the country's shops and supermarkets. Other by-products from the mills are pig feed and firewood.

Other products from the forest that generate income include fruits, thatch and handicrafts produced from pandanus. There is a small processing industry producing juice and jam from pandanus, banana, pumpkin and papaya.

Copra is a key export for Kiribati. *Randy Thaman*

Threats to Kiribati's forests

Climate change

Apart from Banaba, almost all of the islands in Kiribati are less than 4 m above sea level. Rising sea levels and increasing salinity are therefore very real threats to the islands, including their forests and agroforests. Effects

Seawater inundation is killing this breadfruit tree. *Lex Thomson*

are already being seen – coconuts, pandanus and breadfruit, Kiribati's most important trees, are dying due to drought and seawater inundation in the lowest lying areas. Agroforestry further inland is also in danger as seawater increases soil salinity and affects the freshwater lens.

Population pressure

Population pressure is a problem in South Tarawa, as more people move to the urban area. Impacts include clearing for homes and infrastructure; over-harvesting of nearby forests for wood for fuel, carving, building materials, medicines and other products; and pollution from dumping of rubbish.

Invasive species

The Papuana taro beetle has almost totally eliminated the growing of giant swamp taro, bananas and some other crops in the agroforestry systems of South Tarawa. This seriously undermines food security on Kiribati's most populous island. Rats, feral cats and ants also seriously threaten bird populations in some of Kiribati's important forest and bird conservation areas.

High population density in South Tarawa is causing environmental problems, including overharvesting from nearby forests. *Randy Thaman*

Looking to the future

Without a specific forest policy, the future of Kiribati's trees and forests, and the people, birds and other plants and animals that depend on them, is uncertain. Development of a policy, and an accompanying plan of action, would be a valuable step towards sustainable forest management. A forest policy for Kiribati might include some of the following:

- Collaborate with the Pacific islands community to exchange tree genetic resources, and rebuild the full complement of Kiribati's native trees.
- Increase propagation of native tree species to supply planting programs.
- Develop planting programs that aim to restore degraded habitats, based on native species and useful introduced species.
- Work with the young people of Kiribati, to raise awareness among the next generation of islanders, and to equip them with knowledge to sustainably manage their forests.
- Develop community-based agroforestry action plans that build on local knowledge and commitment to improve and strengthen agroforestry systems in a culturally and environmentally appropriate way (see box).
- Develop legislation to protect areas of special importance, for example for conservation of biodiversity.
- Develop an invasive species action plan to help control and eradicate serious pests and diseases that threaten Kiribati's limited plants and animals.

Working with young people and equipping them with the knowledge to sustainably manage their forests is vital for the future of Kiribati. *Randy Thaman*

Community-based agroforestry action plans

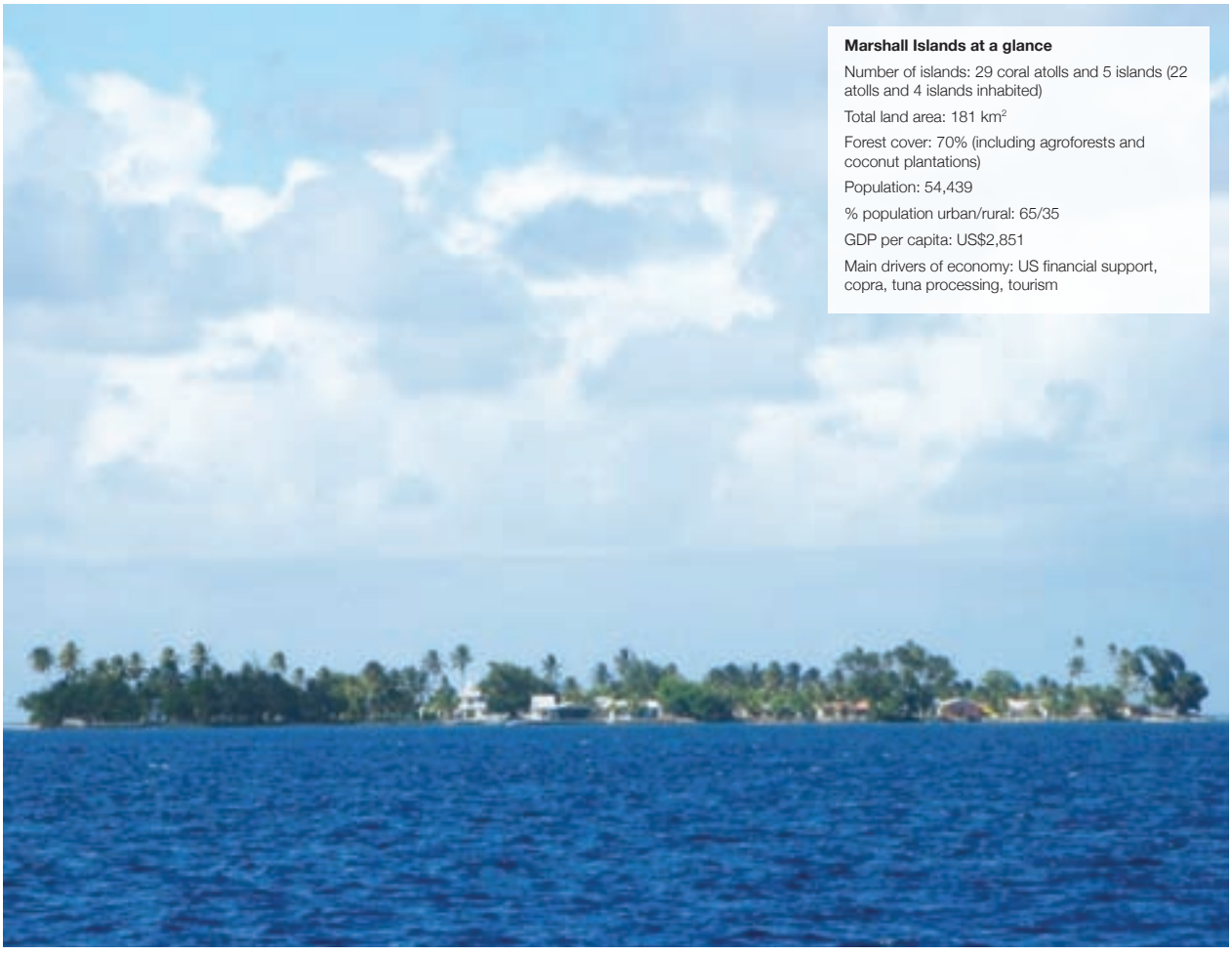
Community-based agroforestry action plans hold great promise for improving agroforestry systems on atolls. The development of these plans brings together two key groups: (1) the local community and (2) outside stakeholders, including government departments, regional and international organisations, local and international non-government organisations (NGOs), funding organisations, and foreign consultants. Bringing these groups together allows to capitalise on local knowledge and commitment on the one hand, and outside expertise, funding and support on the other. The process also raises awareness of new technologies and what is happening outside the local area; improves understanding of the problems and potential for development at the local level; and it should lead to the development of practical, realistic, and culturally and environmentally appropriate plans.

A workshop held in Kiribati in 2000 laid the groundwork for developing such plans. Participants carried out a community-based survey in three villages on Tarawa Atoll, gathering information from local communities on the current status of trees, forests and agroforestry at the community or village level. This information was then analysed to show how it could form the basis for an action plan.

Randy Thaman

Marshall Islands

Karness Kusto



Marshall Islands at a glance

Number of islands: 29 coral atolls and 5 islands (22 atolls and 4 islands inhabited)

Total land area: 181 km^2

Forest cover: 70% (including agroforests and coconut plantations)

Population: 54,439

% population urban/rural: 65/35

GDP per capita: US$2,851

Main drivers of economy: US financial support, copra, tuna processing, tourism

Ejit Island, in the Ratak chain. *Karness Kusto*

Summary

The low-lying Marshall Islands have very little natural forests remaining, but have extensive coconut plantations and agroforests. However, the majority of the population now lives an urban life, and traditional knowledge is being lost as the importance of traditional agroforestry systems declines. The country published a Statewide Forest Resources Assessment and Resource Strategy (SWARS) in 2010, in which it identified four priority issues for the coming years: biodiversity, food security and sustainable livelihoods, coastal reinforcement, and urbanisation. The future of the forests in the Marshall Islands depends on the islanders rediscovering their heritage, and a revitalisation of traditional agroforestry systems. This will contribute to sustainable forest management, as well as to a healthier lifestyle for the people of the Marshall Islands.

The forests of the Marshall Islands

The Marshall Islands are divided into two chains – the Ratak (sunrise) chain in the east and the Ralik (sunset)

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chain in the west. They are all low islands. The average height of land above sea level is less than 2 m, and the highest point, a sand hill on Likiep Atoll, varies from 7.5 to 11 m above sea level.

The atolls vary in size from Kwajelein, the world's largest atoll in terms of the area of its lagoon (16 km^2 land area with a lagoon of more than 2,000 km^2), to Bikar (0.5 km^2 of land and 37 km^2 of lagoon) and Namdrik (nearly 3 km^2 of land and just over 8 km^2 of lagoon).

The island soils are mostly poor quality, highly alkaline sandy or gravelly soils. This, as well as the challenging environmental conditions of high salinity, strong winds, limited water resources and periodic drought, limits the vegetation that is able to grow. Thus, only about 22 tree species are found in the natural forest of the Marshall Islands.

Over the centuries most of the natural forest has been converted to agroforest and coconut plantations. Today, very little of the natural vegetation remains on most of the atolls. Remnant stands are found on some of the inhabited atolls. The estimate of 70% forest cover includes agroforests and coconut plantations.

Dominant tree species in the past included pisonia (*Pisonia grandis*) and *Neisosperma oppositifolium*. Unusually for tropical forests, these trees often formed stands of single species. Today, these stands are found only as remnants of the former forest. *N. oppositifolium* is occasionally found inland on some of the northern atolls, while stands of pisonia are very rare.

Strips of natural coastal forest do however remain on many of the atolls. These have been left to provide windbreaks for farming and coconut plantations further inland. Typical species in these forest strips include tree heliotrope or *kiden* (*Tournefortia argentea*), guettarda (*Guettarda speciosa*), pisonia, pandanus (*Pandanus tectorius*) and cordia (*Cordia subcordata*).

Pisonia was once a dominant tree in the Marshall Islands, and still occurs as remnants. *Randy Thaman*

Tree heliotrope is commonly found in coastal forest strips. *Randy Thaman*

The two northernmost atolls of Bikar and Bokak, which are uninhabited, have the most undisturbed natural forest in the Marshall Islands. Each atoll has only nine species of vascular plants, and the only trees found are pisonia, tree heliotrope and scaevola (*Scaevola taccada*) on both, and pandanus on Bokak. These atolls have been recommended as conservation areas as they have important seabird populations and are particularly vulnerable to invasive species.

The Marshall Islands' mangroves are unusual in that they are found primarily inland, in landlocked bays of lagoons. They are found on just a few atolls such as Arno and Majuro, where the main species are *Sonneratia alba* and *Bruguiera gymnorrhiza*, respectively.

A brief history of the Marshall Islands' forests

The youngest of the Marshall Islands breached the surface of the ocean only 2,000–4,000 years ago. The first people to arrive here about 2,000 years ago found very young islands with recently established ecosystems. These they enriched with the food crops and trees they brought with them to develop their agroforestry systems.

The islanders developed effective natural resource management practices that enabled them to grow food crops in the challenging environment of the Marshall Islands. These practices were passed down through

The atolls of the Marshall Islands provide important nesting sites for seabirds such as the red-footed booby. *Randy Thaman*

the generations. They included careful composting of organic matter and returning it to the soils to improve their fertility and structure. A taboo system protected the more vulnerable resources. This traditional system was sustainable and produced enough food for the small population.

Contact with Europeans led to some major changes in the atoll vegetation. In the late 1800s, German traders arrived and established the first coconut plantations for the commercial production of coconut oil and later copra. Large areas were planted with coconut trees. Coconuts and copra remain a significant industry for the Marshallese today.

The Marshall Islands, and their trees and forests, suffered a great deal during the Second World War. The islands were the scene of some of the most intensive fighting late in the war. Kwajalein Atoll, which was the administrative centre of the occupying Japanese, suffered the most intensive artillery bombardment in the entire Pacific war. Other islands also came under fire as the Americans fought to liberate the islands.

After the war, in 1947 the islands were placed under the US as a UN Strategic Trust Territory. Between 1946 and 1958, the US conducted 67 nuclear tests above and around Bikini and Eniwetak Atolls.

In 1986 the Marshall Islands became a self-governing democracy in free association with the US. Since then, there has been extensive infrastructural development, especially around the urban centres of Majuro and Ebeye. The majority of the population now lives an urban life, relying on imported foods and other goods. Traditional knowledge is being lost as the importance of traditional agroforestry systems is reduced.

Sago palm

Sago palms (*Metroxylon* spp.) are found across much of Melanesia, Micronesia and parts of Polynesia. Some species are native to Melanesia, while others were carried to remote islands by early travellers because of their importance as a staple food.

The trunk contains large amounts of edible starch, which can be eaten raw or, more usually, is processed into a flour. In the past, whole logs were baked and taken as food on long canoe voyages. Today, sago palm is a staple food in parts of PNG, and a food supplement on many other Pacific islands.

There are several species of sago palm. *M. sagu* has the highest amounts of starch, and is grown commercially in PNG as well as in Malaysia, Indonesia and the Philippines. The other species include *M. amaricum* found in the FSM and the Marshall Islands; *M. paulcoxii* in Samoa; *M. salomonense* in Solomon Islands; *M. vitiense* in Fiji; and *M. warburgii* which is found across Melanesia and into Polynesia.

In Fiji the growing tip ('heart of palm') is harvested for sale, mainly to Indians to make curries (see photo). Cutting the growing tip kills the tree, and this use has significantly depleted and threatens *M. vitiense*.

Sago palm is also greatly valued in many places as a high-quality long-lasting thatch. Leaves are woven into sheets which are used for roofing or lining walls. On some islands, this is the primary use for sago palms.

Sago palms grow in lowland rainforest and in freshwater swamp forest. They are fast growing, and tolerate a wide variety of soils. They can be used sustainably if they are replanted. There is currently a sago conservation and rehabilitation project in Fiji led by NatureFiji-Mareqeti Viti.

Richard Markham

Guettarda, the national tree of the Marshall Islands. *Randy Thaman*

Forest ownership and management

Land, and therefore forest, in the Marshall Islands is owned and managed under a traditional system. There are three title holders to a parcel of land – the *iroij* (king), the *alab* (chief), and the *dri-jerbal* (worker). All title holders contribute to the development of the land, with the worker being the main manager of the land. The land title is passed on to someone of the same clan usually through a maternal inheritance. The system is complex and, although it is understood by the older generation, the younger generation are less interested in the land and the system is gradually disintegrating.

There is no national forest policy at the present time. The Agriculture Division of the Ministry of Resources and Development has the mandate to promote sustainable agriculture, which includes agroforestry. Among other activities, the Division promotes rehabilitation of agroforestry systems, and replanting schemes using appropriate species.

The Marshall Islands has signed the Micronesia Challenge, a commitment by Micronesian countries to effectively conserve 30% of nearshore marine and 20% of terrestrial resources by 2020. In 2008, the country presented its National Conservation Area Plan for the Marshall Islands, which is a strategy to achieve these targets.

In 2010, the country completed a Statewide Forest Resources Assessment and Resource Strategy (SWARS). This provides an inventory of, and a management strategy for, the forests of the Marshall Islands.

Importance of the Marshall Islands' forests

Conservation of biodiversity

The biodiversity of the Marshall Islands includes not only the natural flora and fauna, both on land and in the ocean, but also their agrobiodiversity, which has been developed over centuries of farming. This agrobiodiversity includes, for example, a rich heritage of local cultivars of pandanus, coconut palms, breadfruit and giant swamp taro.

The Marshall Islands' natural flora includes about 80 plant species, of which only one (a grass) is endemic. Endemic animals include a subspecies of the Micronesian imperial pigeon (*Ducula oceanica*) found in the Ratak chain of the Marshall Islands, the Arno skink (*Emoia arnoensis*), and about 25 insects, some of which are found on only one island.

Bikar and Bokak are important breeding sites for seabirds, including great frigatebirds (*Fregata minor*), brown boobies (*Sula leucogaster*), red-footed boobies (*Sula sula*), wedge-tailed shearwaters (*Puffinus pacificus*), red-tailed tropic birds (*Phaethon rubricauda*), sooty terns (*Sterna fuscata*), white terns (*Gygis alba*), and brown noddies (*Anous stolidis*).

Protection for agroforestry

Without protection from the salt spray and wind, it would be impossible to develop agroforestry systems on the Marshall Island atolls. Natural coastal forest strips of salt- and wind-tolerant tree species provide the perfect protection behind which the islanders can grow breadfruit, bananas, citrus trees, other fruit trees, taro and other useful plants. Trees also play a major role in recycling nutrients, which is critical to the health of agroforestry systems. Guettarda (*Guettarda speciosa*), the Marshall Islands national tree, is well known for its role in improving soil fertility through its leaf fall.

Protection of freshwater resources

The islands have no surface freshwater apart from runoff during heavy rain. Instead, the larger atolls derive their freshwater from an underground lens or water table that 'floats' above the seawater within the permeable limestone rock of the atoll. Both natural forest ecosystems and agroforests are dependent upon the freshwater lens, and also contribute to maintaining the quality of the water.

This fragile water source is critical to survival on the islands and can only be replenished with rainfall. During

droughts or due to overuse on the more populated atolls, the lens is reduced and becomes more saline which can lead to the death of many trees and other plants.

Economic value

Coconuts provide livelihoods for many Marshallese. Coconut oil and copra cake are the country's leading exports.

Handicrafts made from wood from trees such as calophyllum (*Calophyllum inophyllum*), cordia, and tropical almond (*Terminalia catappa*) comprise a small export business. Pandanus is also very widely used to make many products ranging from food and juice to handicrafts and furniture (see box).

Threats to the Marshall Islands' forests

Population increase and urban development

In less than 100 years the population of the Marshall Islands has increased from approximately 10,000 people to around 55,000. About 70% of these people live in the two urban centres of Majuro and Ebeye. The rising populations on these two atolls have been accompanied by urban development that has contributed directly to deforestation.

Loss of traditional knowledge and traditional conservation practices

As more and more Marshallese move to live in the urban centres, they are moving away from their traditional agroforestry systems, and losing knowledge of how to manage these systems and of the important plants within them. Systems that provided food and countless other products for centuries are directly under threat.

Population increase and urban development pose a threat to forests, especially in Majuro and Ebeye. *Randy Thaman*

Traditional conservation practices are part of the agroforestry systems. Governed by *iroij*, they were designed to protect and manage natural resources. Today many of the *iroij* no longer live on the atolls they represent, and few atoll communities have living memory of traditional taboo or *mo*. In some cases, the loss of knowledge, absence of the *iroij* and a lack of enforcement of traditional practices has led to unchecked harvesting of natural resources.

Climate change

Climate change is a major threat to the Marshall Islands and to their forests. The islands are particularly at risk from storm surges and king tides in the short to medium term, and complete inundation in the future. Any rise in sea level causes increased salinity and salt water pollution of the fragile freshwater lenses that sustain terrestrial ecosystems, particularly agroforestry systems that include non-coastal plants.

Invasive species

Invasive plant species currently in the Marshall Islands include *Turnera ulmifolia*, *Bidens alba*, *Sphagneticola trilobata*, *Leucaena leucocephala* and several weeds and grasses. Introduced insects causing concern include fruit flies, mealybugs and coconut scale. Although the Marshall Islands have not so far suffered damage from invasive species to the extent of some other island nations, they pose a very serious threat because of the low biodiversity of the islands. This means that ecosystems can be easily destabilised when a new species is introduced.

Looking to the future

The recently completed Marshall Islands SWARS drew on two significant documents that lay out the country's plans for its future sustainable development, including sustainable management of forests. These documents are the Ministry of Resources and Development's Strategy and Action Plan 2005–2010, and the National Conservation Area Plan for the Marshall Islands released in 2008. The SWARS, with its focus on forest resources, identified the following four priority issues: biodiversity, food security and sustainable livelihoods, coastal reinforcement, and urbanisation. It presents strategies for addressing these issues over the coming years.

The issue of biodiversity conservation is largely

addressed in the National Conservation Area Plan. Strategies include the designation of special reserves and conservation areas, including 'traditional land use conservation areas' that would ensure the survival of traditional agroforestry systems. Strategies addressing the second priority issue, food security and sustainable livelihoods, include efforts to both promote agroforestry and to increase production in these systems. There are also plans to promote traditional crops and urban home gardens. Strategies to contain invasive species are included under both of these priority issues.

Under coastal reinforcement, strategies include replanting of native coastal trees and shrubs, especially around urban areas where these have been cleared. Strategies addressing urbanisation include raising awareness and educating people about the importance of trees and forests, particularly as this relates to their traditional cultural importance.

The future of the forests in the Marshall Islands will depend largely on the people rediscovering this heritage, which includes a deep understanding of how to live in harmony with the environment. The revitalisation of traditional agroforestry systems will contribute to sustainable forest management and to a healthier lifestyle for the people of the Marshall Islands. The trend towards urban living and reliance on imported nutritionally low quality foods has been accompanied by increasing rates of lifestyle diseases like diabetes and obesity. A return to diets based on healthy, locally produced foods will not only address this, but also makes economic sense for the country.

A sustainable future will depend on raising awareness of the importance of forests, especially among urban dwellers who are in danger of losing touch with their natural heritage. *Randy Thaman*

Commercialising pandanus products

The Marshallese have developed many useful varieties of pandanus. A local company, Robert Reimer Enterprises, has recently begun a new line in pandanus food products and is hoping to develop local and export markets for these nutritious and delicious drinks and foods. The products include juice, baby food, syrup and jam. The company began processing pandanus in 2007 and is in the process of scaling up operations. It is working on improving production processes and improving output in terms of both quality and quantity. Better treatment, handling and packaging will increase the life of the products, opening up new market options. The company has also been carrying out awareness-raising activities on pandanus and its products for both locals and tourists. For example, a Pandanus Festival was held in 2009 during which visitors were invited to taste the different products and to give useful feedback that the company is now using as it develops its business.

Apiame Cegumalua

Nauru

Anne Moorhead, Randy Thaman and Julie Ohlson

Phosphate mining has changed the face of Nauru. *Randy Thaman*

Summary

Nauru's forests have been almost completely destroyed by phosphate mining over the last 100 years. Today the country is in economic and environmental crisis. Only forest remnants and scattered trees remain, but these are important to Nauru's recovery and future sustainability as they can be used to propagate new plants for replanting schemes. Carefully selected non-native species also have a role in reforesting Nauru, particularly where soils are very degraded and native species are unable to establish. Rehabilitating the mined out lands and replanting with native and other useful species, and restoring and enriching agroforestry and local food systems, hold the key to economic, cultural, nutritional and environmental recovery for Nauru.

Nauru's forests

Nauru is a small raised limestone island that reaches 70 m above sea level, with low-lying freshwater Buada Lagoon in its centre. The central plateau was called 'Topside' by the phosphate miners, and the coastal strip

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where people live was called 'Bottomside'. These names are now widely used in Nauru. Between the two is an area of escarpment, sloping in some parts and forming steep cliffs in others.

Before phosphate mining began, Topside and the escarpment were covered with indigenous forest. Calophyllum (*Calophyllum inophyllum*) was the dominant tree. Other species included Pacific banyan (*Ficus prolixa*), tropical almond (*Terminalia catappa*), guettarda (*Guettarda speciosa*), and the shrub scaevola (*Scaevola taccada*). Groves of edible pandanus (*Pandanus tectorius*) were also planted on Topside and on parts of the escarpment. Over the years, this forest has been progressively removed to reach the phosphate deposits beneath. Small remnants of the forest and scattered trees are now all that is left in the few areas that have not been mined, and in some areas on the escarpment and around Buada Lagoon.

Where mining operations have been completed the vegetation ranges from bare land in recently mined areas to very limited natural regeneration, even where operations were completed over half a century ago. In some areas introduced casuarina (*Casuarina equisetifolia*) has established sparse populations, and along some roadsides and undeveloped areas there are stands of introduced leucaena (*Leucaena leucocephala*) and red-bead tree (*Adenanthera pavonina*).

On some parts of the escarpment there are stands of pisonia (*Pisonia grandis*). This is the main nesting tree for noddy terns (*Anous* spp.), a traditional delicacy, and other seabirds. Beach hibiscus (*Hibiscus tiliaceus*) and tropical almond are also common. There are also individuals of fish poison tree (*Barringtonia asiatica*), lantern tree (*Hernandia nymphaeifolia*), *Ochrosia elliptica*, and the rare small fruit tree *Aidea racemosa*.

There is little remaining coastal forest, as this has been cleared for urban development. Stands of coconuts (*Cocos nucifera*) are found on less-developed areas of coast along with patches of scaevola. There are also scattered individuals of tree heliotrope or *irin* (*Tournefortia argentea*), cordia (*Cordia subcordata*), milo (*Thespesia populnea*), lantern tree and calophyllum. Small areas of mangroves (*Bruguiera gymnorrhiza* and *Rhizophora stylosa*) also remain, mainly in the northeast of the island.

How Nauru's forests were lost

Before phosphate was discovered, Nauruans had a traditional island lifestyle that was closely associated with the land and its plants and animals, as well as the

Calophyllum, once the dominant tree, now exists only as remnants. *Randy Thaman*

Introduced casuarina has established some sparse stands. *Randy Thaman*

ocean. The forests provided food, drinks, building and boatbuilding materials, tools, clothing, fuel, medicines, dyes, ornaments and many other products and services. Nauruans lived in harmony with their environment, and derived from it most of their material and spiritual needs.

The phosphate deposits, which accumulated on the island over thousands of years from fossilised seabird guano, were discovered at the start of the 20th century, at a time when farming was a fast growing industry in many parts of the world. Phosphate was very valuable as fertiliser and mining operations soon began, spelling the beginning of the end for Nauru's forests.

The Nauruan lifestyle changed very quickly. Income from phosphate sales meant that people no longer needed to depend on their environment for food and other products, but could afford to buy imported substitutes. For several decades Nauruans enjoyed a high standard of living, although a great deal of the income and capital from phosphate mining was spent unwisely. And as the forests and trees disappeared, Nauruans no longer had any option but to import their food and other products. As a result of the shift from their traditional nutrient-rich diet to a diet of nutritionally poor imported foods and drinks, and a change to a sedentary urban lifestyle, Nauru now has some of the highest rates of diseases such as diabetes, cardiovascular disease and obesity.

Today, the phosphate reserves are almost exhausted, most of the forests and many of their animals are gone, and the country is dependent on imports and foreign aid. Living standards have fallen, and the government faces bankruptcy. For relatively short-term gains, Nauruans have lost their natural heritage and with it their forests and trees, and much of their traditional culture.

The importance of restoring Nauru's forests

Restoration and protection of the country's forests and trees is one of the most cost-effective ways, as well as the most culturally, nutritionally and environmentally appropriate way, of ensuring a sustainable future for Nauru.

Rebuilding a sustainable economy

Rehabilitating the mined out lands and replanting with native and other selected useful species, and restoring and enriching agroforestry and local food systems, holds the key to economic recovery for Nauru. Once these resources have been restored, Nauruans will again be able to benefit from the products and services they provide. The country will no longer have to rely so much on imports and, with careful management, a more sustainable economy and society can be developed. With the depletion of the phosphate deposits, Nauru has few other natural resources that can be exploited for export, and sustainable island life must therefore be based on self-sufficiency.

Conserving and restoring biodiversity

Because of its small size and remoteness, Nauru has always had very limited biodiversity, and this has been further reduced with the destruction of the forests. To build resilience in the face of future uncertainty – for example that associated with climate change, and fluctuating world food prices – it is critical to restore the island's biodiversity.

Planting trees and restoring the forests will also restore

Mangroves are still found in the northeast of Nauru. *Randy Thaman*

Calophyllum

Calophyllum (*Calophyllum inophyllum*) is a coastal tree species growing extensively throughout the tropics. In the Pacific islands it is valued for its fine reddish wood, and an oil obtained from the nuts. It is also important as a coastal protection species, and is very wind and salt tolerant.

Calophyllum is often logged from the forest for its timber, which is highly valued for furniture, boat building and woodcarving. Oil from the nuts is traditionally used for massage, and medicinally for burns and skin ailments. It is also sometimes burned in lamps. The oil is produced commercially in Vanuatu, Fiji and Tahiti, and commands a high price on the internet. The fragrant flowers are used to scent hair and bark cloth, and in traditional leis.

Randy Thaman

habitats for wildlife, especially birds. A relatively small number of bird species have been recorded from Nauru, about 25 species, nine of which are thought to be resident. Many of these birds are culturally important to Nauruans. Hunting of brown and black noddy terns (*Anous stolidus* and *A. minutus*) has a long tradition in Nauru and provides an important ceremonial food and source of protein. Frigatebirds (*Fregata minor*) are kept as pets and are the focus of ceremonial competitions. Of global conservation significance, Nauru has one endemic bird species, the Nauruan reed warbler (*Acrocephalus rehsei*).

Challenges to restoring Nauru's forests

Restoring Nauru's forests and trees will not be easy. There are particular challenges that will need to be addressed, along with the considerable practical and technical efforts and financial resources that will be needed.

Loss of native species

Sixty-three native plant species have been recorded from Nauru, and about half of these have been lost or reduced to very small numbers with the clearing of the island's forests. Native species that have evolved and adapted to Nauru's conditions, and varieties of food and medicinal plants that have been selected over the centuries by Nauruans for different uses, are valuable genetic resources for rebuilding Nauru's environment. These lost or threatened species and varieties need to be recovered, culturally rediscovered, and protected.

Invasive weeds

The removal of Nauru's natural vegetation has allowed invasive plants to establish in many parts of the island. While some are useful, others are not – and all reduce grow-back of native species. Leucaena, for example, was introduced as a quick-growing windbreak and because it fixes nitrogen in the soil. It has now spread to areas of Topside, the escarpment and the coastal plain and is inhibiting regrowth of native species. The red-bead tree, casuarina and Panama cherry (*Muntingia calabura*) are similarly actively spreading on the mined land. Low-growing weeds such as wedelia or trailing daisy (*Sphagneticola trilobat*) are also spreading rapidly, especially around Buada Lagoon, and preventing the growth of native tree seedlings.

Loss of traditional knowledge

Traditional knowledge of Nauru's plants and trees has been lost along with the forests. Many of the older generation who knew the uses of the plants and trees, and how to grow them, are no longer alive. Wild food

Phosphate has been exported from Nauru since early in the 20th century, providing significant income for the country but spelling disaster for Nauru's forests. *Randy Thaman*

Frigatebirds are kept as pets and used in ceremonial competitions. *Randy Thaman*

and medicinal plants, so important for health in the past, are in many cases lost or not known by the current generation. Nauruans will need to relearn about their natural and cultural heritage as the forests are restored and agroforestry and food systems enriched.

Land ownership

Nauru is divided into more than 600 separately owned parcels of land. While these traditionally belonged to families, actual ownership is with individual family members who pass on their land to their descendents. This means that today each parcel of land has many shareholders. Reaching consensus on future land management and tree planting will be difficult and complicated.

Looking to the future

Nauru faces an uphill task to restore its damaged environment, but this will be essential if the country is to build a sustainable future. By replacing and enriching lost inland, escarpment and coastal forests, including mangroves, and conserving and developing better agroforestry and food systems, Nauru will be able to restore ecosystem services, ensure food and economic security and health for its people, and rediscover its lost culture.

There are currently three strategies addressing land rehabilitation in Nauru – the government's National Sustainable Development Strategy (2005–2025), the Nauru Rehabilitation Corporation's Five Year Strategy ((2007–2012) and the Sustainable Land Management Milestones. The National Sustainable Development Strategy has broad goals in areas such as land use, environment and agriculture. The Nauru Rehabilitation Corporation deals with the practicalities of land rehabilitation and the development of that land according to agreed land use plans. The Sustainable Land Management Unit operates at the community level, engaging people in the process of restoring a sustainable environment. The Milestones were developed following a public consultation in April 2010. These three groups will need to work together towards restoring the trees and forests of Nauru over the coming years.

Nauru's program for the recovery of its trees and forests has three key areas: the conservation of native trees and plants that still exist; rehabilitation and replanting of the mined lands, escarpment and selected coastal areas; and the improvement of agroforestry systems and food gardens.

The plants that still exist on Nauru can provide material to propagate new plants for replanting schemes. These species are already adapted to the unique conditions

Many Nauruans are returning to growing their own food in urban agroforestry systems. *Randy Thaman*

on Nauru, and restoring some of the original habitats will contribute to recovering the natural biodiversity. For example, reforesting coastal and upper escarpment areas with native species such as pisonia, cordia, tropical almond and lantern tree will restore habitat for the culturally important noddy terns. Where native tree species or varieties have been lost, these can be sought on nearby islands and reintroduced.

There are also non-native species that could have a role in reforesting Nauru, particularly where soils are very degraded and native species might be unable to establish.

Restoring Nauru's forests will require an intensive program of planning, planting and post-planting care until new trees are fully established. In 2010, a nursery was beginning to take shape as a first step in this program.

With the economic downturn, many Nauruans are returning to growing their own food, medicinal plants, plants for leis and garlands, and other products. There are many small food gardens and agroforestry systems in the urban areas, both on the coastal plain and around the lagoon, and these can be enriched and expanded. Agroforestry systems on the island have developed over centuries, and include many introduced species. Again, the most valuable will be those species and varieties that have already shown themselves to grow well in Nauru.

The next generation of Nauruans depend on restoration of their forests for a sustainable future. *Randy Thaman*

Reforesting Nauru

Because phosphate mining removes the phosphate-rich soil, the first step in reforestation is to redevelop the soils. The mining leaves tall coral pinnacles that must be broken and levelled before the ground is compacted with bulldozers. The pinnacles are then crushed and placed on the compacted ground as a substitute for subsoil. A layer of rejected phosphate soil is then added, followed by topsoil and mulch. This recreated soil is then ready for planting.

Planting will be done following an agreed upon land use plan in which areas have been identified for agroforestry, conservation, and other uses. Nurseries will propagate and supply appropriate seedlings for the different areas.

This practical work will need to be supported by education and awareness-raising, capacity building, policy and legislation. A community-based pilot project is an important next step to demonstrate the feasibility of rehabilitating and reforesting Nauru.

SPC

Northern Mariana Islands

Anne Moorhead and Margie Falanruw

Northern Mariana Islands at a glance

Number of islands: 14 (6 inhabited, but only 3 with significant populations)

Total land area: 457 km^2

Population: 63,072

% population urban/rural: 90/10

GDP per capita: US$12,638

Main drivers of economy: Financial assistance from the US, tourism, garment making

Most of Saipan's natural forest has been cleared for development and agriculture. *USDA-NRCS*

Summary

The natural forests of the Commonwealth of the Northern Mariana Islands (CNMI) include tropical dry forest and limestone forest. The northern islands are mostly uninhabited and undisturbed, while the three inhabited islands in the south, Saipan, Tinian and Rota, have been most highly impacted by humans. Today, wildfires, invasive species (including feral goats, pigs and cows) and urban development (on the three main islands) present major threats to the forests. The country has committed to the Micronesia Challenge, which includes a commitment to conserve at least 20% of its land resources by 2020. The CNMI's Statewide Forest Resources Assessment and Resource Strategy (SWARS), completed in June 2010, proposes a 5-year plan for the country's forests with the three themes: conserve working forest landscapes, protect forests from harm, and enhance public benefits from trees and forests.

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The forests of the Northern Mariana Islands

A north–south chain of 10 high volcanic islands and four raised limestone islands comprises the Commonwealth of the Northern Mariana Islands (CNMI). Almost the entire population of the country lives on the three southerly islands of Saipan, Tinian and Rota, with the majority on Saipan, the largest island.

The islands have relatively low biodiversity, with around 500 plant species in total, including native and introduced species. The dominant natural forests are tropical dry forests on the volcanic islands because, with the distinct dry season, rainfall is not high enough year round to support rainforest; and limestone forest on the limestone islands.

The northern islands are mostly uninhabited and undisturbed, except where animals are grazed. They are geologically young islands and some, such as Anatahan, Pagan and Uracas, are still volcanically active. The natural vegetation is pioneer communities and forest. Casuarina (*Casuarina equisetifolia*) is common as it is one of the first trees able to colonise after volcanic activity has ceased. Pisonia (*Pisonia grandis*) dominates in some of the forest patches. *Elaeocarpus joga*, which occurs across Micronesia, and *Aglaia mariannensis*, an understory tree found only in the CNMI, are dominant in others. Asuncion has a forest dominated by the endemic *Terminalia rostrata*.

The southern islands are geologically older, limestone islands. Natural vegetation here is limestone forest, although significant areas remain only on Rota and in pockets on southwest Tinian. Tree species include vesi or *ifit* (*Intsia bijuga*), beach hibiscus (*Hibiscus tiliaceus*) and pandanus (*Pandanus* sp.) in the lower and drier areas; *Serianthes nelsonii*, *Heritiera longipetiolata*, *Artocarpus* spp., and *Osmoxylon mariannense* on the higher terraces; and in the highest and wettest parts, trees such as *E. joga*, *Hernandia labyrinthica*, *Fagraea berteroana*, *Guettarda* sp. and Pacific banyan (*Ficus prolixa*).

The coast of Rota. *CT Snow*

Asuncion. *Margie Falanruw*

Saipan's high population density means that most of the accessible natural forest has been cleared for development and agriculture. Most trees in low-lying areas are now part of agroforestry or urban forestry systems. An area of more than 60 ha in the highlands is however protected as a conservation area and has secondary forest with native and introduced species.

Tinian experienced heavy fighting during the Second World War, and the island has very little remaining natural vegetation.

After the Second World War, in an attempt to restore vegetation and reduce soil erosion, leucaena (*Leucaena leucocephala*) was widely planted on both Saipan and Tinian. The tree quickly became invasive and now dominates much of the vegetation on both islands. Similarly, *Acacia confusa* was planted during the Japanese administration, and extensive thickets of this small tree occur in the highlands of Saipan and in parts of Rota.

A brief history of the CNMI's forests

The indigenous Chamorro people have lived on the Northern Mariana Islands for more than 3,000 years. Before the arrival of Europeans, the main impacts on the forests were from burning and clearing for small-scale agriculture. However, low population densities limited the damage.

Casuarina

Casuarina (*Casuarina equisetifolia*) is a hardy salt-, drought- and wind-tolerant tree that grows on the coasts, but is extremely adaptable and is also found inland on a wide range of soil types. Its ability to fix nitrogen means it can grow in poor soils when few other trees can survive. It often grows as a pioneer species for example after a volcanic eruption. It is native to Melanesia and an ancient introduction across the rest of the Pacific region.

Casuarina wood was traditionally used for construction of buildings. It is also an excellent fuelwood; and the bark is widely used in traditional medicines. It is a fast-growing tree, and can reach 20 m in 12 years. Growing on the beach, it has an important role in coastal stabilisation and protection. As it is so hardy and adaptable, it can become invasive under some conditions.

Randy Thaman

The Spanish arrived in the mid-16th century and claimed the islands, which they later sold to Germany at the end of the 19th century. Copra production was promoted on Saipan, Tinian and Rota during the 19th century, and much of the lowland natural forest was cleared for coconut plantations. When the Japanese took the islands during the First World War, they changed the emphasis to sugarcane production on the fertile limestone soils. The Japanese also introduced and planted forests of *A. confusa*, to provide fuelwood.

Thus by the beginning of the Second World War, much of the natural forests on these three islands had already been cleared for agriculture or plantations. During the war, both Saipan and Tinian were the sites of major battles. As well as the many human casualties, much of the remaining forests and trees were destroyed. Tinian then became a US military base, and more land was cleared to accommodate personnel and infrastructure.

Former sugarcane and pineapple plantations on Saipan are now leucaena-dominated scrub. *USDA-NRCS*

By the end of the war, an estimated 95% of Tinian's forests had been removed.

Rota was not involved in the wartime battles, and today it has the most extensive intact natural forests in the country.

Forest ownership and management

Land is either publicly or privately owned in the CNMI. The government is in the process of redistributing some of the public land to indigenous private landowners.

CNMI is a signatory to the Micronesia Challenge, which is a commitment to "effectively conserve at least 30% of the near-shore marine and 20% of the terrestrial resources across Micronesia by 2020". The islands of Maug, Uracas, Asuncion and Guguan are protected and managed for conservation, with entry restricted to scientific research. Other protected sites, including Forbidden Island and Bird Island, permit access for educational and scientific purposes, while sites on Saipan, Tinian and Rota are less restrictive.

The Forestry Section of the Department of Lands and Natural Resources is responsible for the protection, management and improvement of forest resources on both public and private land. The Forestry Section works with private landowners to improve land management practices and support forest conservation on private land. Landowners are encouraged to develop a Forest Stewardship Plan with the Forestry Section and the Forestry Advisory Council.

'Commonwealth Forests' are multiple-use conservation areas managed for forest products, recreation, water and wildlife. The Forestry Section and the Division of Fish and Wildlife together manage the Commonwealth Forests.

Importance of the CNMI's forests

Conservation of biodiversity

Rota has the most intact limestone forest, and this forest is home to many rare and endangered plants and animals. Two trees, *Serianthes nelsonii* and *Osmoxylon mariannense*, are officially endangered – the latter is found only on Rota. Three endangered bird species – the Mariana crow (*Corvus kubaryi*), the Rota bridled white-eye (*Zosterops rotensis*), and the Mariana common moorhen (*Gallinula chloropus guami*) – are also found here, as well as one of the two native bats, the Mariana flying fox (*Pteropus mariannus*). Rota is also the last stronghold of the Marianas fruit dove (*Ptilinopus roseicapilla*), one of the most colourful and beautiful birds in Micronesia.

The uninhabited northern volcanic islands, especially Agiguan, Guguan and Maug, serve as roosting areas for seabirds; and the endemic Marianas megapode (*Megapodius laperouse*) occurs on all of the volcanic islands (with a few sightings on Saipan). Asuncion's *Terminalia* forest hosts many endemic species, including the Mariana flying fox, the Marianas megapode, the Micronesian starling (*Aplonis opaca*) and the Micronesian honeyeater (*Myzomela rubrata*).

Tourism

Tourism is the main industry in CNMI, with most visitors coming from Japan, Korea and China. Although numbers have declined in the last few years, tourism remains one of the most promising sectors for boosting the economy. Success will depend on managing the natural environment to preserve its beauty, both on land and in the sea.

Threats to the CNMI's forests

Invasive species

The scarlet or ivy gourd (*Coccinia grandis*), which was introduced to Saipan in the 1990s, is currently the most serious invasive species. It has spread rapidly and is now found over about 80% of the island. It poses a threat to the remaining natural forests and to agroforests and urban forests.

Feral goats, pigs and cows are present on some of the northern islands, and have damaged large areas of forest by their grazing. Without effective control they will continue to be a major threat on these islands.

Wildfires

Wildfires are often started by hunters to attract deer to the new seedlings that sprout following burning. As well as damaging trees and preventing regeneration, fires contribute to soil erosion and the replacement of forest and trees by degraded grassland and scrubland.

Urban development

The three inhabited islands, and in particular Saipan, have growing populations and associated urban and infrastructure expansion. The tourism industry is also contributing to urban expansion, mainly through the development of resorts on the coasts.

The government of CNMI is considering the possibility of relocating people to other, currently uninhabited islands to relieve population pressure. If this goes ahead, it poses a threat to forests on these islands.

Expansion of the US military presence on nearby Guam also has implications for the CNMI, especially Tinian, where there are plans to build rifle ranges, casinos and resorts to attract US military 'tourists'.

Looking to the future

The CNMI's Statewide Forest Resources Assessment and Resource Strategy (SWARS), completed in June 2010, proposes a 5-year plan for the country's forests. The SWARS identified the following three national themes:

- Conserve working forest landscapes
- Protect forests from harm
- Enhance public benefits from trees and forests.

Leucaena, an invasive, can be turned into poles for use on the farm. *USDA-NRCS*

Tourism is a promising developing sector, but also represents a threat to coastal forests. *USDA-NRCS*

Strategies under the first theme include identifying and conserving high-priority forest ecosystems for conservation, and promoting sustainable forest management in these areas. The second theme includes addressing threats posed by wildfire and invasive species. The third theme identifies the following benefits from trees and forests: air and water quality, soil conservation, biological diversity, carbon storage, forest products, forestry-related jobs, wildlife, wildlife corridors and habitat, and recreation. Proposed strategies include restoring watersheds, working with private landowners on forest stewardship, and a renewed focus on urban and community forestry.

Palau

Ann Kitalong

Palau at a glance

Number of islands: 487 (9 inhabited)

Total land area: 444 km^2

Forest cover: 80% (includes mangroves, plantations and agroforests)

Population: 20,518

% population urban/rural: 77/23

GDP per capita: US$8,423

Main drivers of economy: Tourism, fishing, agriculture

The forests of Babeldaob. *Ann Kitalong*

Summary

The Republic of Palau comprises the large volcanic island of Babeldaob and many smaller islands, including the unique Rock Islands. Much of the country's forests remain intact and relatively undisturbed, and the country has the highest biodiversity in Micronesia. Natural and plantation forests supply timber for local use and export; and many people depend on agroforestry systems for food and other products. In 2006 the President of Palau set up the Micronesia Challenge which sets ambitious conservation targets for land and ocean ecosystems. Today, an estimated 25% of Palau's land is protected. Palau is in a Compact of Free Association with the US, and in 2010 carried out a Statewide Forest Resources Assessment and Resource Strategy (SWARS) which identified key issues for Palau's forests, and strategies to promote sustainable forest management.

Palau's forests

The flora of Palau shares many common species with the Philippines and Indo-Malaysia, the source of much of its biodiversity. All forests in Palau are classified as

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lowland tropical rainforest, but within that category there are different types depending largely on the soil. Islands are either of volcanic origin or raised limestone islands or atolls, and this is reflected in the soils. Volcanic islands include Babeldaob, Ngerkebesang, Malakal and Koror; the raised limestone islands include Peleliu, Angaur and the Rock Islands; and the atolls include Kayangel, Pula Anna, Helen Reef and Tobi Reef, the westernmost island.

Babeldaob is the largest island, comprising 80% of Palau's land area. The natural vegetation is rainforest, although extensive areas, particularly in the south, have been cleared and are now grasslands. South of Babeldaob is Koror, the most densely populated island, with approximately 14,000 people. It is also the most developed of Palau's islands. Extending some 30 km south of Koror are the Rock Islands, a group of hundreds of mostly small, uninhabited, steep-sided raised limestone islands covered by limestone forest. They are home to many endemic plant species.

Rainforest on the volcanic islands is also known as volcanic forest. Where undisturbed, these are the most species-rich forests in Micronesia, with many endemic plants and animals. More than half of Palau's forest is volcanic forest. One of the most common tree species in these forests is *Campnosperma brevipetiolata*. Others include *Alphitonia carolinensis*, calophyllum (*Calophyllum inophyllum*), *Elaeocarpus joga*, *Gmelina palawensis*, *Maranthes corymbosa* and *Pterocarpus indicus*.

The forests of the raised limestone islands are also species rich, with common trees and shrubs including *Aidia racemosa*, *Badusa palauensis*, *Bikkia palauensis*, *Buchanania palawensis*, *Eugenia reinwarditiana*, guettarda (*Guettarda speciosa*), vesi or *dort* (*Intsia bijuga*), *Morinda latibractea*, *Pandanus dubius*, *Premna serratifolia* and scaevola (*Scaevola taccada*). Some adaptable species are found in both extremes of alkaline limestone soils and acid volcanic soils.

The coastal areas of volcanic islands and raised limestone islands and atolls also have coastal forests. Common species here include tree heliotrope (*Tournefortia argentea*), fish poison tree (*Barringtonia asiatica*), cordia or *kalau* (*Cordia subcordata*), lantern tree (*Hernandia nymphaeifolia*) and scaevola.

The Rock Islands. *Ann Kitalong*

Fruit bats: Friends of Pacific island forests

Fruit bats (mainly *Pteropus* spp.), or flying foxes, are a familiar sight on many Pacific islands, particularly at dusk when they take to the wing. Many islands have their own endemic species or subspecies of fruit bat. Their natural habitat is tropical forest, where they roost during the day and forage at night for fruit and nectar. They may travel as far as 60 km to seek food. Through this feeding behaviour they play an important role in pollination and seed dispersal of many different plant species, and help to maintain forest biodiversity. Along with other pollinators such as insects and birds, they thus play a crucial role in forest ecosystems.

Bats are an important part of the culture on many Pacific islands, and feature in myths and legends. They are also traditionally hunted for food in many countries.

Sadly, fruit bats are under serious threat on many islands, through loss of habitat and over-hunting. Some species are known to have already gone extinct, for example the large Palau flying fox (*Pteropus pilosus*) disappeared towards the end of the 19th century, and the Guam flying fox (*Pteropus tokudae*) was last seen in the late 1960s. Fruit bats mature late, generally produce only one young at a time, and care for their young for a long time. As a result, their populations do not increase very fast. Sustainable forest management must include protection of these and other vital species that together ensure healthy forest ecosystems.

Margie Falanruw

Mangrove forests, which make up more than 10% of Palau's forests, are found along most coastlines of the volcanic islands and on the protected coastal flats of some of the limestone islands and atolls, particularly on Peleliu and some of the Rock Islands. There are more than 24 mangrove species in Palau, with *Rhizophora* spp. often the dominant species.

Other types of forest found in Palau include coconut (*Cocos nucifera*) plantations, agroforests, mahogany (*Swietenia macrophylla* and *S. mahagoni*) plantations, urban forest and casuarina (*Casuarina equisetifolia*) forest. Casuarina is a native and highly adaptable tree and is the dominant tree in parts of Angaur, Peleliu and some of the Rock Islands.

A brief history of Palau's forests

The larger and inhabited islands of Palau have been significantly impacted by human activities, particularly since the start of the 20th century.

In 1899 Palau came under German rule, and exploitation of natural resources for export began. Mining of bauxite and phosphate on Babeldaob and Angaur caused the destruction of areas of forest on these islands. Coconut plantations were established at about the same time on many islands, to supply copra and coconut oil for the world market. Copra was the leading industry in Palau until the 1970s, when tuna fishing took over.

After the Japanese seized the islands in 1914, mining activities continued and large areas of southern Babeldaob were cleared of their natural forest to make way for pineapple and sugar plantations. The Japanese also planted the first mahogany plantations on Babeldaob.

The Americans fought the Japanese for Palau in 1944, in the Battle of Peleliu. As a result of the battle and the subsequent military occupation, some of the forests of Peleliu and Angaur were damaged or destroyed. Large areas of forest were also cleared on Koror and Babeldaob for communication stations and fortifications.

The various foreign administrations over the years introduced many plants to Palau for timber, food and medicine. Plantations of coconut, pineapple and cocoa were established throughout Babeldaob. In 1922 the South Seas Industrial Experiment Station began the introduction and propagation of economic and subsistence plants. Many trees now seen as invasive species were introduced at this time, for example the shade tree *Paraserianthes falcataria* (also called *Falcataria moluccana*), and the red bead tree (*Adenanthera pavonina*).

Forest ownership and management

About 30% of Palau's land is privately owned, while the remainder is public land under the jurisdiction of the individual states (Palau has 16 states) and a small portion is owned by the national government. The state land authorities therefore play a major role in forest management.

Government bodies involved with the management of forests include the Palau Natural Resource Council, which is mostly an advisory body; the national Forestry

Program; and the Urban and Community Forest Council. The Palau Conservation Society is an active NGO that works closely with the government on forest conservation issues.

Private landowners are eligible for technical assistance from the Forestry Program, including help with the development of forest management plans. The Forestry Program has developed guides for tree planting for many useful species, and also propagates and distributes saplings to landowners.

The Micronesia Challenge was launched by Palau's President in 2006, and is a commitment to effectively conserve at least 30% of marine resources and 20% of terrestrial resources across Micronesia by 2020 (see box on page 96). Palau is leading the way, with currently 25% of its land protected. This includes the Ngardok Nature Reserve, the Ramsar wetland site, and the Ngiwal watershed.

Palau is in a Compact of Free Association with the US, and in 2010 carried out a Statewide Forest Resources Assessment and Resource Strategy (SWARS). With input from the community at all levels, the SWARS identified key issues for Palau's forests, and strategies to address them. The SWARS provides a framework for tackling the problems facing Palau's forests, and moving towards sustainable forest management.

Importance of Palau's forests

Conservation of biodiversity

Palau has the highest terrestrial biodiversity of all the countries in Micronesia. There are approximately 1,260 species of plants, of which 830 species are native and at least 194 are endemic. Many of these are found on Babeldaob.

Palau has 50 resident bird species, 10 of which are endemic. There are two species of bat, the Palau flying-fox (*Pteropus pelewensis*) and the sheath-tailed bat (*Emballonura semicaudata palauensis*); a third species, *Pteropus pilosus*, is now thought to be extinct. Palau also has an endemic frog, *Platymantis pelewensis*, as well as at least nine endemic lizards and two endemic snakes, the Palauan blind snake (*Ramphotyphlops acuticauda*) and the bevel-nosed boa (*Candoia superciliosa*). Palau also has an estimated 5,000 species of insects, of which over 300 are known to be endemic.

The green turtle (*Chelonia mydas*) and hawksbill turtle (*Eretmochelys imbricata*) nest regularly in Palau and depend on intact coastal forests and beaches for their nesting grounds. The critically endangered hawksbill turtle nests mainly in the southern lagoon of Koror. The endangered green turtle nests mainly in the Southwest islands. Coastal erosion and coastal deforestation threaten the nesting habitat of both turtle species.

Tourism

Tourism is currently the top industry in Palau. Annual numbers of tourists are approaching 80,000 and are predicted to increase to 100,000 by the end of 2012. Most visitors come from Japan, Taiwan and Korea. Tourists come for the natural beauty of the islands, for their beaches and for diving on the reefs. Healthy forests both inland and on the coast are vital to maintain this industry.

Timber

Palau's forests provide timber for domestic needs, while its plantations supply both domestic and a small export market. Native species harvested from the forests include calophyllum and *Pterocarpus indicus*. Calophyllum is also grown in plantations, and exported along with mahogany.

Agroforestry is the mainstay of traditional life in Palau. *Ann Kitalong*

Agroforestry

Agroforestry is the mainstay of traditional life in Palau and supplies most of the daily needs of the majority of the people. Many different trees are grown alongside the staple root crop taro using complex irrigation and drainage systems, crop rotation and organic fertilisers.

Threats to Palau's forests

Population growth and urban development

Population growth and accompanying development are a threat on several of the islands, especially Babeldaob and Koror. About 70% of the population lives on Koror, an area that has seen some of the highest levels of urban development and population growth in recent years.

The Ngerikiil watershed – Palau's most important watershed, supplying nearly 80% of the population – is under threat from several development projects. Housing developments are replacing forested areas on the lower slopes, while expansion of the international airport is also encroaching on the watershed.

In 2007, an 83 km circular highway was completed on Babeldaob. While this has opened up the island for tourism and development, there are negative impacts on forests. Housing and infrastructure are expanding in the lowlands at the expense of the natural forests, while previously inaccessible upper watersheds with old growth forests and swamp forests are now accessible and more vulnerable.

Climate change

Sea level is projected to rise by between 0.2 and 0.9 m by 2100. Many low-lying parts of Palau will be affected, particularly if sea level rise is at the higher end of the projection. The atoll state of Kayangel, for example, will be completely under water, as will all of Koror's coastal infrastructure. The Rock Islands, which are a major tourist attraction as well as home to many endemic plant species, will also be inundated. Agroforests near to the coast will be affected by seawater intrusion, which will damage food production.

Fire

Wildfires are a frequent occurrence on some of Palau's islands, and are preventing regrowth of forest in grassland areas that were previously cleared for agriculture. There is limited fire-fighting capacity in Palau, and during the dry season uncontrolled fires can burn over large areas. Most wildfires are started by people, to clear land for farming, paths for hunting, or simply as arson. Invasive weeds which are often highly flammable have added to the problem.

Roads and other infrastructure are damaging the forests. *Randy Thaman*

Invasive species

Many invasive plants have become established in Palau, but so far they have not had major impact on the natural ecosystems. They do however pose a threat in the future if not managed. Examples are the weeds mile-a-minute (*Mikania micrantha*), cogon grass (*Imperata cylindrica*) and *Chromolaena odorata*, and introduced trees such as African tulip tree (*Spathodea campanulata*), *Paraserianthes falcataria* and the red bead tree.

The greater sulphur-crested cockatoo (*Cacatua galerita*) was introduced to Palau in the 1940s and has established populations on the limestone islands and numbers are increasing on Babeldaob. The cockatoos feed on the growing tips (hearts or meristems) of the endemic palm *Hydriastele palauensis* and are responsible for killing large stands of these trees.

Introduced macaque monkeys (*Macaca mulatta*) have also become established on various islands, particularly on Angaur, where they are having significant impacts on crops and agroforests.

Looking to the future

Palau's forests and ecosystems are still mostly intact, and it is important to ensure that they are safeguarded in the future. Palau's traditional culture, as well as a healthy economic and environmental future for the country, depend on sustainable management of its forests.

Palau's recent SWARS identified key issues that need to be addressed to ensure this future. These are:

- Climate change
- Population growth and urbanisation
- Water quality and quantity
- Wildfire and public safety
- Conservation and protected areas
- Sustainable use of forest resources
- Urban forest sustainability.

Strategies were outlined for moving forward on these issues, which provide a framework for managing Palau's forests over the next few years. Under population growth and urbanisation, for example, strategies include building capacity for land use planning, developing and implementing land use plans, and native tree propagation and planting in priority areas. Strategies for managing wildfires include developing methods for monitoring fires, carrying out awareness and education campaigns, and developing community-based fire response capability.

Plans for sustainable use of forest resources include rehabilitating and replanting coconut plantations so that the country, and especially rural communities, can benefit from the many coconut products. The Forestry Program will continue to promote planting of useful and native tree species, particularly in priority areas such as watersheds, and agroforestry systems.

Palau's traditional culture depends on sustainable management of its forests. *Ann Kitalong*

The Micronesia Challenge

Recognising the vulnerability of Micronesia's ecosystems, the Micronesia Challenge was set up to provide a framework for conservation across the region. The Federated States of Micronesia, the Marshall Islands, Palau, Guam and the Commonwealth of the Northern Mariana Islands have all committed to the Challenge, which has an overall goal to conserve at least 30% of ocean resources and 20% of land across Micronesia by 2020. These targets far exceed the latest global targets agreed by the UN in October 2010, which are 17% of land and 10% of oceans by the same date. The Nature Conservancy provides support and funding to the Challenge.

Practical work under the Challenge includes identifying priority areas for conservation, establishing these areas as protected under protected area networks, training and education, and developing supporting policy in the region. The Micronesia Conservation Trust has also been set up as a sustainable source of financing.

Palau is leading the way in Micronesia for the setting up of protected areas, and currently has 25% of its land under a protected area network. Financing is through an environmental fee in Palau and the Micronesian Challenge Trust.

The Micronesia Challenge sets a global precedent, and has inspired several island countries in other regions of the world, such as Fiji, Grenada and Indonesia, to adopt similarly ambitious conservation targets.

Sustainable agroforestry will provide food and other products for Palau's people into the future. *Randy Thaman*

Polynesia

Samoa. *Tolusina Pouli*

American Samoa

Dan Aga and Anne Moorhead

American Samoa at a glance

Number of islands: 7 (6 inhabited)

Total land area: 199 km^2

Forest cover: 85% (includes mangroves, urban forests and agroforests)

Population: 65,896

% population urban/rural: 50/50

GDP per capita: US$9,041

Main drivers of economy: Tuna processing

Primary rainforest in American Samoa. *Neil Gurr*

Summary

American Samoa has some of the most pristine forests in the Pacific, which contain many rare and endemic plants and animals. Of the seven islands only Tutuila has a significant population. Unique lavaflow forest has been cleared on the southern plain of Tutuila to allow for development, and the remaining forest is under threat. Even here, however, urban forests have been planted and are given high priority by the residents. This US territory recently completed a Statewide Forest Resources Assessment and Resource Strategy (SWARS) which outlines its plans for sustainable forest management over the coming years.

American Samoa's forests

American Samoa consists of seven islands: five inhabited high volcanic islands (Tutuila, Aunu'u, Ofu, Olosega and Ta'u), one inhabited atoll (Swains) and one uninhabited atoll (Rose). The largest island, Tutuila, has about 70% of the total land area. About 96% of the territory's people

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live on Tutuila, mostly on the southern coastal plain. Apart from this densely populated area, where forests have been cleared for agriculture and development, American Samoa has some of the most intact forests in the Pacific islands region.

The natural vegetation of the southern plain of Tutuila is called lowland lavaflow rainforest. Once covering about 1,200 ha, this forest has now been reduced to an estimated 11 ha. The lavaflow rainforest is characterised by very tall trees including giant banyan (*Ficus* spp.) and tava (*Pometia pinnata*). Many native animals depend on this forest.

The north of Tutuila is still mostly covered with natural forest, including some primary forest. The montane scrub vegetation on the summits of Tutuila's mountains is home to many endemic and rare native plants.

American Samoa's highest peak – Mount Lata, which rises to 964 m – is on the second largest island of Ta'u. Mount Lata's vegetation is known as summit scrub, and is characterised by stunted trees covered with epiphytes, vines and ferns. This area is an important nesting site for the threatened Tahiti petrel (*Pseudobulweria rostrata*).

Coastal forest. *Carla Appel*

Urban forest in Tutuila. *Neil Gurr*

All of the islands have coastal forest in undisturbed coastal areas. Common trees are tree heliotrope or *tausuni* (*Tournefortia argentea*), beach hibiscus or *fau* (*Hibiscus tiliaceus*), cordia (*Cordia subcordata*) and coconut (*Cocos nucifera*). Mangrove forest occurs on just two islands, Tutuila and Aunu'u. The largest mangrove forests are on the south side of Tutuila in the lagoons of Leone and Nu'uuli villages. Three mangrove species are present – red mangrove (*Rhizophora mangle*), Oriental mangrove (*Bruguiera gymnorrhiza*), and puzzlenut (*Xylocarpus moluccensis*).

The two atolls support typical coastal species such as coconut, pandanus (*Pandanus tectorius*), guettarda (*Guettarda speciosa*) and tree heliotrope. Pisonia (*Pisonia grandis*) is a common tree on Swains Atoll, but

The giant banyan is a dominant tree in the lavaflow forest. *Neil Gurr*

is declining on Rose Atoll because of hurricane damage and other unknown reasons.

American Samoa's urban forests are defined as trees managed by people in and around residential and public areas such as gardens, parks, roadsides and sports fields. There are approximately 1,250 ha of urban forests with the majority in and around the densely populated villages in southwestern Tutuila Island. Urban forests have a combination of native and non-native trees planted and maintained for many purposes such as food, shade, ornament, wind breaks, building materials, medicine, shoreline protection and boundary markers.

A brief history of American Samoa's forests

American Samoa's forests have been modified since the arrival of the first Polynesians. These settlers practised traditional slash-and-burn agriculture, but had relatively little effect on the forest because their population was small.

The first significant impacts on the forests came during the late 1800s, when many acres of forest were cleared and converted to coconut plantations to supply the coconut oil and copra trade.

Early in the 1900s American Samoa became a territory of the US. During the Second World War large numbers of US marines were stationed on the islands. Vegetation was cleared for airstrips, housing and other infrastructure around the military base on Tutuila.

Today the government and a tuna cannery are the largest employers in American Samoa. The transition from dependence on farming to steady income jobs has allowed primary native forests to remain intact. At the same time, job and educational opportunities have attracted many immigrants, which has increased the population and added a threat to the forests.

Forest ownership and management

The majority of land on American Samoa – around 90% – is communally owned by extended families or *aiga*. The remainder is owned by the government, by private landowners or by churches. Communal lands are managed under the traditional Samoan *matai* (chiefly) system. Each *aiga* is headed by a *matai*, and the *matai* holds authority over the land and makes decisions about activities related to the land.

The National Park of American Samoa was established on communal land under a 50-year lease agreement between the US National Park Service and the local *aiga* who retains ownership of the land. The terrestrial portions of the national park, on Tutuila, Ta'u and Ofu, cover about 13% of the territory's land area. Rose Atoll is also protected as a National Wildlife Refuge.

The American Samoa Forestry Program is based at the American Samoa Community College Division of Community and Natural Resources. The USDA Forest Service provides funding and technical support for the Forestry Program. The Program focuses on urban and community forestry, forest health and forest stewardship.

There are currently no laws to prevent removal of trees, or to protect the habitat of rare or endangered species. However, the Forestry Program works to raise awareness among communities, farmers, government agencies and others of the need to protect the forests.

Cordia

Cordia (*Cordia subcordata*) is a coastal tree found throughout the Pacific islands. It grows particularly well on the dry, sunny side of islands, and it is often planted as a shade tree around homes. It is wind and salt tolerant and a good species for coastal protection. It has a shallow spreading root system that helps prevent soil erosion.

The attractive chocolate brown and pale wood is highly valued as it is lightweight, soft and easily worked. It is a favoured wood for canoemaking and woodcarving in the atolls and many other areas in the Pacific. The beautiful orange flowers are also traditionally used in leis (garlands), and the fruit was used in the past to make glue.

Cordia has a very important place in the culture and folklore of several Pacific island countries. The trees were often planted around sacred places. In Tuamotuan mythology cordia is said to have been one of the first trees created.

Randy Thaman

A Forest Stewardship Program laid the groundwork for improving forest management, and a recent Statewide Forest Resources Assessment and Resource Strategy (SWARS) will build on that program, with focus on the key issues identified by stakeholders. These key issues in the SWARS are: sustainability of urban forests, protection of coral reefs, conservation of wetlands, maintaining fresh water quality, and conservation of native flora and fauna.

Importance of American Samoa's forests

Conservation of biodiversity

American Samoa's forests are home to many rare plants and animals. In the largely undisturbed montane forests of the high islands, endemic plants include a species of pandanus, *Pandanus reineckei*, the shrubs *Melicope richii* and *Cyrtandra geminate*, and a grass, *Ischaemum stokesii*.

The lavaflow rainforest of the Tafuna Plain is a unique habitat that is fast disappearing, jeopardising the survival of the native animals that depend on this forest for food and shelter. Fruit of the giant banyan tree, for example, is eaten by the Pacific pigeon (*Ducula pacifica*), the Samoan starling (*Aplonis atrifusca*), the purple-capped fruit dove (*Ptilinopus porphyraceus*) and the many-coloured fruit dove (*Ptilinopus perousii*). The latter is one of American Samoa's rarest birds and depends almost entirely on the banyan trees for its food. Banyan trees also provide roosts for the Samoan flying fox (*Pteropus samoensis*).

The Samoan swallowtail butterfly (*Papilio godeffroyi*) was once found on all the larger Samoan islands, but now appears to be restricted to American Samoa. Larvae have been collected from *Micromelum minutum*, a small tree found along ridge and slope forests.

Reptiles include the Pacific boa (*Candoia bibroni*) on Ta'u, and several geckos and skinks, among them one endemic skink, *Emoia samoense*, found only on Ta'u and Tutuila.

Value to communities

Despite the fact that about half of American Samoa's population now lives in urban areas, the forest and its products are still very important in their everyday lives. Urban forests and agroforests now supply many products and ecological services, and the sustainability of these forests was given high priority by stakeholders in the recent SWARS.

Many-coloured fruit dove. *SPC*

Tourism

Tourism is a developing sector in American Samoa, with ecotourism ventures increasing. More than 7,000 tourists visited the islands in 2008, the majority from the US. Tourists come for the pristine environment and the fauna and flora on land and in the sea. Healthy forests will support development of the industry.

Threats to American Samoa's forests

Population growth

Population growth is a significant threat to forests on the main island of Tutuila. Many American Samoans from the neighbouring islands of Ofu, Olosega and Ta'u migrate to Tutuila for better employment opportunities and education. Tutuila also attracts immigrants from outside the territory. In order to sustain the increasing population, large areas of forest have been cleared and replaced by agriculture and other development. The lavaflow rainforest of the Tafuna Plain has been reduced to a small patch of just 11 ha, and, as the demand for food grows, farmers are starting to clear forest on the steeper slopes nearby.

The mangrove forests of Tutuila and Aunu'u Islands have also declined significantly over the past 25 years. In 1985 there was an estimated 60 ha of mangrove forests on these two islands; by 2009 that was down to 36 ha. Residents clear and fill in mangrove areas for building homes, businesses and churches, and for dumping trash. Although American Samoa's mangroves are protected under the Federal Coastal Zone Management Acts of 1972 and 1990, enforcement of the law is difficult.

Unemployment

American Samoa's labour force consists of three sectors: government (35%), private/other (36%), and, until recently, two large tuna canneries (29%). In 2008 the two tuna canneries employed 4,861 people, but in 2009 one of them closed leaving more than 2,000 people unemployed. It is unclear whether the remaining cannery will continue in American Samoa or move elsewhere where labour costs are lower. Loss of one or both canneries and associated businesses will dramatically decrease local tax revenues making current levels of public sector employment unsustainable. Unemployment is a potentially serious threat to forests in American Samoa, as with little land and no source of income, residents may be inclined to increase subsistence and commercial agricultural production, and clear forests to do so.

Introduced species

Probably the greatest danger to the native rainforest is the spread of exotic invasive plants. Serious threats already established in American Samoa include the African tulip tree (*Spathodea campanulata*), Mexican rubber tree (*Castilla elastica*), *Paraserianthes falcataria* (also called *Falcataria moluccana*), red-bead tree (*Adenanthera pavonina*), strawberry guava (*Psidium cattleianum*), cinnamon (*Cinnamomum verum*) and false kava (*Piper auritum*).

Feral pigs are abundant in many forested areas where they spread invasive plants, damage understory vegetation, destroy riparian areas by their feeding and wallowing behaviour, and also increase sediment-laden runoff to streams and coastal waters. Pig densities have been reduced in some forested areas by snaring and hunting, but remain high in other areas.

Looking to the future

The people of American Samoa value their forests highly. Key issues identified in the recent SWARS show that urban forests, coral reefs and wetlands are seen as priority ecosystems, while natural forests are recognised as critical for conservation of native flora and fauna, for watershed and soil protection, and to maintain water quality. Strategies outlined in the SWARS aim to move towards sustainable management of these forests and ecosystems.

Pago Pago Harbour on Tutuila. Urban expansion is displacing the forests, and moving up the slopes. *Neil Gurr*

The vision for urban forests is well-managed and healthy forests, with native as well as useful introduced species, that provide for the urban population of Tutuila. Education, awareness raising, demonstrations and planting programs are strategies to realise this vision.

Healthy coral reefs will be ensured by measures to limit soil erosion and nutrient runoff into the sea, including reforesting watersheds with native species. This same strategy will help to protect wetlands and maintain fresh water quality. Restoration of mangroves is also planned.

Conserving native flora and fauna will be addressed by reforestation of key areas with native species, as well as controlling invasive species, and where possible clearing them from the forest. The Forest Legacy Program is also contributing by providing a mechanism for forest conservation. Conserving the last remnant of lowland lavaflow rainforest is at the top of the list under this program.

Building local capacity, effective collaboration between stakeholders, and community participation will all be vital to achieving the vision set out in the SWARS. A recent project, which addressed watershed restoration, demonstrated how this can be done (see box).

Acknowledgements

Thanks to Aufa'i Areta, Neil Gurr, and Mary Taufete'e for their help with this chapter.

Professional Internships in Pacific Terrestrial Islands Ecosystem Management (PIPTIEM) Project

The goal of the PIPTIEM program is to prepare young professionals to lead terrestrial natural resources management in their countries. Two members of the American Samoa Community College (ASCC) were granted internships under the PIPTIEM project, funded by the USDA Forest Service. After a formal training phase at the University of Hawaii, they returned to American Samoa to put their learning into practice through a watershed restoration project in the village of Nu'uuli.

The Nu'uuli Papa stream watershed is a threatened watershed in a village/urban setting. The stream discharges into one of the few remaining mangrove forests in American Samoa. The interns first met with members of the Nu'uuli village council to discuss the project and secure access to the project site. They then carried out an assessment of the watershed, identifying trees and invasive species. They collected data on wildlife use and sources of pollution. They also carried out education and awareness-raising activities with three church youth groups as well as residents living near the stream.

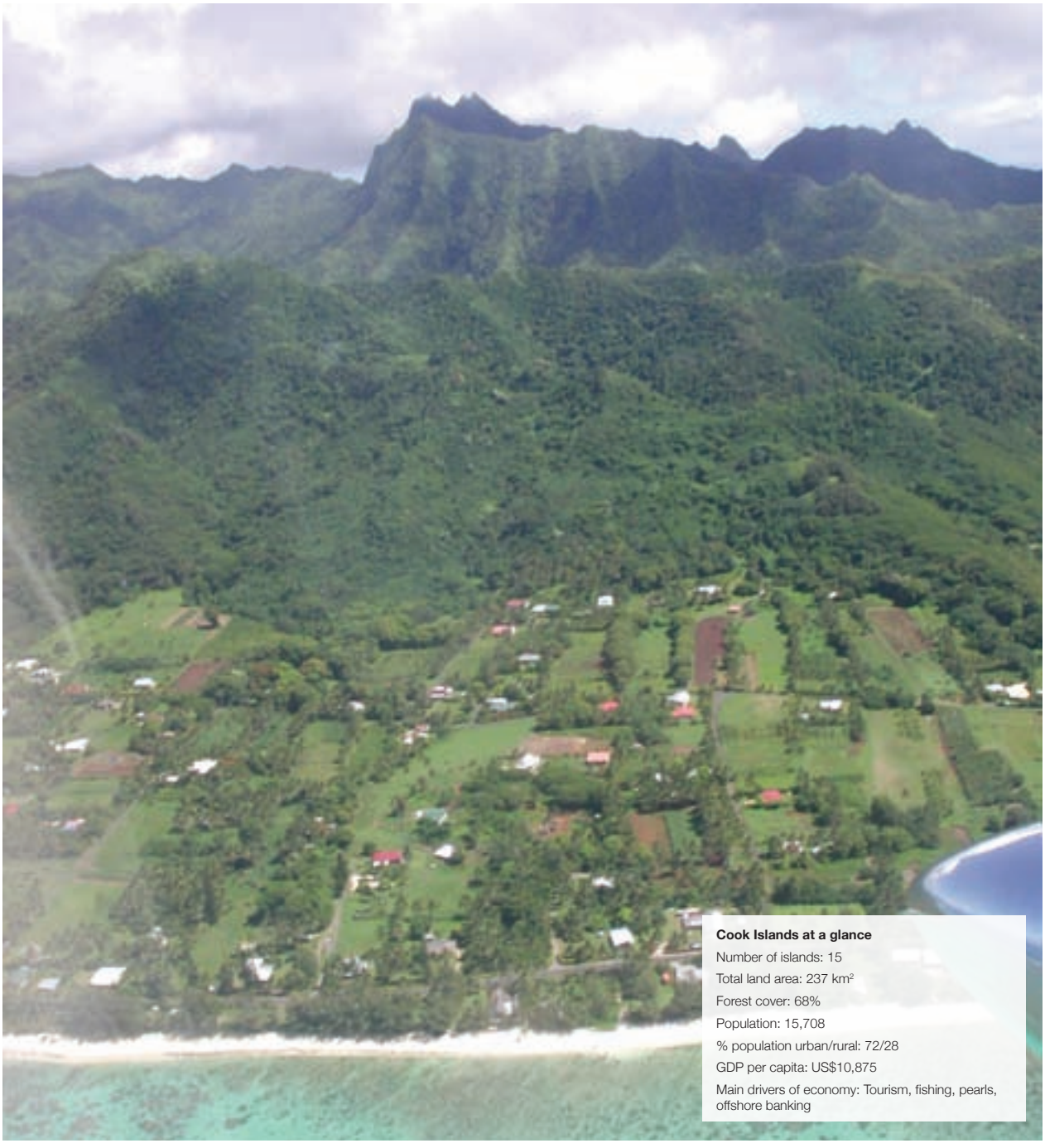
One hundred and fifteen young people volunteered to help the project. Starting at the mouth of the stream and working up through the watershed, trash and debris were removed. Nearly half of a hectare was cleared of the invasive false kava, and 22 invasive albizia trees were also removed. The area was replanted with 50 trees of five native species – vesi (*Intsia bijuga*), tropical almond (*Terminalia catappa*), malili (*Terminalia richii*), milo (T*hespesia populnea*) and *Flacourtia rukam*. The American Samoa Environmental Protection Agency (ASEPA) and ASCC water technicians assisted with monitoring of water quality of the stream.

Building on this very successful start, the project will continue to maintain the Nu'uuli Papa stream watershed into the future, continuing the collaborative effort of the community and the various government and non-government agencies.

ASCC

Cook Islands

Noo Tokari



Cook Islands at a glance

Number of islands: 15

Total land area: 237 km^2

Forest cover: 68%

Population: 15,708

% population urban/rural: 72/28

GDP per capita: US$10,875

Main drivers of economy: Tourism, fishing, pearls, offshore banking

Rarotonga. *Lex Thomson*

Noo Tokari is Senior Project Officer in the Cook Islands' Ministry of Agriculture.

Ivirua Caves on Mangaia. *Lex Thomson*

Summary

The Cook Islands have natural rainforest, limestone forest, and coastal and atoll forests, as well as some pine plantations. The main island of Rarotonga has significant primary montane rainforest and cloud forest, with some endemic species. With tourism the biggest income generator for the country, preserving the forests is important for economic reasons as well as for social and environmental reasons. The country has made initial steps towards developing a forest policy, but now needs to turn goals and objectives into a functional plan that can be put into practice.

The forests of the Cook Islands

The 15 Cook Islands are spread over 2 million km^2 of ocean. The Northern Group is mainly low-lying atolls. The Southern Group, where the majority of the population lives, includes the high volcanic island Rarotonga which is the largest island, the lower island of Aitutaki, and four raised limestone islands, Mitiaro, Atiu, Mauke and Mangaia. These four islands have central volcanic hills surrounded by makatea – ancient raised limestone reefs up to 2 km wide.

Approximately 63% of the Cook Islands land is under some kind of natural forest cover. Forest types are limestone forest, atoll forest, coastal forest and rainforest (lowland, montane and cloud forest). A further 5% is under forest plantations, mainly of Caribbean pine (*Pinus caribaea* var. *hondurensis*), which are found on four islands – Mangaia, Rarotonga, Mauke and Atiu.

On most islands, little natural forest remains on the lowlands because of the impact of humans over the centuries. However, on the high island of Rarotonga, the mountainous interior still has significant primary montane rainforest, and cloud forest on the highest peaks.

The makatea islands have similar flora to the lowlands of Rarotonga. Most of the interior volcanic hills are now under agroforestry, with many introduced species. The rugged makatea zones, however, remain covered by mostly indigenous species because of the almost inaccessible terrain. Forests here include a mixed-species forest dominated by *Elaeocarpus tonganus* and *Hernandia moerenhoutiana*, a pandanus (*Pandanus tectorius*) scrub forest, and a *Barringtonia asiatica* forest.

On the low-lying atolls, which are only a few metres above sea level, the vegetation is limited with coconut (*Cocos nucifera*) and pandanus the most common trees. Also found are the shrubs *Heliotropum anomalum* on the beach and inland, scaevola (*Scaevola taccada*) and pemphis (*Pemphis acidula*) behind the beach, and forest patches of pisonia (*Pisonia grandis*) and guettarda (*Guettarda speciosa*).

Makatea vegetation on Mangaia. *Lex Thomson*

A brief history of the Cook Islands' forests

Prior to European contact, Cook Islanders on the larger islands mostly lived inland, and depended heavily on the forests and agroforests for their daily needs. This had some impact on the forests, but low population density limited the damage.

The arrival of Europeans is associated with people relocating to live in the coastal areas. Populations began to increase around the same time, and the lowland forests were gradually cleared for agriculture.

Commercial agriculture on Mangaia. *Lex Thomson*

In the mid-20th century, the Cook Islands developed a significant commercial agricultural sector for export, mainly to New Zealand. Large areas of Rarotonga, Mangaia, Aitutaki, Atiu, Mauke and Mitiaro were cleared and planted with citrus trees (oranges, lemons, limes, tangerines and grapefruit), tomatoes, bananas and pineapple. Trees were also felled to make wooden boxes for transporting the fruit. Albizia (*Albizia lebbeck*) was introduced at this time, as a useful wood for making the boxes.

This industry ended in the 1980s when competition from other parts of the world became too great. Many of the citrus plantations were abandoned.

Around this time, a forestry program was started to combat soil erosion in Rarotonga, Aitutaki, Mangaia, Atiu and Mauke. Trees planted were mainly *Acacia* and *Eucalyptus* species and Caribbean pine. The pine proved to be the most successful, and planting expanded and now covers an area of about 1,100 ha.

Forest ownership and management

Most land in the Cook Islands, and therefore most of the forests, are privately owned. An exception is the central forested area of Rarotonga, which is owned by the State.

The Cook Islands has no clearly defined forest policy, and no government forestry department. Forestry falls under the responsibility of the Ministry of Agriculture. The role of the Ministry is limited to the provision of advice and information regarding protection, management and utilisation of tree resources, and promoting their protection.

Individual islands have responsibility for managing their forests. Mangaia and Atiu have been actively developing their forest resources, planting pine and acacia, although these activities were brought to a halt in 2007.

Four areas are designated for conservation purposes in the Cook Islands. These are the bird sanctuaries on the islands of Suwarrow, Manuae and Takutea, and Takitumu Conservation Area on Rarotonga, which serves as a

A pine plantation in the Cook Islands. *Lex Thomson*

reserve for the threatened endemic bird, the Rarotonga monarch or flycatcher (*Pomarea dimidiata*).

Importance of the Cook Islands' forests

Conservation of biodiversity

There are about 540 plant species found in the islands, the majority introduced. An estimated 130 species are native. The montane rainforest of Rarotonga has many endemic and interesting species, including a giant liana, the water vine (*Entada phaseoloides*). The cloud forest is known to have nine endemic species of flowering plants, including the tree daisy (*Fitschia speciosa*), which is an important tourist attraction.

At least seven bird species are endemic to the Cook Islands. Three of these – the Atiu swiftlet (*Collocalia sawtelli*), the Rarotonga starling (*Aplonis cinerascens*) and the Mangaia kingfisher (*Todiramphus ruficollis*) – are each found on just one island. The Atiu reed warbler (*Acrocephalus kerearako*), a fruit dove (*Ptilonopus rarotongensis*), a kingfisher (*Todiramphus ruficollaris*) and the Rarotonga monarch or flycatcher are found on at least two islands. The Rarotonga monarch was recovered from near extinction through an intensive conservation program in the 1980s and 1990s. The mountains of central Rarotonga are also one of the few known breeding grounds of the herald petrel (*Peterodroma heraldica*).

Value to rural communities

Particularly on the remote atolls, people get many of their daily essentials from the trees and forests. Coconuts and pandanus are key trees on the atolls.

Wood carving is a great tradition in the Cook Islands. Trees used include calophyllum (*Calophyllum inophyllum*), milo or *miro* (*Thespesia populnea*) and cordia (*Cordia subcordata*). Today, these carvings are sold to tourists and represent the only export from the forest.

Breadfruit

Breadfruit (*Artocarpus altilis*) is not native to the Pacific islands, but was introduced by early settlers. Today it is one of the most important food trees of the region, and is widely grown on most Pacific islands, usually in village and homegardens and in agroforestry systems. The trees produce large numbers of carbohydrate-rich fruits, which are an important seasonal staple food on many islands, and are especially important on some of the wetter atolls where the tree is able to grow. Fruits vary in shape, size and weight depending on the variety, with some weighing up to 6 kg. Fruits are cooked by roasting, baking, boiling or steaming, or can be deep fried into chips. There is the potential for small-scale export of both fresh fruit and chips to countries like New Zealand and the USA.

Breadfruit also has traditional medicinal uses, for example the latex is used externally to treat broken bones, sprains and skin ailments, and internally for diarrhoea and stomach problems. The leaves, roots and bark are also used medicinally. The wood is used as a lightweight timber and in some places for canoe making and houseposts, and the inner bark was traditionally used for bark cloth. The sap was used for caulking canoes.

A closely related species, dugdug (*A. mariannensis*), is native to the Mariana Islands and Palau and is also grown in Kiribati, Tuvalu and Tokelau. This wild relative hybridises readily with breadfruit, and many hybrid varieties are now grown as staple food trees across Micronesia and some other atolls.

Randy Thaman

Tourism

Tourism is the biggest income generator for the Cook Islands. Current visitor numbers are about 100,000 per year. Ecotourism is promoted in the islands, for example tourists can visit the Takitumu Conservation Area on Rarotonga for hiking and bird watching.

Timber

The pine plantations are about to begin producing timber (for example, 92,000 poles are anticipated from 200 ha on Mangaia). The next stage will be treatment and processing for high value end uses. Investment from private sources or aid donors is now needed to support the development of local enterprises that can capitalise on this resource.

Threats to the Cook Islands' forests

Invasive species

The forests of Rarotonga in particular are under threat from invasive plants. These include the weeds mile-a-minute (*Mikania micrantha*), balloon vine (*Cardiospermum grandiflorum*) and several species of *Merremia*. Invasive trees that are threatening to outcompete native trees include the African tulip tree (*Spathodea campanulata*), several species of *Albizia* and the newly introduced acacia species, *Acacia mangium*.

Fire

Fire is a particular threat to the pine plantations, which are mainly found on Mangaia and Atiu.

Looking to the future

The Cook Islands needs a forest policy to guide its forestry activities in the coming years. Preliminary work has been undertaken, and a goal and objectives have been developed. These are:

- Goal: To enhance the environmental, social and economic values of the nation's forests and ensure that their protection, management and utilisation will sustain those values for future generations.
- Objective 1: To manage and protect the forests in a manner that is acceptable, sustainable and in line with the forests' defined and required functions as determined by the local community.
- Objective 2: To stimulate and encourage community interest and participation in economic development activities related to the wise use of forests and

New uses for coconut

With the decline of the copra trade, many of the Pacific islands countries and territories have lost a major money earner. But new markets, many of them high-value niche markets, are developing to fill the gap.

Virgin coconut oil is becoming a valuable commodity in some countries. Used as a basis for skin care products, and increasingly promoted as a high-quality cooking oil, it has significant export potential. The oil can be produced in small, community-run factories on remote islands, meaning that more of the added value stays in local communities.

Coconut water is becoming extremely popular in many countries as a natural health and sports drink. If Pacific island countries can develop the necessary processing, packaging and transportation, they can tap into this high-value market. Coconut sugar and coconut syrup are also attracting interest as healthy sweeteners.

Coconut shells and husks can also be turned into high-value products. High-grade filter carbon from the shells is used in water filters, for example; while coir from the husks is in growing demand for high-quality car upholstery.

Today, many of the Pacific island countries and territories have old and neglected coconut plantations, but there are some new, high-value uses for these senile trees. With specialised processing, the fine-grained, attractive wood can be turned into high-quality flooring, benchtops and furniture which command premium prices in Asia, America and Europe. There are also potential local markets, including the tourist industries in the islands. A valuable by-product of the timber processing is nutrient-rich mulch that can be used to improve soils. Removing old trees frees up land for replanting or for other productive uses; and using them for timber eases pressure on the natural forests.

Vinesh Prasad

resources derived from them. The utilisation of forest resources should follow sustainable development principles.

- Objective 3: To encourage and stimulate training activities and develop dialogue with resource owners on the need to sustainably protect, manage and promote the forest resources.
- Objective 4: The Ministry of Agriculture to provide research and advice on the sustainable use of forest resources.

The next step should involve communities to identify and categorise forest functions according to locations and community needs. This will allow a forest management plan to be developed, and legislation to be put in place to help put the policy and plan into practice.

French Polynesia

Léopold Stein

French Polynesia at a glance
Number of islands: 121 (76 inhabited)
Total land area: 3,521 km^2
Forest cover: 57% (including plantations)
Population: 268,767
% population urban/rural: 51/49
GDP per capita: US$21,071
Main drivers of economy: Tourism, pearls, agriculture

Natural forests on the mountains of Tahiti. *Jean-François Butaud*

Summary

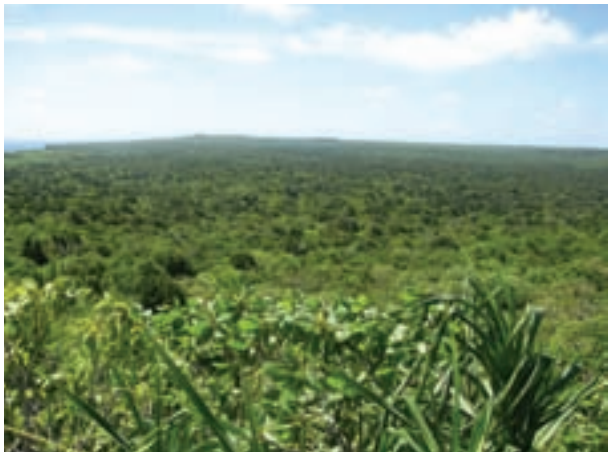
French Polynesia's five island groups are isolated and remote from one another, and each group has distinctive natural vegetation with many species that are endemic to that group. In all five island groups, much of the natural forest has been degraded over the centuries. Today, the government is promoting the expansion of plantations to supply some of the country's timber needs. French Polynesia is one of the Pacific region's main tourist destinations, and preserving the natural forests is important for this sector. Invasive species are however a significant threat, particularly the tree *Miconia calvescens*, which may have already replaced a quarter of the rainforest on Tahiti. French Polynesia's Forestry Plan for 2011–2020 lays out intentions for the country's plantations as well as proposed planting programs for trees such as pandanus, medicinal plants and endangered species.

French Polynesia's forests

French Polynesia consists of five groups of islands; from north to south these are the Marquesas Islands, the

Léopold Stein is Head of the Forest and Rural Area Division of the Rural Development Department of French Polynesia.

Cloud forest at 1,350 m elevation, Tahiti. *Jean-François Butaud*



Makatea forest on Makatea Island. *Jean-François Butaud*

Society Islands, the Tuamotu Archipelago, the Gambier Islands and the Austral Islands. Apart from the Tuamotu Archipelago, which is a chain of atolls (except for Makatea Island, which is a raised limestone island), most of the main islands are high volcanic islands. Tahiti, in the Society Islands, is the largest island and has more than half of the country's population.

The 2000 km^2 of forests in French Polynesia can be roughly broken down as follows:

- 142,000 ha of natural forest (primary and secondary)
- 50,000 ha of coconut (*Cocos nucifera*) plantations
- 5,880 ha of Caribbean pine (*Pinus caribaea* var. *hondurensis*) plantations
- 3,245 ha of planted protective forest cover, primarily softwood
- 395 ha of fine hardwood plantations.

Natural forests

The island groups are quite remote from one another, and each group has distinctive natural vegetation with many species that are endemic to that group. In total, there are about 900 native plant species across the islands of French Polynesia, of which an estimated 63% are endemic. Lowland and montane rainforest, and cloud forest on the high peaks, are the most common natural forests of the high volcanic islands. On the inhabited islands much of the lowland and accessible montane rainforest has been cleared over the centuries. The larger islands of the Marquesas once had tropical dry forests on the drier western sides of the mountains, but most of this has been lost.

Plantations

There are four types of plantations. Coconut plantations occupy by far the largest area, although their importance for copra has declined and today many are neglected. Caribbean pine plantations have been planted across the five island groups on a total of 15 islands. Fine hardwood plantations include mahogany (*Swietenia macrophylla*), teak (*Tectona grandis*) and African mahogany (*Khaya senegalensis*). Trees have also been planted for soil and watershed protection on some of the high islands; species include casuarina (*Casuarina equisetifolia*), *Paraserianthes falcataria* (also called *Falcataria moluccana*), Caribbean pine and albizia (*Albizia lebbeck*).

A brief history of French Polynesia's forests

The forests of all five island groups have been impacted by people, in various ways. The Marquesas were densely populated several hundred years ago, and most of the lowland and accessible higher forests were cleared or overharvested during this period. The Society Islands were similarly affected over the centuries, and later, during the colonial era, by extensive planting of commercial crops including coconuts, sugarcane, coffee and oranges. The Marquesas and Australs also had significant areas planted with commercial crops during this period. The Gambier Islands lost nearly all of their natural forest over the centuries, to overexploitation as well as damage from introduced species such as cattle, horses, goats and rats. The Australs also lost large areas of forest from overexploitation by populations that were too large for the islands. The island of Makatea was mined for phosphate between 1908 and 1966, which destroyed most of its natural forests.

As well as clearing and harvesting the forests, people also brought new, useful plant species to them. Today, many of these species are integrated into the secondary forest.

During the 1960s, the government recognised the potential for developing plantations to supply timber for the country, to create jobs, and also to protect soils and watersheds. Trials of both indigenous and exotic species helped to identify suitable species for the different aims, and these were the foundations of today's plantations.

French Polynesia first developed a Forest Policy in 1977. In 2003, a Forestry Plan was developed that focused on managing the movement and marketing of the plantation timber so that the outer islands could be competitive,

Toi

Toi (*Alphitonia zizyphoides*) is native to the Pacific region from Vanuatu to French Polynesia. It is highly valued in traditional medicine. The bark is boiled and used to treat stomach problems, headaches, coughs and many other ailments; while the sap is used to treat earache and swellings, among other things. A compound in the bark has been found to have anti-inflammatory properties and named alphitol. Toi is also a valuable fuelwood, and the timber is used in construction. The tree grows naturally in lowland and lower montane rainforest. It is tolerant of a range of soils, and is fast growing, reaching up to 30 m in height.

Lex Thomson

and thus reduce migration from the outer islands to urban centres. In January 2011 a new Forestry Plan for 2011–2020 laid out objectives for expansion of pine and hardwood plantations, and proposals for planting programs for endemic sandalwood (*Santalum insulare*), pandanus (*Pandanus tectorius*), medicinal plants and endangered species.

Forest ownership and management

In French Polynesia, about 85% of forest land belongs to private owners, and the remainder is public property.

The Forestry Service is committed to establishing forest parks, arboretums, and seed plantations to supply nurseries with adequate quantities of high quality seedlings.

French Polynesia has drawn up 'general development plans' for the different local areas. These include planning for forest reserves. These plans are in the early stages of implementation, but the hope is to involve communities and community leaders in the process.

There are three protected areas in the inhabited islands – the Te Faaiti Nature Park on Tahiti, Mount Temehani Ute Ute on Raiatea in the Society Islands, and the Vaikivi Nature Reserve on Ua Huka in the Marquesas. The small, uninhabited islands of Hatutu, Eiao, Motu One and Mohotani in the Marquesas, Scilly and Bellinghausen in the Society Islands and Taiaro Atoll in the Tuamotus are all protected as nature reserves. These protected areas total about 2% of the total land area of French Polynesia.

French Polynesia has legislation in place to protect its forests and trees, for example, any cutting or uprooting of trees must be authorised beforehand. A list of 167 native and endemic plants are protected by law.

Importance of French Polynesia's forests

Conservation of biodiversity

Among the most isolated in the world, the islands of French Polynesia have many endemic species of plants and animals in their forests.

The Marquesas Islands have more than 300 native plant species of which nearly half are endemic to the islands. Endemic birds include the ultramarine lory (*Vini ultramarina*), the Nuku Hiva pigeon (*Ducula galeata*), the Marquesas ground dove (*Gallicolumba rubescens*), the Marquesas kingfisher (*Halcyon godeffroyi*), the Fatuhiva monarch (*Pomarea whitneyi*), the Iphis monarch (*P. iphis*)

The forests could become a major ecotourism attraction in French Polynesia. *Jean-François Butaud*

and the Marquesas monarch (*P. mendozae*), all of which are at risk of extinction. The islands also have more than 70 species of land snail.

The Society Islands also have a high snail diversity – notably 53 endemic *Partula* land snail species. They have more than 600 native plants, with again nearly 50% endemism. Birds include the green-backed heron (*Butorides striatus patruelis*), the Society Islands pigeon (*Ducula aurorae*), the Tahiti reed warbler (*Acrocephalus caffer*), the Tahiti swiftlet (*Aerodramus leucophaeus*), and the Tahiti monarch (*P. nigra*).

Biodiversity on the atolls of the Tuamotus is lower than on the high islands. Makatea Island has some remaining natural forest, and is home to the Polynesian pigeon (*Ducula aurorae*), the Makatea fruit dove (*Ptilinopus chalcurus*) and the Tuamotu reed warbler (*Acrocephalus atypha*). Some 22 seabirds also breed in the Tuamotus.

The Australs also have lower biodiversity, but high endemism. The Rimatara reed-warbler (*Acrocephalus rimatarae*) and the Rapa fruit-dove (*Ptilonopus huttoni*) are found only on the islands of Rimatara and Rapa, respectively.

Miconia calvescens invading the forest on Tahiti. *Jean-François Butaud*

Tourism

French Polynesia is one of the Pacific region's main tourist destinations. As elsewhere, ecotourism is expanding, and the natural forests with their many unique species of plants and animals should become a major tourist attraction, alongside the beaches and the culture.

Timber

The Caribbean pine plantations are beginning to produce timber, and output will increase in the coming years. On Nuku Hiva in the Marquesas, for example, a private company is planning to harvest up to 5,000 m^3 per year. Small logging operations are also under way on Tahiti, Moorea, Nuku Hiva and Hiva Oa. The hope is to develop sustainable plantations that deliver 50% of French Polynesia's timber.

Threats to French Polynesia's forests

Invasive species

The main threat to the forests of French Polynesia comes from introduced and invasive species. Animals that have caused extensive damage to the country's vegetation and its wildlife include feral goats, pigs, cattle and horses on many of the islands. Invasive plants that are outcompeting native species on some of the islands include Chinese guava (*Psidium cattleianum*), lantana (*Lantana camara*), Java plum (*Syzygium cumini*), African tulip tree (*Spathodea campanulata*) and *Cecropia peltata*. On Tahiti, Moorea and Raiatea, the invasive tree *Miconia calvescens* is a very serious threat to the forests. The tree's large leaves and dense canopy shade out seedlings of all other species, so that nothing else can grow. The tree produces very large numbers of seeds which are spread by birds. On Tahiti, where it first established, it may already have replaced a quarter of the rainforest.

Urbanisation and agriculture

Urbanisation, and expansion of agriculture to feed the urban population, pose a threat on the more populated islands, especially the Society Islands. The threat is mainly to lowland and coastal forests, but on Tahiti and Nuku Hiva in the Marquesas housing developments and cattle farming are now encroaching at above 600 m.

Expanding tourist infrastructure also poses a threat on some islands, for example new hotels, roads and golf courses.

Looking to the future

French Polynesia's plantations will be important in the coming years, as production increases. The Forestry Plan for 2011–2020 lays out the intended expansion of the plantations. The Plan also has proposals for planting programs for other species of importance, such as pandanus, medicinal plants and endangered species.

The Forestry Service is setting up collection plots (arboretums) of indigenous forest species and exotic species of economic value, for educational purposes. There will also be research into ways to add value to the forest resources in French Polynesia. A program of planting medicinal plant species is in progress on Tahaa in the Society Islands.

Sandalwood holds potential as a profitable crop for some of the outer islands, and the development of plantations is proposed for the future. Conservation work and the establishment of seed orchards are already under way (see box).

French Polynesia is also developing a project for conservation of coconut genetic resources on Rangiroa and Raiatea.

Pine plantations on Rurutu. *Jean-Yves Meyer*

Conserving Polynesia's sandalwood

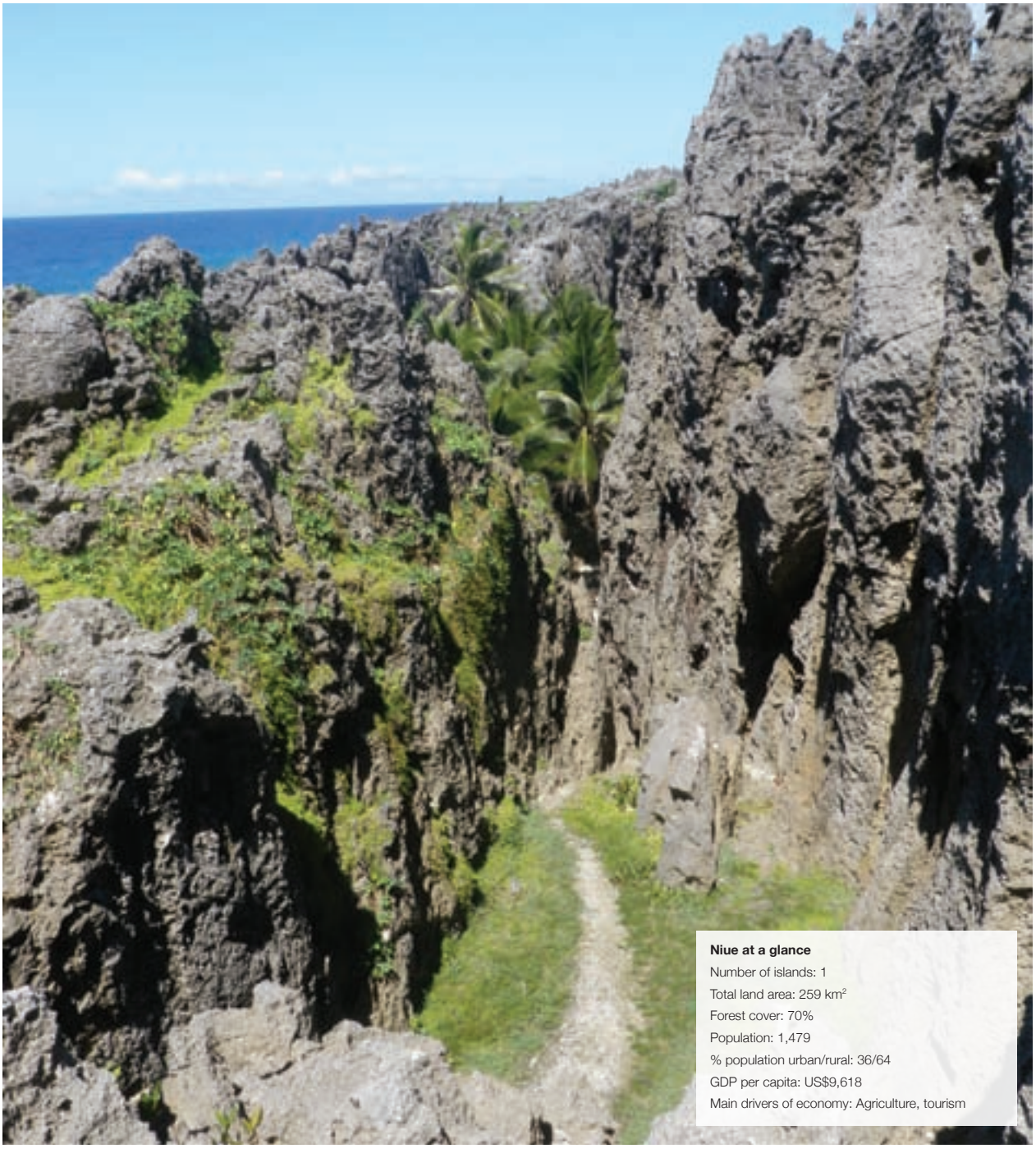
Sandalwood has been overharvested on many Pacific islands, and is now rare. Introduced rats eat the seeds, which has contributed to the problem. Where natural stands remain, they are usually small and difficult to access. Yet sandalwood has great potential as a high-value forest product, and many people are interested in planting and growing this tree.

In French Polynesia, work has been under way for 10 years to develop plantations of the seven native varieties of *Santalum insulare*, for both conservation purposes and to serve as seed orchards. Seeds were sought and collected from natural populations for planting. As at the end of 2010, four different varieties have been planted in separate plantations on five islands. In total, nearly 9 ha have been planted with more than 2,500 saplings. Varieties are grown in isolation in a plantation – i.e. one variety per plantation – to keep the variety pure. Some of the first plantations are already producing seed, which is being grown in nurseries, and seedlings are now available to the Forestry Service and to the general public.

Jean-François Butaud

Niue

Brandon Tauasi



Niue at a glance
Number of islands: 1
Total land area: 259 km^2
Forest cover: 70%
Population: 1,479
% population urban/rural: 36/64
GDP per capita: US$9,618
Main drivers of economy: Agriculture, tourism

Niue is a raised limestone island. *Lex Thomson*

Brandon Tauasi is Head of Forestry in Niue.

Summary

Niue is a single raised limestone island with extensive natural forests upon which the small population depends for many products and services. Agriculture is a competing land use that has resulted in clearing of significant areas of forest in recent decades, and continues to be a threat to the forests. The country is building a framework for sustainable forest management through its Forest Policy, a Code of Harvesting Practice, forest legislation, and a Forest Development Plan. Turning these into good practice is the next challenge for Niue.

Niue's forests

Niue is a raised limestone island with a highest point of around 68 m above sea level. The country is a self-governing state in free association with New Zealand. Niue's population has been declining in recent years, from a peak of 5,000 in the early 1980s to the present number of less than 1,500. The public sector is the main employer, and most Niueans also engage in subsistence agriculture and fishing. There is a small agricultural export industry, with taro, noni and vanilla the main export crops.

Large areas of the forest were cleared for agriculture during the 1980s and early 1990s, but with improved awareness and declining populations this has slowed in recent years. Today the island has extensive forests, which include a small amount of primary rainforest, secondary forest and coastal forest. The rainforest is mostly found on the eastern side of the island.

Soils are typically dry shallow limestone soils and biodiversity is low with less than 200 plant species, none endemic. The undisturbed forest is tall and dense, and many of the trees have buttress roots to help anchor the tree in the shallow soil. The forest is dominated by two *Syzygium* species (*Syzygium richii* and *S. inophylloides*); other important trees include *Dysoxylum forsteri*, *Planchonella torricellensis*, tava (*Pometia pinnata*) and *Macaranga seemanii*. The coastal forest has salt-tolerant species such as fish poison tree (*Barringtonia asiatica*), cordia or *motou* (*Cordia subcordata*), tropical almond (*Terminalia catappa*), Tahitian gardenia (*Gardenia taitensis*) and *Bikkia tetrandra*.

Rainforest is found on the east of the island. *Brandon Tauasi*

A brief history of Niue's forests

Early Niueans cleared small areas of forest by the slash-and-burn method to practise small-scale, shifting agriculture. As the population of the island increased, and farming became more mechanised, more extensive areas of forest were cleared. Fallow periods were also reduced, which caused degradation of Niue's already poor soil, and resulted in the need to clear more forest.

As well as clearing for agriculture, timber was harvested from the forests for building materials. From 1980 to the mid-1990s in particular, these two activities contributed to significant deforestation on the island.

Niue developed its first Forest Policy in 1994, which highlighted the need to conserve the island's trees. This had some success, and deforestation slowed. A new Forest Policy was endorsed in 2000 which promotes conservation as well as sustainable management of the forests and trees.

From the late 1980s, New Zealand funded a forestry project to develop plantation forest on the island, with introduced species such as mahogany (*Swietenia macrophylla*) and red cedar (*Toona australis*). However, these did not grow well and many of the trees were blown down by Cyclone Heta in 2004. Cyclone Heta was a category 5 cyclone that directly hit Niue, causing extensive damage to both plantations and natural forests.

Forest ownership and management

Almost all of the land on Niue, and the trees on the land, are under customary ownership by family groups called *magafaoa*. All members of the *magafaoa* have the right to use the land and to participate in land use decisions. Land can be leased for up to 60 years, but cannot be

Fish poison tree, found in the coastal forests of Niue, flowers at night and is pollinated by bats and moths. *Richard Markham*

Pandanus

Pandanus (*Pandanus tectorius*) is a vastly useful small tree that is found throughout the Pacific region, usually in coastal forest but also further inland. As well as occurring naturally, preferred varieties are selected and planted in homegardens. There are hundreds of traditional varieties that have been selected for different characteristics, for example for their fruit or for leaves that make fine mats.

Almost all parts of the plant are used. Branches are used for construction, making ladders, tools and weapons, and for fuel. Roots are made into ropes, while the flowers are used for decoration and to scent coconut oil. Leaves are used for weaving and thatching – pandanus mats and baskets are seen throughout the Pacific islands. Many varieties have nutritious edible fruits that are a staple food in parts of Micronesia and on atolls in Polynesia. Fruits are eaten raw as a snack food, made into puddings, or processed.

Pandanus is also an important medicinal plant, for example in Kiribati leaves are used to treat flu, hepatitis and asthma, and in Palau a drink is made from the roots to treat stomach ailments. Pandanus features in the folklore and mythology of many Pacific island countries, emphasising its importance through the centuries.

Pandanus is tolerant of drought, salt and strong winds. It grows in a wide range of soils, and often grows in sandy soils right on the beach. It is an important coastal protection tree and a windbreak, and is sometimes planted to protect food crops from salt spray.

SPC

The coconut crab was abundant on Niue until recently. *Lex Thomson*

sold except to the Crown or government. Traditional management includes a taboo system which is used to protect certain areas, for example sacred areas or breeding areas of important animals, such as the coconut crab (*Birgus latro*).

Niue developed its Forest Policy and a Code of Harvesting Practice after wide consultation among stakeholders. There is currently no forest legislation, however legislation is under development. A forest inventory was carried out in 2008 (see box), and a Forest Management Plan based on this is in preparation. The Forestry Department has very limited capacity, and the Department of Environment is taking the lead in developing the legislation and the management plan.

There are two conservation areas on Niue – the Huvalu Conservation Area and the Hakupu Heritage and Cultural Park. These areas are protected by traditional taboo rather than legislation. There are also nine protected areas on the island, protected by village council bylaws and taboo.

Importance of Niue's forests

Conservation of biodiversity

The native plants that are well adapted to Niue's conditions are vital to the future of the country, and their conservation is therefore essential.

The forests provide habitat for many animals, some of which in turn are needed for the trees' survival. For example, the Tongan flying fox (*Pteropus tonganus*), the only native mammal, is the sole pollinator of some of Niue's tree species, and also helps disperse fruits.

Of the 31 species of birds recorded, 15 are known to breed on the island. These include the Polynesian triller (*Lalage maculosa whitmeei*), the Polynesian starling (*Aplonis tabuensis brunnescens*), the Pacific pigeon (*Ducula pacifica*), the blue-crowned lory (*Vini australis*) and the spotless crake (*Porzana tabuensis*).

There are at least five species of lizard. There are also eight known species of land crab, including the coconut crab which is an important traditional food, but may be under threat from overharvesting and loss of habitat. The coconut crab is a highly threatened species on most Pacific islands, but has been abundant in the limestone habitats of Niue until recently.

Value to communities

Niueans mostly live a traditional lifestyle and depend on the forest for many products and services. While timber harvesting has declined, small amounts are still extracted for building and to make canoes. Other trees provide foods, medicines and garlands and perfumes for special occasions. Three forest animals are traditionally hunted for food – the coconut crab, the flying fox and the Pacific pigeon. As landowners, communities also benefit from royalties if they agree to commercial logging on their land.

Tourism

Tourism is a growing sector in Niue, with most visitors coming from New Zealand, many of them returning Niueans. Niue lacks palm-fringed beaches, but has many other attractions such as coastal caves and rockpools, fishing, diving, and inland activities such as rainforest walks.

Threats to Niue's forests

Agriculture

The high demand for taro in New Zealand is encouraging the expansion of this crop, which could result in further forest clearing. The government has identified the agriculture sector as a priority for expansion, which carries a risk to forests and trees if not managed carefully. The strategy, however, is to focus on high-value small-

volume crops, in particular vanilla, and to manage this development sustainably, with an emphasis on organic farming.

Commercial logging

There is currently little commercial logging in Niue, with just one local company cutting less than 15 m^3 per year. However there has been recent interest from a Malaysian logging company to log the Hakupu Forest Reserve, which would probably spell the end for the largest remaining area of forest on Niue.

Looking to the future

Niue has gone some way to developing a framework for sustainable management of its forests, through development of a Forest Policy, a Code of Harvesting Practice, and the drafting of forest legislation. The forest inventory was an important step in defining the forest resources, and a Forest Management Plan based on this is in preparation (see box). The next step will be turning these policies and plans into good practice.

A strategy for the future is to focus on growing high-value small-volume crops like vanilla. *SPC*

Building a forest inventory

An inventory of Niue's forests was carried out in 2008. Based on the findings, a Forest Management Plan is in preparation.

The team used Google Earth images to prepare a map of broad forest types. Two major forest types were identified, mature dense forests and regenerating medium dense forest, plus a third non-forest category.

Using this map, a number of 500 m x 500 m plots were chosen randomly. Within these plots, all trees with a trunk diameter of 20 cm or more were identified to species level and recorded. Within subplots of 10 m x 25 m, the same was done with trees with trunk diameter between 10 and 20 cm; and in further subplots regenerating trees with diameter less than 10 cm were recorded. There were 15 random plots in the mature dense forest, and 10 in the regenerating medium dense forest. The results of the sampling were entered into a database, and used to develop the country-wide inventory.

The next steps are public consultation, and allocation of functions to the different forest types and areas, for example conservation, production or rehabilitation. This will form the basis of the Forest Management Plan, which should also allocate roles and responsibilities, and set out requirements for funding, a timeframe and monitoring.

Brandon Tauasi

Pitcairn Islands

Anne Moorhead and Noeleen Smyth

Pitcairn Islands at a glance

Number of islands: 4 (1 inhabited)

Total land area: 47 km^2

Forest cover: Pitcairn Island <30%; Henderson 70%

Population: 50

% population urban/rural: 0/100

GDP per capita: not available

Main drivers of economy: Subsistence agriculture, fishing, handicrafts, honey

The coast of Henderson Island. *Dave Williamson*

Summary

Of the four islands in the Territory of the Pitcairn Islands, only Pitcairn itself is inhabited, by the descendants of the Bounty mutineers and their Tahitian companions. Over the years they have altered the island's forests. Today natural forest is found only in inaccessible places, and the alien invasive rose apple tree covers large areas of the island. Henderson Island, by contrast, is a unique example of the natural vegetation of an undisturbed raised limestone Pacific island, and has been designated a World Heritage Site. The two atolls, Ducie and Oeno, have very limited vegetation. A plan to develop the tourism sector brings both opportunities and threats to the forests of the Pitcairn Islands.

The forests of the Pitcairn Islands

The British Overseas Territory of the Pitcairn Islands comprises the high island of Pitcairn, the raised limestone island Henderson, and Ducie and Oeno Atolls. Only Pitcairn is inhabited, by the descendants of the Bounty mutineers and their Tahitian companions who today number around 50 people.

Anne Moorhead is a science writer and editor. Noeleen Smyth is Conservation Botanist in the National Botanic Gardens in Dublin, Ireland; she is author of the Pitcairn Islands Environment Management Plan.

The two atolls, which are both less than 1 km^2 in land area, have very limited coastal vegetation. Ducie is mainly covered with tree heliotrope (*Tournefortia argentea*), a small tree found across the Pacific region. Only one or two other plants have been identified on the island. Oeno has more plant species – about 16 have been recorded. Tree heliotrope and pisonia (*Pisonia grandis*) are the dominant trees in a forest at the southern end of the island, and pandanus (*Pandanus tectorius*) is also abundant on the island. The Pitcairn islanders use Oeno as a holiday island, and have introduced several trees for their use, such as Norfolk Island pine (*Araucaria heterophylla*) and calophyllum (*Calophyllum inophyllum*).

Pitcairn's forests have been more heavily altered by the island's inhabitants. Less than 30% of the island is today covered with natural forest, mostly in the inaccessible valleys. Common trees here include the endemic *tapau* (*Homalium taypau*), *rata* (*Metrosideros collina*), beach hibiscus (*Hibiscus tiliaceus*), Pacific banyan (*Ficus prolixa*) and two *Glochidion* species, one endemic to the island and the other found on just one other island, in French Polynesia. Rose apple (*Syzygium jambos*) is an introduced timber and fruit tree that has become invasive and now covers significant areas of the island. Agriculture, scrub vegetation and ferns cover most of the remaining land.

Henderson Island is the largest island in the group. It has been uninhabited since around the 15th century and is today mostly covered by undisturbed natural forest. On the central plateau is a limestone forest dominated by pisonia, *Celtis pacifica* and the endemic *Nesoluma st-johnianum*. There is also an endemic sandalwood variety, *Santalum insulare* var. *hendersonense*. Pandanus is very common, covering perhaps 15% of the island. Coastal forest trees include tree heliotrope, scaevola (*Scaevola taccada*) and the introduced trees cordia or *tau* (*Cordia subcordata*) and milo or *miro* (*Thespesia populnea*).

The endemic *tapau* on Pitcairn Island. *Noeleen Smyth*

Inland vegetation of Henderson Island. *Michael Brooke*

A brief history of the Pitcairn Islands' forests

The Pitcairn Islands are extremely remote, and have been uninhabited for much of their history. A small population of Polynesians lived on Henderson Island for a few hundred years up to the 15th or 16th century, but the island has been uninhabited and largely undisturbed since then. The two atolls have never had permanent populations, and their forests have been little disturbed.

Pitcairn Island is the most accessible island and the only one where agriculture is possible. At the same time Henderson was inhabited, Pitcairn also had a Polynesian population. Like Henderson, these people had died out or left the island by the 16th century, and Pitcairn was uninhabited when the Bounty mutineers and their Tahitian companions arrived, in 1790.

Twenty-seven adults and a baby arrived on the Bounty and established the community that survives on Pitcairn to this day. They immediately set about building and equipping their homes from the forest, and *tapau* was a key timber tree. They cleared small areas of land in the valleys and began growing crops. From these small numbers, the population rose to a peak of 233 in 1937, and then declined to present levels. Over these years, much of the natural forest was cleared or logged for useful species, so that today undisturbed forest is found only in some inaccessible areas. Some trees have also been introduced, including rose apple which has become invasive and is now widespread on the island.

Milo

Milo (*Thespesia populnea*) is a medium tree that grows on coasts and behind mangroves across the entire Pacific island region. It is a very attractive tree, with heart-shaped leaves and yellow hibiscus-like flowers, and is often planted as an ornamental and as a shade and street tree. It prefers full sun, and tolerates salt and wind well, making it a useful coast windbreak species.

Milo also provides a prime carving wood that is easy to work, shrinks only slightly on drying, and is durable. The wood is used to make bowls, utensils, carved figures and other ornaments.

Milo has long been part of Pacific island culture. In ancient Tahiti, for example, the tree was planted around temples, and its leaves were used as ceremonial offerings. Branches were also attached to canoes to signify peace.

The leaves and bark are used in traditional medicines in various countries. Extracts from the tree have been shown to have anti-bacterial and anti-viral properties.

Richard Markham

Henderson Island's history is most interesting because of what has not happened. Henderson is the only raised limestone island in the Pacific that has not been affected by the arrival of Europeans in the region. Because of its remoteness and limited landing options, it has escaped military use, mining for phosphate, and clearing for agriculture and settlements. It also has very few introduced plant species, none of which has become invasive; the Polynesian rat is the only problematic alien species. Henderson is a unique example of the natural vegetation of a raised limestone Pacific island, and in recognition of this was designated a World Heritage Site by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1988.

Forest ownership and management

The Island Council is responsible for local government and administration in the Pitcairn Islands, including land use. Land tenure on Pitcairn recently underwent reform. All privately owned land was claimed by the Island Council for reallocation. This land is now under the control of the Island Council, and leased to islanders for their use. Henderson Island and Ducie and Oeno Atolls are owned by the State.

The Pitcairn Islands have a law that aims to protect endangered species, but no specific forestry law or regulations. An Environment Management Plan for the islands was drawn up in 2007, but has not been approved for implementation.

As a requirement for its World Heritage status, a Management Plan was developed for Henderson Island in 2004, in cooperation with the Pitcairn community and other stakeholders. The Plan aims to protect and conserve the flora and fauna of Henderson Island, ensure sustainable management of wood resources used by the Pitcairn Islanders, and ensure responsible tourism. A Management Committee on Pitcairn Island is responsible for implementing the Plan. To date, work has mostly focused on exploring the possibility of eradicating the Polynesian rat from the island.

Importance of the Pitcairn Islands' forests

Conservation of biodiversity

Both Pitcairn and Henderson islands have unique plant and animal communities, with many endemic species for their small size.

Pitcairn Island is thought to have between 10 and 13 endemic plant species, including the tree *tapau* and a giant fern, *Angiopteris chauliodonta*. The Pitcairn reed warbler (*Acrocephalus vaughani*) is found only on Pitcairn, and is endangered. Seabirds breeding on Pitcairn include the white tern (*Gygis alba*), the common noddy (*Anous stolidus*) and the red-tailed tropic bird (*Phaethon rubricauda*).

Henderson Island is a unique example of how raised limestone Pacific islands might look if they had not been disturbed by humans, and its importance is recognised by the world community through UNESCO. Henderson is thought to have nine endemic plants. There are four endemic land birds – the Henderson crake (*Porzana*

atra), the Henderson fruit dove (*Ptilinopus insularis*), the Henderson lorikeet (*Vini stepheni*) and the Henderson reed warbler (*Acrocephalus taiti*) – as well as 15 nesting seabirds.

Ducie and Oeno Atolls are home to hundreds of thousands of seabirds, especially petrels. An estimated 90% of the world's population of Murphy's petrel (*Pterodroma ultima*) is found on Ducie, with smaller colonies on Oeno and Henderson. The herald petrel (*Pterodroma heraldic*) and Kermadec petrel (*Pterodroma neglecta*) also nest on Ducie, as well as white terns and red-tailed tropic birds.

Income

Carved wooden handicrafts are a main source of income for the Pitcairn Islanders, which they sell to visitors mostly from passing cruise ships. Traditionally, the islanders use milo and cordia wood from Henderson Island for their carvings; they visit Henderson about once a year to collect the wood.

The Islanders also export high-quality honey to the UK and New Zealand. The bees use nectar from many of the flowering trees on the island to make the honey.

Tourism

There is little tourism in the Pitcairn Islands because of their remoteness and inaccessibility. Currently between five and 10 cruise ships normally stop at the islands each year. However, there are plans to improve transport links via French Polynesia, and to develop the tourist market. Tourist attractions are centred on the natural and the cultural heritage of the islands, and maintaining healthy forests is therefore important.

Murphy's petrels on Henderson Island. *Richard Cuthbert*

Invasive rose apple on Pitcairn Island. *Noeleen Smyth*

Threats to the Pitcairn Islands' forests

Invasive species

On Pitcairn Island the alien invasive rose apple tree is posing a significant threat to the remaining forests, as it outcompetes many of the native forest species. Where rose apple has invaded the forest, species diversity is reduced to less than half of that seen in unaffected natural forest. A recent project investigated different control options, but many of these are time consuming, and with limited funding progress has been slow.

If transport links to the islands improve, this brings an increased risk of more undesirable species being introduced.

Goats are also problematic on Pitcairn Island, as they graze new seedlings and prevent regrowth. They also graze pandanus along the coast, increasing the risk of erosion on steep slopes.

Tourism

The proposed expansion of tourism carries a risk to the forests and trees of the Pitcairn Islands. Trees may be cleared for new infrastructure, and tourist visits to the forests could have negative impacts if not managed carefully.

Looking to the future

The Pitcairn Islands' forests and trees are to some extent protected by the remoteness of the islands which limits human impacts. This may however change in the future with improved transport links. These are part of a plan to develop a more sustainable economy for the territory,

The community nursery on Pitcairn Island.

which includes developing the tourism sector and increasing the number of permanent residents to around 100.

The draft Environment Plan aims to manage these developments while protecting the fragile environment of the islands. The Plan recommends carrying out environmental impact assessments before beginning any new projects, to ensure that impacts are minimal.

Specific recommendations in the Plan that would contribute to sustainable management of the forests and trees include:

- Carrying out an assessment of the 'carrying capacity' of the Pitcairn Islands for both permanent residents and tourists in order to place appropriate limits in the different land use zones.
- Drawing up environmental codes of conduct for tourists to the islands.
- Designating and protecting nature reserves on Pitcairn Island.
- Restoring degraded habitat on Pitcairn Island, including the eradication of rose apple and replacing it with native species; expanding the island's nursery and propagating more native species, particularly those under threat; and developing a volunteer program to carry out habitat restoration work.
- Propagating and growing threatened plant species from Henderson Island and Oeno Atoll on Pitcairn Island.

Acknowledgements

Thanks to the Pitcairn Islanders, Jay and Carol Warren, Steve Waldren, Naomi Kingston, the Overseas Territories Environment Fund and the Pitcairn Island Office, Auckland.

Islanders have cleared this site of rose apple and are replanting with native species. *Noeleen Smyth*

Samoa

Maturo Paniani

Samoa at a glance
Number of islands: 9 (4 inhabited)
Total land area: 2,785 km^2
Forest cover: 60%
Population: 183,123
% population urban/rural: 21/79
GDP per capita: US$2,672
Main drivers of economy: Tourism, agriculture, fishing

Lake Lanotoo on Upolu. *Tolusina Pouli*

Summary

Much of the lowland rainforest on Upolu and Savaii has been replaced by agriculture and urban development, and the remaining natural forest is degraded. During the 1980s, the forest clearance rate of 3% per annum was one of the highest in the world. About a quarter of Samoa's plants are endemic. The forests are also important for the tourist industry and for the products and services they provide to rural communities. Samoa's Forest Policy of 2007 lays out a vision of sustainably managed, healthy forest ecosystems that provide a range of cultural, social and economic benefits as well as ecological services.

Samoa's forests

Samoa comprises two large high volcanic islands and seven smaller volcanic islands. The two main islands – Upolu and Savaii – together account for 99% of Samoa's land area. Savaii is the largest island, and is still volcanically active – the last eruption was early in the 20th century. Savaii also has the country's highest

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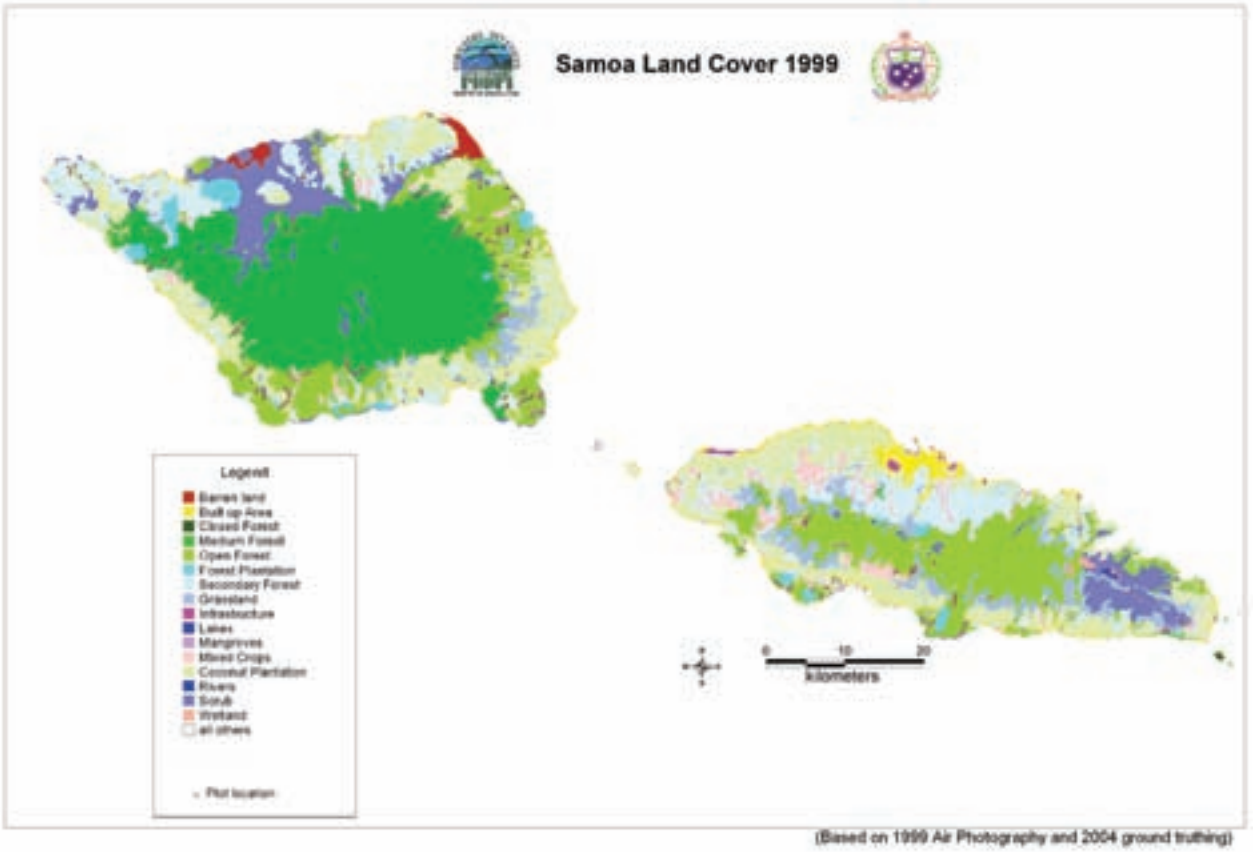

point, Mount Silisili, at 1,585 m. Upolu has the country's capital, Apia, and the majority of the population. Its highest peak is 1,116 m. Two of the small islands – Manono and Apolima – are inhabited, while five others – Nuutele, Nuulua, Namua, Fanuatapu and Nuusafee – are uninhabited.

The natural vegetation of Samoa is tropical rainforest in the interior and coastal and mangrove forest along the coasts. The rainforest includes lowland, montane and cloud forest. Today, however, much of the lowland rainforest on Upolu and Savaii has been replaced by agriculture, urban development (especially on Upolu) and introduced invasive species. Much of the montane and cloud forest is also degraded. However, Upolu and Savaii still have estimated forest cover of 47% and 69%, respectively. On Upolu, this is mostly classified as highly degraded 'open forest' with discontinuous crown cover; while Savaii has open and medium forest, which is denser but still degraded.

About a quarter of Samoa's plants are endemic. The major indigenous tree species dominating the rainforests are tava (*Pometia pinnata*), *Planchonella samoaensis*, *Dysoxylum* spp., *Syzygium inophylloides*, *Calophyllum samoense*, *Palaquium stehlinii*, *Terminalia richii*, *Diospyros samoensis* and *Canarium samoense*. Trees of the coastal forest include calophyllum (*Calophyllum inophyllum*), fish poison tree (*Barringtonia asiatica*) and casuarina or *toa* (*Casuarina equisetifolia*). Vesi or *ifilele* (*Intsia bijuga*) was formerly more common but has been logged out in many areas for its high value wood.

Mangroves (*Rhizophora samoensis* and *Bruguiera gymnorrhiza*) are found in several areas, particularly on the south coast of Upolu.

Abandoned coconut plantations are found on both Savaii and Upolu. Forest plantations are managed for timber on both islands; tree species include mahogany (*Swietenia macrophylla*), teak (*Tectona grandis*), and two eucalypts (*Eucalyptus urophylla* and *E. tereticornis*).

A brief history of Samoa's forests

The first islanders are believed to have arrived 3,000–4,000 years ago. They had limited impact on the forests over the centuries, through clearing for subsistence agriculture, harvesting for timber and other useful products, and hunting of forest animals for food.

Europeans first came to Samoa in the early 18th century.

In the 19th century the Germans played a major role in developing the islands for commercial agriculture, particularly copra, cocoa, rubber and sugarcane. Large areas of lowland forest were cleared for these crops, mainly on Upolu. In the 20th century, when the rubber trade declined, bananas were planted in its place.

Over the last century, forests have been logged for timber and cleared for agriculture and settlements. Approximately one-third of the country's forests were cleared between 1977 and 1992, with much of the timber exported. The forest clearance rate of 3% per annum was one of the highest in the world at the time. In 2007 the government of Samoa banned commercial logging in native forests, although logging is still permitted in community woodlots.

Two cyclones in the early 1990s – Cyclone Ofa in 1990 and Cyclone Val in 1991 – together destroyed many trees in Samoa, perhaps as high as 50% of trees on Upolu.

The first national Forest Policy was approved in 1994. This was reviewed and updated as the second Forest Policy in 2007. A Code of Logging Practice was drawn up in 2003. A new Forestry Management Act was approved by Parliament in January 2011, which strengthens the government ban on commercial logging in native forests.

The Forestry Division has a One Million Tree Planting Campaign under way, which began in November 2009 and continues to November 2012. By the end of the first year, 392,050 seedlings had been distributed for planting. The campaign includes awareness raising through radio, television and newspaper.

Forest ownership and management

More than 80% of Samoa's land is under customary ownership. The remainder is privately owned or government owned.

Savaii, looking towards the coast. *Lex Thomson*

Matavanu crater on Savaii, with natural regeneration 100 years after the last eruption. *Lex Thomson*

Customary land is owned by the chief or *matai*, and the extended families of the *matai* all have rights to the land. The rights pass from parents to children. Customary land cannot be subdivided or sold. Its development potential is, therefore, severely limited.

The Forestry Division's mandate includes management of forest conservation, forest production, providing forestry information, research on forestry issues, and planning sustainable forest management programs. The community plantation program is one of the most important. The program works with communities to help rehabilitate degraded forests, helps with monitoring of areas planted by farmers, and also works on government lands such as national parks.

Importance of Samoa's forests

Conservation of biodiversity

Samoa's flora is one of the most diverse in Polynesia, with about 25% of plant species endemic to Samoa and 32% endemic to the Samoan archipelago (which includes American Samoa). Many of these plants are considered threatened or endangered.

Canarium nut

Canarium nut (*Canarium indicum* var. *indicum*) has been valued in Melanesia for thousands of years for its edible nuts. It is native to eastern Indonesia, PNG, Solomon Islands and Vanuatu, where it grows naturally in lowland rainforest. Today it is also cultivated outside the forest, and has been introduced into Fiji and Samoa.

The oil-rich nut is an important contribution to the diet on many of these islands. It is eaten fresh, or roasted or smoked. It is also traded locally, providing income. As well as the nuts, the tree is used for timber, and a preparation from the bark is used medicinally. Canarium nut is also important culturally – songs, stories and dances relating to the tree have been recorded, and in the Solomon Islands the traditional calendar is based on the trees' flowering and fruiting cycle.

There is potential to develop a commercial and export canarium nut trade in Melanesia. However, there is currently great variation in the size, shape and quality of nuts. Realising the commercial potential will depend on the selection and extensive planting of superior nut types, with for example good flavour, thin shells and large nuts.

Randy Thaman

There are three native bats – the Samoan flying fox (*Pteropus samoensis*), the Pacific flying fox (*P. tonganus*) and the sheath-tailed bat (*Emballonura semicaudata*), although the latter may have disappeared from the islands. The Samoan and Pacific flying foxes are traditionally hunted for food, and numbers have declined

Terminalia richii, known locally as *malili*, is endemic to the Samoan archipelago and is one of the most cyclone-resistant trees. *Lex Thomson*

because of this and habitat loss, partly due to serious damage from tropical cyclones Ofa and Val in the early 1990s.

Thirty-five land birds are found in Samoa and 21 sea and shore birds have been recorded. Nine of the land birds are endemic – the tooth-billed pigeon (*Didunculus strigirostris*), the Samoan woodhen (*Gallinula pacifica*), the Samoan broadbill (*Myiagra abiventris*), the Samoan triller (*Lalage sharpie*), the Samoan whistler (*Pachycephala flavifrons*), the flat-billed kingfisher (*Todiramphus recurvirostris*), the Samoan white eye (*Zosterops samoensis*), the Samoan fantail (*Rhipidura nebulosa*) and the Mao (*Gymnomyza samoensis*).

Fourteen species of lizard, one of which is endemic to the archipelago (*Emoia samoensis*), and one snake (the Pacific boa – *Candoia bibroni*) are also found in Samoa.

Value to rural communities

The majority of Samoans live a rural life and the trees and forests have an important social and cultural role in their everyday lives. They provide food, fuel and medicines, garlands and perfumes, and many other products. They also have an economic role, for example many people carve handicrafts to sell. Communities also earn money from timber from community woodlots, which is processed by a small local company which operates a sawmill. Medicinal plants and preparations from forests are also traded. For example locally processed juice of the noni fruit (*Morinda citrifolia*) has a small export market.

Recreation and ecotourism

There are five national parks in Samoa. The oldest and best known is the O Le Pupu-Pu'e National Park, on the south coast of Upolu. A survey in 2007 found that 7,900 people visited Togitogiga Waterfalls Recreational area in O Le Pupu-Pu'e that year. Mount Vaea Scenic Reserve, close to Apia, is also well visited by city dwellers and tourists. The other three national parks are on Savaii. Ecotourism is also beginning to be promoted.

Threats to Samoa's forests

Commercial agriculture

Over the last couple of centuries, much of Samoa's forest has been cleared for commercial agriculture. The rate of clearance was particularly serious during the export taro boom of the 1980s when farmers rapidly expanded production, until 1992 when an outbreak of taro leaf blight destroyed the entire taro crop. However other crops have also been developed commercially and taro is recovering as new, resistant varieties are introduced to Samoa. Over the years management of soil fertility has not been given priority, and soil health is now poor. In response farmers are clearing more land, and this poses a new threat to remaining forests.

Much forest has been cleared for commercial agriculture, for example to grow taro for export. *Richard Markham*

Land tenure issues

Customary land ownership means that many people share rights to areas of land. It is difficult to plan strategic land use with such a system, as people have different ambitions for their land, and it is difficult to get consensus on a joint plan for sustainable management.

Looking to the future

Samoa's Forest Policy of 2007 lays out a vision for the country's forests, of sustainably managed, healthy forest ecosystems that provide a range of cultural, social and economic benefits and ecological services.

The Policy considers native forests and planted forests separately. For native forests, it anticipates rehabilitated forests with a full complement of their natural biodiversity, forests that protect water catchments and provide useful products to local people. The project described in the box is beginning to contribute to this vision.

The forests will contribute to the tourism business, especially ecotourism. Other potential economic benefits from the native forests include: developing the market for medicinal products, through research into forest plants and innovative benefit-sharing arrangements with multinational pharmaceutical companies; and producing water to supply bottled water and brewing industries.

The aim for forest plantations is that they will complement agriculture as a major source of employment in rural areas, they will provide timber, and they will support an export industry based on value-added forest products such as furniture, carvings, honey, nuts, noni juice, bamboo and sandalwood oil.

Protecting the native forests and water catchments is part of Samoa's Forest Policy. *Richard Markham*

Community-based forest conservation

There is little protected forest in Samoa, and formally protecting land is difficult because of customary ownership. People understand the importance of conservation, but have had little opportunity to participate in conservation activities. A new project is attempting to address this, by working with communities, building interest and skills in protected area management, and empowering people to participate in and lead conservation activities. The project is working in five villages in Samoa, with the participation of more than 7,000 people. New protected areas are being set up, and management plans are being developed with the communities. The project is also looking at incentives for biodiversity conservation and sustainable forest management, and helping communities develop these. It is also working on resource mobilisation for biodiversity conservation in the forests; mainstreaming biodiversity into other sectors; and developing supporting policy.

Lex Thomson

Tokelau

Anne Moorhead and Randy Thaman

Coconut is the dominant tree on the atolls of Tokelau. *Randy Thaman*

Summary

Tokelau's three atolls have typically poor soils and a very limited native flora. The natural forests have mostly been cleared for coconut plantations and settlements, although there are small areas of inland atoll forest and coastal forest. Tokelauans live a semi-traditional lifestyle that depends heavily on their land and marine resources, and their village agroforests are very important. The key to Tokelau's future, especially under the threat of climate change, lies in maintaining their coastal structures, and in planting and protecting the trees and plants that supply their practical needs and vital ecosystem services.

Tokelau's forests

Tokelau consists of three atolls located about 480 km north of Samoa. From north to south, the atolls of Atafu, Nukunonu and Fakaofo are separated from each other by some 64 and 92 km of ocean, respectively. All three are classic atolls with large central lagoons surrounded by reef islets. The largest island is Nukunonu with a land area of about 470 ha, followed by Fakakofo at 400 ha and Atahu at 355 ha. There are four villages – two on Fakaofo and one on each of the other atolls. Most of the approximately 12 km² of land lies between 3 and 5 m above sea level.

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Native atoll forest on the lagoon coast of Atafu. *Randy Thaman*

The islands have typically poor atoll soils with high salinity, and moderate rainfall although drought and tropical cyclones occasionally affect them. Because of the harsh conditions and isolation, the indigenous vegetation is limited to about 35 species, of which about 15 are trees or shrubs. There are also about 150 introduced plants that have been recorded, including food plants such as breadfruit, banana, taro and papaya, weeds and ornamental plants.

The main vegetation types of Tokelau are remaining small areas of inland atoll forest, coastal forest and scrub, coconut plantations, excavated taro pits, and village and houseyard agroforests, including communal pig-rearing areas. There are no mangroves in Tokelau.

The most dominant vegetation type is coconut (*Cocos nucifera*) plantations. Most of these have an understory of coconut seedlings, other smaller trees and shrubs such as scaevola (*Scaevola taccada*), and ferns such as the bird's-nest fern (one of the only vegetables available on the atolls) and the fragrant fern (*Microsorium grossum*), which is made into garlands for dancing and used in medicines.

In the small remaining areas of native atoll forest, which are mostly lagoonside, the most common species are pisonia (*Pisonia grandis*), cordia or *kanava* (*Cordia subcordata*), guettarda (*Guettarda speciosa*), lantern tree (*Hernandia nymphaeifolia*), pandanus (*Pandanus* spp.) and coconut. On the ocean coast, tree heliotrope or *tauhunu* (*Tournefortia argentea*), pandanus, coconut and guettarda are the most common species. In open scrubby areas, scaevola and the shrub or small tree pemphis (*Pemphis acidula*) are common.

On the main islets, the village and houseyard agroforests include a range of useful trees and medicinal plants. Common food trees include a number of varieties of breadfruit, edible pandanus, tropical almonds (*Terminalia*

Tropical almond

Tropical almond (*Terminalia catappa*) is found in coastal forests across the Pacific and Indian oceans, and is an important coastal protection tree. It is tolerant of strong winds and salinity, and has a spreading fibrous root system that stabilises coastal soils. It also has many useful wood and non-wood products that are highly valued by coastal communities. The timber is used to make furniture, tools and canoes, and as a fuelwood. The nuts can be eaten fresh from the shell or preserved by drying or smoking. The leaves and bark have medicinal uses, and are also used to produce dye.

Tropical almond propagates easily and is fast growing. It has potential to be developed for commercial production of timber and nuts.

Richard Markham

catappa and *T. samoensis*), native figs (*Ficus tinctoria*), papayas, and banana and plantain. Also planted are sugarcane and hibiscus spinach (*Abelmoschus manihot*). A recently introduced tree that is now successfully planted in village gardens is the drumstick or horseradish tree (*Moringa oleifera*), which has edible leaves that are rich in vitamins and minerals including iron, which are often lacking in atoll diets. Other common native and introduced multipurpose plants in the villages are cordia, calophyllum (*Calophyllum inophyllum*), premna (*Premna serratifolia*), frangipani (*Plumeria rubra* and *P. obtusa*) and Tahitian gardenia (*Gardenia taitensis*). Cordia is considered the finest carving wood in Tokelau and used

Agroforestry on Atafu. *Randy Thaman*

for making canoes, paddles, and the famous reef boxes used to store shell lures and other valuables while at sea.

The excavated taro pits, which are now found mostly on the reef islets, have giant swamp taro (*Cyrtosperma chamissonis*) planted in the pits with useful trees planted or protected nearby. The leaves of the trees are used for mulching and other purposes.

There are also extensive areas of communal pig pens on all three atolls, which are sheltered under trees such as cordia and coconut.

A brief history of Tokelau's forests

Tokelau has been inhabited for about 1,000 years. Early Tokelauans lived a traditional subsistence lifestyle, with fish, coconuts, pandanus and giant swamp taro the main staples, and over the years adding breadfruit, papaya, banana and plantain. The few indigenous tree species were put to good use for building homes and making canoes, tools, utensils, handicrafts, medicines, dyes, fish poisons and a wide range of other products. Tree species such as cordia and lantern tree were selectively harvested for their useful wood.

After the arrival of Europeans into the region, much of Tokelau's original forest was gradually replaced or modified with coconut palms to produce coconut oil and copra for export. In 1948 Tokelau became a New Zealand territory.

Cyclones can wreak havoc on small, resource-poor countries like Tokelau. Cyclones Ofa (1990) and Percy (2005) both caused extensive damage to Tokelau's fragile lands, felling trees and also killing them through seawater inundation. Coconuts, pandanus and bananas were badly affected.

Each village rears pigs in a communal pen. *Randy Thaman*

Forest ownership and management

All the land in Tokelau is under customary ownership, mostly held by family groups although some land is common land. The head of the family makes decisions on land management.

There is no formal forestry sector in Tokelau. The government department with responsibility for agriculture and forestry is the Ministry for Economic Development, Natural Resources and Environment.

Bananas are one of the few fruits that grow on the atolls. *Randy Thaman*

Importance of Tokelau's trees

Conservation of biodiversity

Tokelau's limited biodiversity makes each plant and animal species all the more important.

Tokelau has no known endemic species. About 26 bird species have been recorded, including noddies, terns and pigeons which all breed on the islands. Migratory seabirds are common visitors.

Value to communities

Tokelauans live a semi-traditional lifestyle that depends heavily on natural resources. As they have for centuries, they use local wood, particularly cordia, for building, making canoes, and for carving. Much of their food comes from their agroforestry systems, the most important trees being coconut, breadfruit, pandanus, papaya and native fig.

Threats to Tokelau's forests

Climate change

Rising sea levels threaten the future of the atolls and their trees. Climate change is also predicted to bring more frequent and more intense storms – and indeed this may already be happening.

Population growth and over-harvesting

High population densities on the atolls pose a threat to the trees, especially as it leads to over-harvesting of wood and other products. Preferred wood species such as cordia are in decline as a result.

Looking to the future

Sustainable forest management for Tokelau means planting and nurturing enough native and useful introduced trees in the remaining forests, agroforests and village and homegardens to supply the needs of the communities and provide essential ecosystem services in the future.

Nurseries to propagate useful species and supply replanting programs would be a valuable investment for Tokelau. Strengthening agroforestry systems, with particular attention to soil health, would decrease vulnerability of communities in the face of future uncertainties such as climate change. Planting for coastal protection is also an important measure against the threat of rising sea levels.

Tokelauans rely on local wood for many of their household needs. *Randy Thaman*

Strengthening agroforestry systems will reduce the vulnerability of communities on Tokelau. *Randy Thaman*

Tonga

Tevita Faka'osi and Randy Thaman

Tonga at a glance

Number of islands: 179 (36 inhabited)

Total land area: 650 km^2

Forest cover: 10%

Population: 103,365

% population urban/rural: 23/77

GDP per capita: US$2,629

Main drivers of economy: Agriculture, tourism, aid, remittances

Tongatapu's forests have been replaced by agriculture and coconut plantations. *Cenon Padolina*

Summary

Most of Tonga's natural forests have been cleared over the centuries, first to make way for coconut plantations, then for agriculture to feed a growing population and to produce crops for export. As a result, today most of Tonga's tree products and services come from rural and village agroforestry systems. With continuing population growth, the remaining forests and agroforests are under threat. In response, Tonga recently developed a Forest Policy that aims to protect and conserve the remaining natural forests, expand plantations for timber, and promote tree planting in priority areas and in agroforestry systems on bush and town allotments.

Tonga's forests

The Kingdom of Tonga has four main island groups – Tongatapu and 'Eua in the south, the Vava'u group in the north, the Ha'apai group in the centre, and the Niuas in the far north. All of the main islands of Tongatapu, Ha'apai and Vava'u groups are raised limestone islands, while the islands of the Niuas, the islands of Kao and Tofua to the

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west of the Ha'apai and a number of other islands in the west are recent volcanic islands.

Tonga has relatively little of its natural forests still surviving. Over the centuries, these have been replaced by agriculture and agroforestry systems, including coconut plantations, on most of the accessible areas of the inhabited islands. Excluding these agroforests and plantations, an estimated 10% of Tongan land is today forested. Most of this forest is found on the island of 'Eua, on the uninhabited islands, or in steep and otherwise inaccessible areas.

Tongatapu is the largest of Tonga's islands, with an area of 260 km^2 and rising to 80 m above sea level near the southeastern coast. More than half of the country's population lives here. About 72% of the land is under agriculture, and just 3% is under natural forest, mainly mangrove and coastal forest.

The main island of Vava'u is the second largest island. The terrain rises gently from the south to the north, reaching a highest elevation of 150 m. The main vegetation is coconut with an understory of secondary forest growth. Natural forest is found only on hills and headlands, and on the cliff edges on the north and western coastlines.

'Eua is the third largest island in Tonga and, geologically, is the oldest island in the Kingdom. The island rises from the west in a series of limestone terraces, to an eastern ridge that has elevation of 312 m. The largest area of remaining natural forest in Tonga is found on 'Eua along the eastern coast. Most of this area – about 450 ha – has been designated a national park. Some of the inland tree species include *Garcinia myrtifolia* and *Calophyllum neo-ebudicum* as the two dominant species, plus *Maniltoa grandiflora*, *Pleigynium timoriense*, *Dysoxylum tongense*, *Elattostachys falcata*, *Alphitonia zizyphoides*, *Rhus taitensis*, and Tonga's only native gymnosperm tree species, *Podocarpus pallidus*. Tree species in lowland and coastal sites include tree heliotrope or *touhuni* (*Tournefortia argentea*), lantern tree (*Hernandia nymphaeifolia*), scaevola (*Scaevola taccada*), *Terminalia* spp., wild nutmeg (*Myristica hypargyraea*) and *Neisosperma oppositfolium.* The only forestry plantation in Tonga is also on 'Eua, where about 500 ha of land are planted with mainly Caribbean pine (*Pinus caribaea* var. *hondurensis*) and red cedar (*Toona ciliata*) adjacent to the national park.

'Eua forest. *Christine Fung*

Mangroves on an inland lagoon in Vava'u. *Randy Thaman*

Late in the Vava'u group and Tofua and Kao in the Ha'apai group are volcanic islands with some remaining natural forest. Late's natural forest is found mainly on the slopes and inside the crater in the southwest of the island. Tofua's surviving forests are similarly found in gullies and on steep slopes in its crater and on the south and western slopes of the island.

Kao, which lies just northeast of Tofua, has the highest point in Tonga (1,046 m). The island is extremely steep and exposed. The lower part of the island has natural forest while higher parts are bare rock or grass. There is also some cloud forest on the peaks.

Niuafo'ou, the most remote island, has remnant forest on the steep sides of the caldera which is still largely intact. On Niuatoputapu, a small area of secondary forest still remains on the central ridge, while Tafahi is mostly forested, and supports a cloud forest.

Mangroves are mainly confined to the inland lagoons of Vava'u and Tongatapu and bordering the large central lake on the island of Nomuka in southern Ha'apai. The three main species present are *Rhizophora mangle*, *R. stylosa* and *Bruguiera gymnorrhiza*.

A brief history of Tonga's forests

The first significant impacts on Tonga's forests came with the international trade in sandalwood, and later copra. Sandalwood was harvested and exported beginning in the 18th century, while the copra trade got under way in the 19th century. Areas were cleared on all of the main islands for coconut plantations.

After this period, the main impact on Tonga's forests was a gradual one of increasing population pressure and commercial agriculture over the last century. The country's population increased from around 20,000 at the start of the 20th century to more than 100,000 today. This has been accompanied by conversion of the vast majority of the natural forests to agriculture and agroforests.

In the 1960s and 1970s, bananas were grown as an export crop and large areas of forest, including some mangrove and coastal forest, were cleared for this purpose, mainly on Tongatapu, Vava'u and 'Eua. Significant amounts of timber were also used to make boxes for transporting

Paper mulberry

Paper mulberry (*Broussonetia papyrifera*) is a shrub or small slender tree growing up to 12 m, and is native to Japan and Taiwan. It was an ancient introduction by the early settlers of Polynesia and Melanesia, as far east as Hawai'i, and it became important for the tapa or bark cloth produced from its bark. Today, tapa is still commonly made in Fiji and Tonga and to a lesser extent in Samoa and some parts of Melanesia, but the tree is no longer common in other countries. Tapa is used for ceremonial clothing and exchange items, string bags or for sale as a traditional handicraft. In Tonga and Fiji, large pieces of tapa cloth up to 50 m long can fetch up to US$1,000.

Tapa is made from the inner bark, which is stripped and separated from the outer bark, pounded, preserved and decorated with traditional tannins and dyes.

Only male trees were transported to the Pacific islands so that flowering and fruiting is not seen in the Pacific region. Instead, trees are propagated from root or stem cuttings. The tree is quite tolerant of climate and soil conditions, but grows best on moist volcanic soils and does not survive on atolls.

SPC

Feeding a growing population has had a major impact on the forests of Tonga. *Randy Thaman*

the bananas. More recently, from the 1980s, Tonga was growing large areas with squash for export to Japan. This contributed significantly to the removal of many of the useful trees that used to be part of Tonga's rich traditional agroforestry system. This industry is now in decline due partly to disease and competition from new producers.

In the 1950s, the Government set up a forest farm on 'Eua. Small-scale trials of exotic species were carried out, followed by larger scale plantings, mainly of pine and red cedar, but also silky oak (*Grevillea robusta*) and *Cedrella odorata*. In 1960, a forest nursery was established on Tongatapu.

The Forests Act became law in 1961, and established the Forestry Division for the management and development of Tonga's forest resources. The Act allowed for the creation of forest reserves and control of forest use, however the Act is limited in its application and not very effective.

A new Forest Policy was approved by the Government in 2009. The Policy lays out Tonga's ambitions for sustainable forest management into the future. A Code of Logging Practices was endorsed in 2009 for the monitoring of forestry activities carried out at the 'Eua Forest Plantation, and a national Code of Forestry Practices was prepared in 2010.

Forest ownership and management

Under the Constitution, all land in Tonga is the property of the Crown. Each Tongan male over the age of 16 can legally register two allotments, a town allotment and a bush allotment, of about 0.4 and 8.25 acres, respectively. Therefore most land is under the management of individual Tongans, although because of increasing population allotments are not always available.

The 'Eua plantation is owned by the Government and managed by the Tonga Timber Company. The Code of Harvesting Practice developed for the plantation helps ensure low-impact harvesting, and that soils, water and biodiversity in the plantation are protected.

The Forestry Division of the Ministry of Agriculture and Food, Forests and Fisheries works with the public, supplying tree seedlings from its nurseries for agroforestry systems, and advice and support through its extension program.

The 'Eua National Park is the largest protected area in Tonga.

Importance of Tonga's forests

Conservation of biodiversity

Tonga has about 420 species of plants, 11 of which are endemic. The forest on 'Eua is particularly important, with eight endemic species found there, and most of Tonga's ferns.

The country is home to some 20 species of land and freshwater birds. These include the Tongan whistler (*Pachycephala jacquinoti*), found only in the Vava'u group, and the Niuafo'ou megapode (*Megapodius pritchardii*), which is the last megapode surviving in Polynesia. The island of Fonualei is an important breeding ground for sooty terns (*Sterna fuscata*), with more than 100,000 birds breeding there each year.

An agroforestry allotment in Vava'u. *Randy Thaman*

Tonga has nine species of gecko, nine skinks and one snake, the Pacific boa (*Candoia bibroni*).

Value to rural communities

Traditional agroforestry systems in Tonga include the food trees coconut, breadfruit, plantain and banana, citrus species, mango, papaya, avocado, and Malay apple (*Syzygium malaccense*). In addition to these are many other trees that are useful for medicines, firewood, garlands and perfumes and other uses. Crops grown beneath include taro, giant taro, kava, yam, sweet potato and cassava. These traditional systems are the mainstay of life in Tonga, and provide the basic food and other needs for the majority of the Tongan people.

The forests and agroforests provide up to half of Tongan households with their fuel for cooking. It is estimated that more than 33,000 tonnes of wood may be burned for this purpose each year.

Selling carvings, commonly made from wood from coastal forests, brings income into rural communities. Milo (*Thespesia populnea*) and cordia (*Cordia subcordata*) are the preferred woods for this purpose.

Tourism

Tourism is increasing in Tonga, and brings significant revenue to the country. Numbers of visitors are currently around 40,000 per year.

Timber

Tonga does not produce enough timber for its own needs and therefore imports significant amounts. However, with expansion and improved management of the 'Eua plantation, the government hopes to be able to improve its domestic supply and provide up to 50% of the country's needs. This can be supplemented with timber from the bush allotment agroforestry system, and the Forestry Division is promoting timber species for allotment planting. Coconut timber using senile coconut trees from old plantations is also providing increasing amounts of useful timber.

Threats to Tonga's forests

Expanding agriculture

Commercial agriculture is a threat to the forests and the agroforests of Tonga. Intensive monoculture, as seen in recent years with squash and cassava, has replaced large areas that were under traditional agroforestry systems. Population pressure is also contributing to the problem. Illegal farming and grazing of animals is happening on plantations and forest reserves, and people are also starting to farm the uninhabited islands.

Overharvesting of wood for fuel is causing deforestation on Tonga's outer islands. *Randy Thaman*

Unsustainable harvesting

Over-harvesting of wood for fuel, woodcarving, construction, medicinal use and other purposes is causing deforestation. As supplies become limited, fuelwood is being shipped from other islands to supply the market in Tongatapu, causing deforestation on other islands. Mangroves are also being cut for fuel.

Invasive species

Cordia alliodora was one of the first exotic species introduced for trial on 'Eua Forest Farm. However it has now become an invasive species in both the 'Eua plantation and the 'Eua National Park. It is also spreading on Tongatapu and Vava'u.

Looking to the future

The population of Tonga will continue to rise in the coming years, and the threat this creates for the forests will need to be managed. The new Forest Policy aims to do this, through the protection and conservation of the remaining natural forests; expansion and careful management of plantations for timber; and tree planting programs for priority areas and agroforestry on both bush and town allotments.

A comprehensive inventory of the forests is planned as a first step. Information from the inventory will be used to produce forest maps for the management of forest resources. The inventory will categorise the indigenous

forests by species and types of biodiversity and identify priority forest areas for protection. Conserving forests in national parks and forest reserves will protect biodiversity. Watershed areas will also be protected.

Tonga will seek international funding to support its engagement in climate change related programs and activities. These might include forest conservation activities, reforestation and rehabilitation of cleared and degraded forests, especially mangrove and coastal forests, and tree planting on allotments.

Wood production from the plantations will be substantially increased by improving the productivity of the existing plantation and by increasing the area of plantation. Planting of premium tree species on allotments, both for local consumption and for export, will create valuable resources. The local sawmill industry will be modernised to improve recovery yield and to meet safety requirements. The new Code of Harvesting Practice will be enforced, and commercial forestry operations regularly monitored.

Sandalwood (*Santalum yasi*) is a high value species of potentially considerable value to Tonga, and one which the government plans to develop for export. The Forestry Division is developing a Sandalwood Management Plan to promote planting on allotments, and facilitate harvesting and export.

Finally, a review of the Forest Act of 1961 will be made to provide the legal framework and requirements for the enforcement and implementation of the new Forest Policy.

In the future, premium tree species will be promoted for planting on allotments. *Cenon Padolina*

Building resilience to climate change on 'Eua

Research has shown 'Eua to have a high risk of soil erosion, which will be made worse by deforestation and climate change, for example by more frequent and more severe extreme events such as tropical cyclones. This adds a serious threat to the forests, as people will clear new areas for agriculture if their current croplands become unusable. 'Eua was therefore selected as a pilot site for a project on adaptation to climate change. The main output of the project is a land use plan that promotes sustainable land management practices, and eases the pressure on forest areas. The project is promoting agroforestry and mixed cropping systems with appropriate climate-resilient crops, and also raising awareness in the 'Eua community about climate change, possible impacts, and adaptation measures including sustainable land management. The project is also setting up forest monitoring to measure biodiversity and other forest dynamics and to assess the vulnerability and adaptation capacity of the forest.

Christine Fung

Tuvalu

Itaia Lausaveve and Randy Thaman

Coconut woodland and agroforest is the most widespread vegetation on the atolls of Tuvalu. *Randy Thaman*

Summary

Tuvalu's atoll soils and harsh climate support only limited vegetation, and the coconut palm is by far the dominant tree. There are also small areas of inland and coastal forest on uninhabited islets. Agroforestry systems, which traditionally include coconut, breadfruit, pandanus, bananas, native fig, giant swamp taro and other useful trees, provide many Tuvaluans with most of their daily food and other needs, while mangroves and coastal forests play a critical coastal protection role. Tuvalu is the second lowest country in the world, and the greatest threat to its trees and forests is extreme climate events and climate change. Already trees are being lost as seawater encroaches on the land. Indigenous and long-established tree species that are adapted to the harsh conditions of Tuvalu's atolls are key to Tuvalu's future, both for restoring natural coastal defences and strengthening agroforestry systems to ensure food and productive security.

The forests of Tuvalu

Tuvalu is made up of nine small atolls, all inhabited.

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Coastal forest on Tepuka Islet, Funafuti. *Randy Thaman*

Funafuti has about a third of the population. The highest point on Tuvalu is just 4.5 m above sea level, making it the second lowest country in the world after the Maldive Islands in the Indian Ocean. The atolls have no surface freshwater and rely on freshwater 'lenses' below the surface, and rainwater.

Tuvalu's atoll soils are very nutrient-poor, sandy and dry, which limits the vegetation that is able to survive. Only about 300 plant species have been recorded on the islands, just over 60 being indigenous, about half of which are trees or shrubs. The remainder are introduced, although many of these may no longer be present due to the harsh conditions. There are no endemic species.

Despite severe habitat degradation, selective harvesting of high-value trees and increasing dominance of introduced species, there remains some indigenous forest vegetation. This ranges from small stands of inland forest and larger areas of coastal forest to mangroves and more extensive areas of scrub or shrubland. On uninhabited reef islets and areas away from the main settlements, indigenous species are still dominant.

The main vegetation types are inland forest and woodland; coastal forest and scrub; mangroves; coconut woodland and agroforest; excavated taro gardens; and village, houseyard and urban gardens. There are also many combinations of these categories.

The most widespread vegetation type is coconut-dominated agroforest, which contains other useful indigenous trees that are protected. Coconut is by far the dominant tree in Tuvalu, partly as a result of enthusiastic planting to supply the copra trade during the 19th and 20th centuries. Planting ceased in the mid-1980s, and plantations have to some extent been neglected since then.

Houseyard and urban agroforest gardens are also very widespread, especially on Fogafale Islet, Funafuti and in villages and government centres on the other atolls.

Tree heliotrope

Tree heliotrope (*Tournefortia argentea*) grows on coasts throughout the Pacific region, and is extremely important on some atolls where very few other trees can grow. The wood is used for fuel, canoe parts, handicrafts and tools. The tree is also highly valued in traditional medicine. In Nauru the meristem and inner bark are pounded and used to treat children's rashes, diarrhoea and fish poisoning; in Tonga an infusion of the leaves is used also to treat fish poisoning; and in Kosrae leaves are used in a restorative steam bath after a woman has given birth. The tree is also a useful windbreak, and helps stabilise coastlines.

Randy Thaman

These gardens hold a wide range of deliberately planted indigenous and non-indigenous trees and other useful plants.

Indigenous large trees in remaining forests and planted or protected trees in other areas include pisonia (*Pisonia grandis*), lantern tree (*Hernandia nymphaeifolia*), tree heliotrope or *tauhunu* (*Tournefortia argentea*), cordia or *kanava* (*Cordia subcordata*), calophyllum (*Calophyllum inophyllum*), fish poison tree (*Barringtonia asiatica*) and *Neisosperma oppositifolium*. Smaller trees include beach hibiscus or *fau* (*Hibiscus tiliaceus*), beach almond (*Terminalia samoensis*), premna (*Premna serratifolia*) and guettarda (*Guettarda speciosa*).

Houseyard and village agroforestry systems include many of these same native plants, but also a range of introduced plants such as bananas and plantains, pandanus (*Pandanus tectorius*) varieties selected for eating and for weaving materials, frangipani (*Plumeria obtusa* and *P. rubra*), and casuarina (*Casuarina equisetifolia*).

Although limited in extent, mangroves are found on all Tuvalu's atolls except Nukulaelae, in all cases along protected intertidal lagoon flats or in back-beach basins. There are only two mangrove species, the common mangrove (*Rhizophora stylosa*), and the less common red-flowered black mangrove (*Lumnitzera littorea*).

A brief history of Tuvalu's forests

Polynesians settled most of the islands of Tuvalu around 3,000 years ago. The lives of the people centred around fishing, raising pigs and chickens, and cultivating giant swamp taro. They derived many of their daily needs from the forests and agroforests. Over the centuries they had impact on the forests through clearing for settlements and agriculture, and harvesting of useful products.

Towards the end of the 19th century the islands were known as the Ellice Islands and were part of the British Gilbert and Ellice Islands protectorate. The copra trade was at its height and extensive areas of natural forest were cleared to make way for coconut plantations.

During the Second World War Tuvalu provided a base for the Allied forces. An airstrip was built on Fogafale Islet, the largest of Funafuti's islets, and thousands of personnel were housed mainly on Funafuti. As a result, many trees and mangroves were removed.

Forest ownership and management

Almost all the land in Tuvalu is owned by indigenous landowners. There are two types of land tenure – *vaevae*, where an individual owns the rights to the land, and *kaitasi*, where two or more people share the rights.

There is no official forestry department in Tuvalu – forest management comes under the Department of Agriculture.

Houseyard agroforest gardens are very widespread. *Randy Thaman*

Mangroves play a critical coastal protection role on most of the atolls. *Randy Thaman*

There is no national forest policy. Forestry activities focus on replanting of mangroves, and managing nurseries to supply local tree species for replanting schemes, particularly for coastal protection.

Importance of Tuvalu's forests

Coastal protection

The coastal protection provided by mangroves and coastal forest is vital for survival on the atolls of Tuvalu islands and will become even more critical as sea levels rise with climate change and there are more extreme events such as tropical cyclones, droughts and king tides.

Conservation of biodiversity

Tuvalu has limited biodiversity, so each species is all the more important. Those trees and plants that survive are adapted to the harsh atoll conditions, and they are vital to people's survival, for food, other forest products, coastal protection and other ecological services.

Tuvalu has one endemic gecko, *Lepidodactylus tepukapili*.

Food security

Traditional agroforestry systems, and the sea, provide most Tuvaluans with the majority of their food needs.

Seabirds, which depend on Tuvalu's remaining coastal forests as habitat, are also a significant food source for many people and important to food security. They are also an important indication to local fishermen of the presence of schools of tuna, a resource that is also important to food security. Pisonia and tree heliotrope are particularly important tree species because they provide the main nesting sites for seabirds.

Timber

The large number of senile coconuts in Tuvalu means that there is potential to develop a coconut timber industry, to supply timber for domestic use and possibly also for export. Tuvalu currently imports almost all of its commercial timber, although local timber is used for some local construction.

Threats to Tuvalu's forests

Climate change

The greatest threat to Tuvalu's trees and forests is the rising sea level associated with global warming, and the increased frequency of extreme climate events. Trees are already being lost as seawater encroaches on the land. On Nanumea, for example, part of the seawall collapsed some years ago and an estimated 8 ha of coconuts have been lost as a result. Higher sea levels will also contaminate the freshwater lenses and reduce the supply of freshwater, with negative impacts on agriculture and agroforestry.

Expanding settlements and infrastructure

The population of Tuvalu has more than doubled since 1980, and villages have expanded correspondingly, with associated clearing of trees and forest. Islands have also seen the construction of more roads in recent years. Trees and forests on the main island, Funafuti, are particularly at risk.

Saltwater intrusion on Nanumea. *Ministry of Agriculture, Tuvalu*

Population pressure is contributing to deforestation on the atolls. *Randy Thaman*

Land tenure issues

The land tenure system in Tuvalu is a significant barrier to land use planning. Under the *kaitasi* system many people can share rights to a piece of land, and this often leads to disputes over land management. Indeed, land disputes in Tuvalu are one of the most common court cases and often take a long time to resolve.

Looking to the future

Tuvalu's forests and trees are vital to the country's future. As sea level rises, the coastal defence role of the mangroves and coastal forests cannot be overemphasised. Replanting is already under way in critical coastal areas (see box).

Healthy agroforestry systems that supply the majority of the country's food are also an important goal for the coming years, replacing expensive and poor-quality imported foods. These systems can also form the basis for adaptation to both environmental and economic change, and increased population.

Indigenous and long-established trees, such as coconut, pandanus, breadfruit, banana and native fig, that are adapted to the harsh conditions of Tuvalu's atolls, are key to achieving these goals. Nurseries have already been established on five islands to supply seedlings.

A new timber industry supplied by the many senile coconut palms also holds promise for the future.

Developing a forest policy that promotes and facilitates these goals, within a sustainable forest management framework, will be a valuable next step for Tuvalu.

With the country's highest point no more than 4.5 m above sea level, Tuvalu's future is closely linked to climate change. *Randy Thaman*

Rehabilitating coastal vegetation

A mangrove replanting project, initiated by the Tuvalu National Council of Women, began on the islands of Nanumea, Nukulaelae and Nui in 2005. The women use the mangroves for making handicrafts and to obtain a black dye from the bark, but overharvesting had decimated these resources. The Department of Agriculture stepped in to help, as an opportunity to also promote mangroves for their contribution to food security, wildlife habitat, coastal protection, and other important services. The replanting was successful on Nanumea, but failed on Nukulaelae and Nui, probably because of the impact of very high spring tides.

A further project is in the planning stage on Nanumea, to protect an area that is being badly affected by high tides since the sea wall collapsed. The plan is to develop a thick barrier of native plants, with mangroves and other very salt-tolerant plants on the seaward side, and taller trees with strong root systems, such as cordia, pandanus and casuarina, further inland. The plan awaits funding.

Another project, on Funafuti, is replanting mangroves in the lagoon of Funafala Islet, to enhance the biodiversity of the lagoon. The project is hoping to expand planting to other nearby islets.

Ministry of Agriculture, Tuvalu

Wallis and Futuna

Anne Moorhead, Nicolas Ferraton and Bénédicte Hougron

Wallis and Futuna at a glance

Number of islands: 3 (2 inhabited)

Total land area: 142 km^2

Population: 13,256

% population urban/rural: 0/100

GDP per capita: US$14,700

Main drivers of economy: Subsistence agriculture, fishing, fishing licences

Crater lake and natural vegetation on Wallis. *Nicolas Ferraton*

Summary

The islands of Wallis and Futuna have both had much of their natural forests cleared, mainly for agriculture. The third island, Alofi, is uninhabited and retains much of its natural forest. Caribbean pine plantations on the two inhabited islands are coming into production, and could provide timber for the country if sustainable harvesting and local processing can be set up. Replanting, both to replenish plantations and to restore ecological services, are needed. Strengthening agroforestry systems on these two islands will also be vital, in particular improving soil health and increasing productivity on already cleared land, so that further forest clearing can be avoided.

The forests of Wallis and Futuna

The French territory of Wallis and Futuna comprises three main islands, all of volcanic origin. Wallis, also called Uvea, has rolling hills and crater lakes and rises to a maximum elevation of 131 m. The majority of the territory's population lives here. About 250 km to the

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The north coast of Futuna. *Nicolas Ferraton*

southwest, Futuna and Alofi are higher, mountainous volcanic islands. Futuna has some freshwater springs and creeks, but Alofi has no above-ground freshwater resources. Alofi is uninhabited.

The natural vegetation of the islands is tropical rainforest and coastal forest. Typical trees of the rainforest include *Calophyllum neo-ebudicum*, *Flueggea flexuosa*, *Neonauclea fosteri*, *Planchonella linggensis*, tava (*Pometia pinnata*) and *Syzygium* species such as *Syzygium inophylloides*. Typical coastal forest trees are fish poison tree (*Barringtonia asiatica*), calophyllum or *tamanou* (*Calophyllum inophyllum*), cordia or *kanava* (*Cordia subcordata*), Pacific banyan (*Ficus prolixa*), beach hibiscus (*Hibiscus tiliaceus*) and tropical almond (*Terminalia catappa*).

On Wallis, most of the natural forest has over the years been cleared for agriculture and settlements, and only remnants remain, mostly in the south and the west of the island and around the crater lakes. Coconut (*Cocos nucifera*), planted to supply the copra trade during the 19th and 20th centuries, is the dominant tree on Wallis today. There are also agroforestry systems which include trees such as breadfruit, citrus, mango and papaya. In the north of the island, some areas have been degraded by burning and subsequent soil erosion and only pandanus (*Pandanus tectorius*), ferns and a few shrubs survive – this area is called 'toafa'. Efforts have been made to rehabilitate this land by planting Caribbean pine (*Pinus caribaea* var. *hondurensis*), and these plantations cover approximately 220 ha.

Futuna has the territory's highest point at 524 m. Here remnants of cloud forest are found, and lower down the slopes some montane forest is seen in steep, inaccessible areas. However, in the more accessible areas and in the lowlands the natural forest has mostly been cleared. Again, this has caused soil erosion, and Caribbean pine plantations have been planted over about 300 ha to combat this.

Alofi is about 2 km south of Futuna. It has been uninhabited since about 1840, and is still largely covered with natural forest. Some areas have been cleared for agriculture and are farmed by people from Futuna.

Mangroves used to be found around most of the coast of Wallis, but are now mainly found on the west of the island. There are two mangrove species, *Bruguiera gymnorrhiza* and *Rhizophora mangle*. Mangroves are not found on Futuna or Alofi.

Alofi. *Service Territorial des Affaires Rurales et de la Peche*

A brief history of Wallis and Futuna's forests

The forests of Wallis and Futuna have been gradually but greatly changed over time by the inhabitants of the islands. Over the centuries, more and more land has been cleared for farming, and this has had the greatest historical impact. People also obtained building materials, fuelwood and other useful products from the forests. As populations increased, impacts increased. Because the forests of Wallis were much more accessible they have been degraded the most. The forests of mountainous Futuna and Alofi have fared better.

Many useful tree species have also been introduced over the centuries, and they have changed the shape of today's forests.

With the arrival of Europeans, more of the natural forests were cleared for coconut plantations to supply the copra trade, particularly on Wallis.

The Second World War also brought changes to the forests. American troops were stationed on Wallis and two airfields were built on the island, as well as a road network, with corresponding destruction of vegetation.

Degraded 'toafa' on Wallis, and pine plantations. *Nicolas Ferraton*

Beach hibiscus

Beach hibiscus (*Hibiscus tiliaceus*) is found throughout the tropics, usually in coastal forest where it grows as a sprawling low tree or shrub. The tree can tolerate a wide range of soils, from limestone to brackish swamps.

The wood is used for fuel, and is also used to make tools, handicrafts and canoes. The fibrous inner bark is braided and may be used as rope or made into 'grass skirts'. Leaves are used to wrap food, and also pounded to produce a dye. The beautiful fragrant flowers are often added to garlands, and the flowers, roots and bark all have medicinal uses.

Randy Thaman

Forest ownership and management

Traditionally, the land on Wallis and Futuna is owned by local communities or individual families, and decisions on land management are made by community leaders. More recently however, some land has been sold to private owners.

There is no forest policy or forest-related legislation in Wallis and Futuna. The State Service of Agriculture, Forestry and Fisheries, along with the Territory Service of Rural Affairs and Fisheries, are responsible for forestry. These services work with the customary authorities and individuals, for example to assist with reforestation programs.

There are no protected areas in Wallis and Futuna at the moment, but there are plans to establish some in the next few years. In the past, traditional land management included a system of *tapu* (taboo), where it was forbidden to cut areas of forest. This system was mainly used to protect watersheds. However, population pressure and the need to expand agriculture have taken priority in recent years, and the *tapu* system is now rarely practised.

Importance of Wallis and Futuna's forests

Conservation of biodiversity

Wallis and Futuna has relatively low biodiversity. There are about 350 indigenous plant species, of which seven are endemic. Some species that have been lost from the

Agroforestry on Futuna. *Nicolas Ferraton*

main islands of Wallis and Futuna are still found on the relatively undisturbed Alofi.

About 25 bird species nest on the islands, including the white-collared kingfisher (*Todirhampus chloris*), the Polynesian triller (*Lalage maculosa*) and the Fiji shrikebill (*Clytorhynchus vitiensis*). There are also species of flying fox, lizards and geckos.

Value to rural communities

The vast majority of the people of Wallis and Futuna live a traditional life based on subsistence agriculture and sourcing of products from the natural environment. The role of trees as a source of materials for building, carving, fuelwood, weaving, food, medicines, body ornamentation and many other products is vital to the culture and lifestyle.

Timber

The Caribbean pine plantations were planted in the 1970s and the trees are now ready for harvesting. Wallis and Futuna has until recently been importing all of its timber needs, but if a local harvesting and processing industry can be set up, the country could replace some imports with sustainably managed local wood. Sawmills have recently been set up on Wallis and on Futuna islands as a first step towards this.

Threats to Wallis and Futuna's forests

Population pressure and expanding agriculture

Most of the accessible fertile land on the inhabited islands of Wallis and Futuna has already been converted to agriculture. The main threat is now to the forests on uninhabited Alofi. Some areas of Alofi are already being farmed by people from nearby Futuna, and without any regulation this could expand in the coming years.

Land tenure

The traditional land tenure system, where most of the land is owned by local communities, presents a challenge to the authorities in their efforts to plan and regulate land use and conservation efforts. When traditional land management included a *tapu* system this was less important, but now that the system is breaking down there is a need for strategic land use planning that protects forests and trees. However, it is very difficult to get consensus where many landowners, with different needs from their land, are involved.

A pine plantation on Futuna. *Nicolas Ferraton*

Looking to the future

Moving Wallis and Futuna towards a more sustainable future depends on developing sustainable management of the forests and trees. The country is hoping to become more self-sufficient in timber and in fuel (biofuel from coconuts), for example, but these activities must be addressed within a sustainable resources management framework.

Managing the forest plantations to produce timber for local use is one of the aims for the coming years. This will require good organisation and the development of sustainable harvesting, local processing and development of the right products for the market. Replanting to ensure plantations remain productive will also be needed.

Replanting to restore ecological services is also important in the near future, for example to restore watersheds and control soil erosion. Caribbean pine is the most useful species on very poor and eroded soils, but replanting with native species is also important as these trees are well adapted to the specific conditions of the islands. A project is in the planning stages, to map seed trees on the three islands that could supply nurseries for reforestation programs. The island of Alofi should be fully protected in the future, for conservation of tree genetic resources and other biodiversity.

Strengthening agroforestry systems on Wallis and Futuna, with particular attention to improving soil health, will contribute to preserving the forests on Alofi. Increasing yields on already cleared land is the key to conserving the remaining forests.

Wallis and Futuna is beginning to process wood from the pine plantations, to supply the local timber market. *Marc Sautol-Vial*

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www.worldwildlife.org, Terrestrial Ecoregion Profiles

The 22 Pacific island countries and territories featured in this book have one thing in common – their forests offer the foundation for their sustainable future. However, the same forests also face significant threats that may stand in the way of that future. The book describes the current status of the region's forests, identifies some of the main threats they are facing, and showcases efforts to overcome these and build sustainable forest management systems. In a part of the world where forests are integral to culture and livelihoods, and where fragile environments can hold the key to economic prosperity, it is these systems that will ensure an economically, environmentally and culturally secure future for the islands and their people.