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FIELD SERIES

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EXPERIENCES IN FOREST LANDSCAPE RESTORATION (FLR)

Lessons Learnt from 17 Years of Restoration in New Caledonia's Dry Tropical Forest

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*We dedicate this report to the memory of
Christian Papineau, the first coordinator of the dry
forest programme, who sadly left us in 2017.*

Acknowledgements:



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WWF is one of the world's largest and most experienced independent conservation organizations, with over 5 million supporters and a global Network active in more than 100 countries.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by: conserving the world's biological diversity, ensuring that the use of renewable natural resources is sustainable, and promoting the reduction of pollution and wasteful consumption.

PREFACE

I recently had the pleasure to visit New Caledonia, one of nature's famous gems harbouring numerous species found nowhere else on earth. The global value represented by this diversity of species is phenomenal. Sadly, the degradation of New Caledonia's tropical forest landscapes, especially because of fire and invasive species, is regularly making headlines.

The plight of New Caledonia's dry forests exemplifies a major global challenge: since 1990 we have lost over 449 million ha of natural forest around the globe and degraded much more. Yet the most intact natural forests host an amazing biodiversity, hold a significant amount of carbon and provide ecosystem services crucial to people (e.g. watershed protection, pollination, soil stabilisation among others). These values, natural, economic and social, are behind WWF's strategy to restore degraded lands and forests around the globe; a strategy which is aligned with global commitments under the Bonn Challenge (2011) or the New York Declaration on Forests of the UN (2014) and associated financial mechanisms.

We, at WWF, are concerned given the lack of financial resources reaching priority landscapes and the complexity of the task of restoring a single forest ecosystem. Indeed, we are not just talking about putting seedlings into the ground... The WWF Network's experience has shown that to be sustainable, conservation and restoration projects must be achieved at large scale and need to seek a balance between the multiple functions of land and forests. A huge task... but one that we do not shy away from.

New Caledonia's dry forests represent a microcosm of the global challenge, yet the mobilisation of key partners in New Caledonia for the last 17 years demonstrates that solutions do exist, although they need to be up-scaled. An exemplary partnership has helped to secure some of the last remaining fragments of dry tropical forest in New Caledonia and contributed to saving from extinction rare and endemic tree species. Major advances have been made, notably through the significant knowledge acquired concerning the ecology of the archipelago's unique biodiversity and the establishment of a sustainable governance structure to take forward the dry forest programme, initiated thanks to WWF's catalytic role.

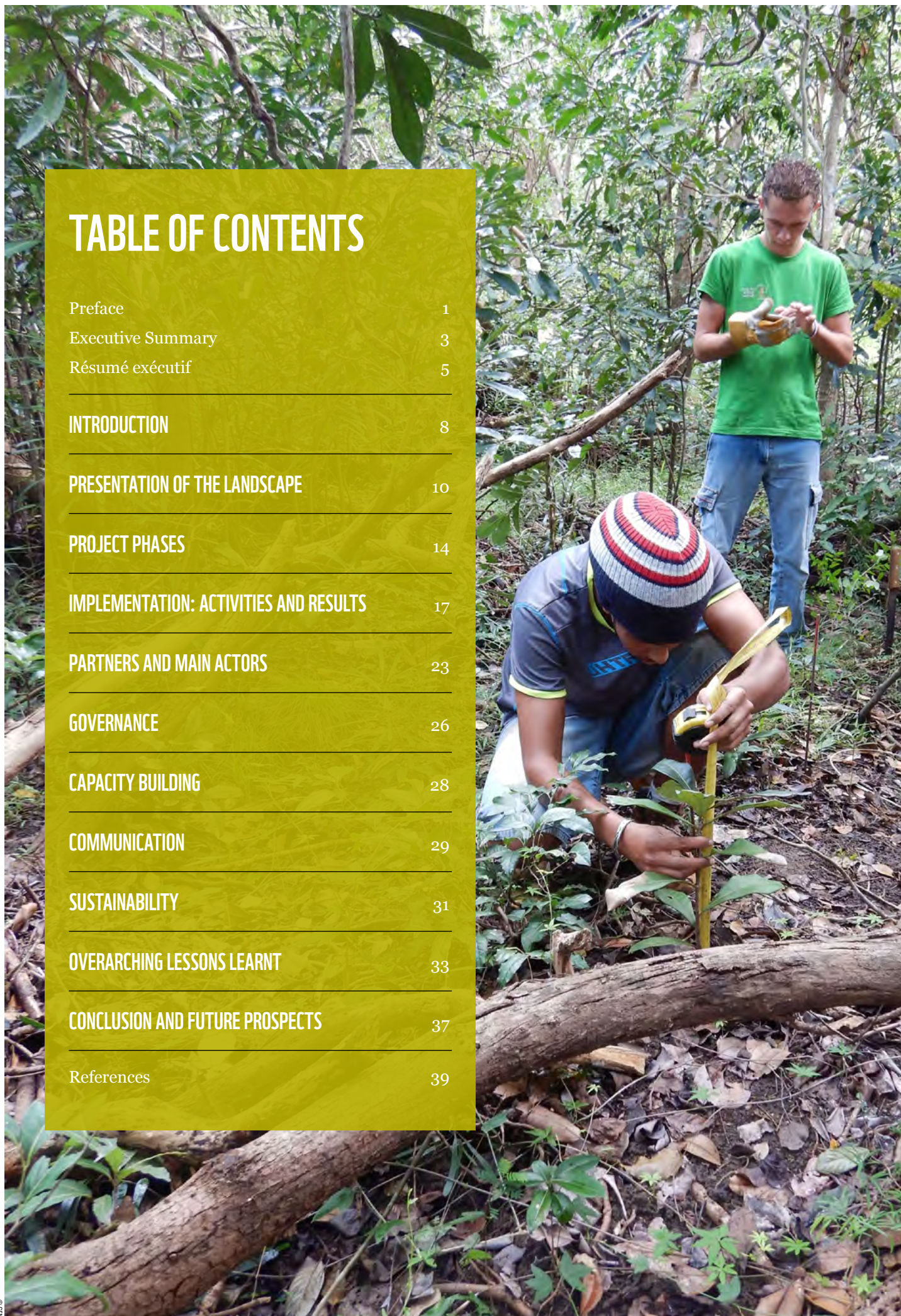
I am confident that this experience in restoring the New Caledonian dry tropical forest is of huge global value. It is with pride that I look back at WWF France's role in tackling this challenge. Indeed, in 2001, following scientists' call to action, WWF opened an office in Nouméa to help caledonian stakeholders to reverse the alarming trend. Today, through this report we aim to spread this pioneering experience across the wider globe. I am sure it will inspire all those struggling to restore the cornerstones of our natural capital: forests.



Pascal Canfin
Director general of WWF-France

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EXECUTIVE SUMMARY

Lessons Learnt from 17 Years of Restoration in New Caledonia's Dry Tropical Forest



Dry tropical forests are among the most endangered ecosystems on our planet. New Caledonia has the privilege of having such a unique ecosystem, but also the global responsibility to protect and restore it. While it once covered approximately half of New Caledonia's main island of Grande-Terre, today the dry forest only covers about 17,500 ha or 2% of its initial extent. A total of 366 plant species have been identified in New Caledonia's dry forest, of which 60.3% are endemic.

Alarmed by the state of loss and fragmentation of the dry forest, nine public and private partners mobilised in 2001 to establish the dry forest programme with the aim to conserve and restore this precious ecosystem. Ten years

later this partnership was consolidated as the 'Conservatoire d'Espaces Naturels de Nouvelle-Calédonie' (CEN) which is a legal entity.

Priority actions have included protecting fragments of dry forest from further threats notably, from invasive exotic species, by fencing to enable natural regeneration and active planting. Much knowledge was developed over the course of the programme on the ecoregion's unique flora. As a result of this knowledge generated, many more tree nurseries can today reproduce indigenous dry forest species and offer them to the wider public.

The area of dry forest fenced and thus protected from grazing animals rose from 55.9 ha (0.3%) in 2000 to 692 ha (4%) in 2017. The number of sites fenced to enable natural regeneration went from 3 to 12 between 2001 and 2017. In addition, legally established protected areas cover 127.3 ha (including a buffer zone). Overall, 178,384 saplings were put in the ground through plantation campaigns over the 17 years of the programme. A list of 68 floral species from the dry forest were submitted to the IUCN Red List of Threatened Species, and 48 saw their status revised. No species became extinct, and the *Pittosporum tianianum* was brought back from the brink of extinction. A long-term governance structure has been established (the CEN) to take the dry forest conservation programme forward and the Province Sud changed its environmental code in 2009 to provide regulatory protection of the dry forest.

Awareness raising has been a central component of the programme, and several communications and awareness raising activities have secured the mobilisation of ordinary New Caledonians. Reigniting pride in their unique natural heritage has helped to ensure stronger public support and engagement in the programme.

WWF played a catalytic role in this programme to facilitate the development of a coordinated and collaborative effort by providing both financial seed support and technical assistance. The initial programme succeeded in mobilising greater engagement the Northern and Southern provinces as well as the local New Caledonian government and French government.

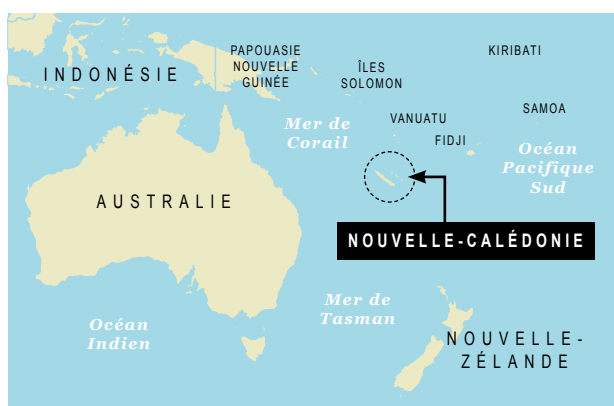
Lessons from this 17 year-long initiative are of relevance beyond New Caledonia as the tropical dry forest is a highly threatened ecosystem facing similar threats in such distant places as Hawaii, the Greater Mekong, South Africa or Central America.

Key lessons learnt over the course of this project are:

- 1 **Causes of degradation and values of forest types need to first be defined:** Conservation and restoration cannot take place without an understanding of the values of specific forests and the underlying causes of their degradation and loss.
- 2 **Ground implementation in scientific knowledge:** Solid knowledge of the ecological elements of the landscape and ecoregion provides the starting point for implementing forest landscape restoration interventions.
- 3 **A hierarchical strategy for intervention is needed:** Restoration is much more than only planting trees. It is a matter of scales (time and space) and strategy.
- 4 **Advancing practical implementation:** While understanding the ecology of species and the socio-economic dynamics within the landscape are key foundations, it is important to couple this understanding with pilot interventions for stakeholders to better appreciate the practical application of the science.
- 5 **Commit to the long term:** Restoration requires long term efforts. In New Caledonia, early public sector engagement in the programme helped to secure the necessary long term commitment.
- 6 **Consider scale and the mosaic of land use across a landscape:** Linkages in the landscape promote resilience and sustainability. Because of the highly fragmented nature of New Caledonia's dry forest, it was particularly important to consider connections across larger scales and the viability of different forest patches.
- 7 **Partner for sustainability:** Bringing diverse stakeholders together around an FLR programme supports multiplication and continuity. A partnership approach was initiated early on in New Caledonia and proved an essential foundation for all future work on restoration.
- 8 **Citizen involvement leads to stronger ownership:** the role of individual citizens is important in large scale restoration initiatives as they can support actions at different levels. This is particularly true where land ownership is largely private, as is the case in New Caledonia.
- 9 **High restoration costs call for alternative approaches:** The high per hectare costs involved in restoration generally, and in the case of New Caledonia's dry forest specifically, hamper wide-scale implementation. Other technical alternatives may be tested (e.g. passive restoration) for long term and larger benefits.
- 10 **Landscape-level thinking requires a shift in mindset:** Small, individual sites tend to fit with private ownership, and in the case of New Caledonia, with the highly fragmented nature of remaining forests. Restoration actions therefore, tend to be implemented around these sites, even if there may be a wider landscape-scale planning or desire to integrate restoration in land use planning tools.
- 11 **Design an exit strategy:** Due to the long-term nature of FLR, the leading organisation carries an important responsibility and should be willing to commit for at least 10-15 years. Furthermore, it should ensure it makes appropriate plans for its exit strategy. The role of the public sector in New Caledonia has been paramount in securing an efficient transition.

RÉSUMÉ EXÉCUTIF

Enseignements de dix-sept ans de restauration dans la forêt tropicale sèche de Nouvelle-Calédonie



Les forêts tropicales sèches comptent parmi les écosystèmes les plus menacés de notre planète. La Nouvelle-Calédonie a le privilège de posséder ce patrimoine unique, mais aussi la responsabilité globale de le protéger et de le restaurer. Car alors qu'elle couvrait autrefois environ la moitié de l'île principale de Nouvelle-Calédonie, Grande-Terre, la forêt sèche couvre aujourd'hui environ 17 500 ha, soit 2% à peine de son étendue initiale. Un total de 366 espèces végétales a été répertorié dans la forêt sèche de Nouvelle-Calédonie, dont 60,3% sont endémiques.

Alarmés par la perte et l'état de fragmentation de la forêt sèche, neuf partenaires publics et privés se sont mobilisés en 2001 pour mettre en place le programme « forêt sèche »

dont le but est de conserver et de restaurer ce précieux écosystème. Dix ans plus tard, ce partenariat a été consolidé sous le nom de « Conservatoire d'Espaces Naturels de Nouvelle-Calédonie » (CEN) qui est une entité légale.

Les actions prioritaires ont inclus la protection des fragments de forêt sèche contre les menaces demeurant actives, notamment les espèces exotiques envahissantes, par des clôtures pour permettre la régénération naturelle et les plantations. Beaucoup de connaissances ont été acquises au cours du programme sur la flore unique de l'écorégion. Grâce à ces connaissances, de nombreuses pépinières peuvent aujourd'hui reproduire des essences indigènes de forêt sèche et les proposer au grand public.

La superficie de forêt sèche clôturée et ainsi protégée des espèces envahissantes a augmenté de 55,9 ha (0,3%) en 2000 à 692 ha (4%) en 2017. Le nombre de sites protégés physiquement afin de permettre la régénération naturelle est passé de 3 à 12 entre 2001 et 2017. En plus, la surface d'aires protégées légalement établies recouvre 127,3 ha (y compris une zone tampon). Dans l'ensemble, 178 384 jeunes arbres ont été mis en terre grâce à des campagnes de plantation au cours des 17 années du programme. Une liste de 68 espèces de la forêt sèche a été soumise à la Liste rouge mondiale des espèces menacées de l'UICN, et 48 ont vu leur statut révisé. Aucune espèce ne s'est éteinte et le *Pittosporum tianum* a été sauvé de l'extinction. Une structure de gouvernance à long terme a été établie (le CEN) pour faire avancer le programme de conservation de la forêt sèche, et la Province Sud a modifié son code de l'environnement en 2009 pour assurer la protection réglementaire de la forêt sèche.

La sensibilisation a été un élément central du programme, et de nombreuses activités de communication et de sensibilisation ont permis de mobiliser les Néo-Calédoniens. Le fait de raviver la fierté de posséder un patrimoine naturel unique a contribué à renforcer le soutien et l'engagement du public envers le programme.

Le rôle du WWF dans ce programme était d'abord de faciliter le développement d'un effort initial coordonné (rôle de catalyseur) en fournissant à la fois un soutien financier et une assistance technique. Le programme initial a réussi à mobiliser un plus grand engagement des provinces, du gouvernement local de Nouvelle-Calédonie ainsi que du gouvernement français.

Les enseignements de cette initiative longue de 17 ans sont importantes au-delà de la Nouvelle-Calédonie car les forêts tropicales sèches représentent un écosystème très menacé qui fait face à des menaces similaires dans des endroits aussi éloignés que Hawaï, le Grand Mékong, l'Afrique du Sud ou l'Amérique centrale.

Les principaux enseignements tirés au cours de ce projet sont :

- 1 **Les causes de la dégradation et les valeurs des types de forêts doivent d'abord être définies** : la conservation et la restauration ne peuvent avoir lieu sans une compréhension des valeurs spécifiques des forêts et des causes sous-jacentes de leur dégradation et de leur déforestation.
- 2 **Mise en œuvre sur le terrain des connaissances scientifiques** : Une solide connaissance des éléments écologiques du paysage et de l'écorégion constitue le point de départ de la mise en œuvre des interventions de restauration des paysages forestiers.
- 3 **Une stratégie hiérarchisée d'intervention est nécessaire** : la restauration est bien plus que seulement planter des arbres. Les échelles d'intervention (temps, espace) comptent.
- 4 **Promouvoir une mise en œuvre pratique** : bien que la compréhension de l'écologie des espèces et la dynamique socio-économique du paysage soient des fondements clés, il est important de coupler cette compréhension avec des interventions pilotes pour les parties prenantes afin de mieux comprendre l'application pratique de la science.
- 5 **S'engager à long terme** : la restauration nécessite des efforts à long terme. En Nouvelle-Calédonie, l'engagement précoce du secteur public dans le programme a contribué à le garantir.
- 6 **Considérer l'échelle et la mosaïque d'utilisation des terres à travers un paysage** : les liens dans le paysage favorisent la résilience et la durabilité. En raison de la nature très fragmentée de la forêt sèche de Nouvelle-Calédonie, il était particulièrement important de considérer les connexions à plus grande échelle et la viabilité des différentes parcelles forestières.
- 7 **Les partenariats sont essentiels pour la durabilité** : réunir diverses parties prenantes autour d'un programme de restauration des paysages forestiers favorise la multiplication et la continuité des actions. Une approche partenariale a été initiée dès le début en Nouvelle-Calédonie et s'est révélée être une base essentielle des travaux de restauration qui ont suivi.
- 8 **La participation des citoyens conduit à une plus grande appropriation** : le rôle des simples citoyens est important dans les initiatives de restauration à grande échelle car ils peuvent soutenir des actions à différents niveaux. Cela est particulièrement vrai lorsque la propriété foncière est largement privée, comme c'est le cas en Nouvelle-Calédonie.
- 9 **Les coûts nécessitent une réflexion alternative** : les coûts élevés par hectare de la restauration en général, et dans le cas de la forêt sèche de Nouvelle-Calédonie en particulier, entravent la mise en œuvre à grande échelle. D'autres techniques alternatives peuvent être testées (restauration passive notamment) pour obtenir des bénéfices plus grands et à long terme.
- 10 **Penser au-delà du niveau du site nécessite un changement de mentalité** : les petits sites individuels tendent à s'accorder avec la propriété privée, et dans le cas de la Nouvelle-Calédonie, avec la nature très fragmentée des forêts restantes. Les actions de restauration ont donc tendance à être mises en œuvre autour de ces sites, même s'il peut y avoir une planification à l'échelle du paysage plus large ou un désir d'intégrer la restauration à l'aménagement du territoire.
- 11 **Concevoir une stratégie de sortie pour le WWF** : en raison de la nature à long terme de la restauration des paysages forestiers, l'organisation principale assume une responsabilité importante et devrait être prête à s'engager pendant au moins 10 à 15 ans. En outre, elle devrait s'assurer de faire des plans appropriés pour sa stratégie de sortie. Le rôle du secteur public en Nouvelle-Calédonie a été primordial pour assurer une transition efficace.



INTRODUCTION

Situated in the Pacific Ocean, 1,200km east of Australia, the French overseas territory of New Caledonia boasts a unique flora. Exceptional rates of floral endemism characterise this remote archipelago. In 2000, New Caledonia's dry tropical forest was identified as one of WWF's 238 priority ecoregions (Olson and Dinerstein, 2002) and the whole archipelago is classified as one of the world's 25 biodiversity hotspots (Myers *et al.*, 2000).

The dry tropical forest lies along the west coast of New Caledonia's main island of Grande-Terre, where the capital city of Nouméa can be found, and where European settlers first established their communities in the mid-19th century. The ecoregion represents about a third of Grande-Terre and ranges from sea level to about 500m of altitude, as defined in the Province Sud's environmental code (Article 232-3; Province Sud, 2017). It straddles two of the country's three provinces (Province Nord and Province Sud). The tropical dry forest ecoregion of New Caledonia is one of only a few such fragile ecosystems with other dry tropical forests found for example, in Hawaii, Costa Rica and other parts of Latin America.

THE ENTIRE
NEW CALEDONIAN
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BIODIVERSITY
HOTSPOTS.

Restoration was prioritised by WWF in New Caledonia starting in the late 1990s when scientific surveys first revealed on the one hand the uniqueness of the ecosystem, and on the other its current state of degradation, fragmentation and overall loss. The restoration approach promoted by WWF was 'forest landscape restoration' (FLR) which aims to restore the functions – such as protecting water sources, fields, pollination and the provision of food and other materials - that trees provide to nature and to people in deforested or degraded landscapes. It was defined in 2000 by a group of experts as “*a planned process that aims to regain ecological integrity and enhance human wellbeing in deforested or degraded landscapes*” (WWF and IUCN, 2000). The process explicitly emphasises both a human and an ecological dimension recognising the need to secure short term benefits for people while aiming to improve ecological integrity. Forest landscape restoration was promoted by WWF as a new option in a context where conservation stakeholders in New Caledonia were mainly trying to develop reclamation after mining and site level conservation (Vallauri and Géraux, 2004).

FLR in WWF's Global Forest Programme

WWF's 2001-2006 'Forests for Life' programme centred around three targets: a protected areas target, a sustainable forest management one and an FLR one. The FLR target was “to undertake at least twenty FLR initiatives in the world's threatened, deforested or degraded forest regions to enhance ecological integrity and human well-being by 2005”. WWF contributed specific steps along the way to this global target, including leading the implementation of 10 FLR long term initiatives.

Outside of the WWF network, much has been achieved at an international level to raise FLR's political profile and to advance technical understanding through implementation in key landscapes (Mansourian and Vallauri, 2014).

Today, WWF's Global Forest Strategy aims to contribute to the international ambition to restore “350 million hectares of forest landscapes” by 2030 (New York Declaration on Forests and Bonn Challenge on FLR). These global efforts aim to reverse the trend of forest loss and degradation by putting an emphasis on restoring the ecological functions of degraded forest landscapes.

Remaining fragments of dry tropical forest on Pic aux chèvres, north of Nouméa. Urban sprawl is one of the main causes of deforestation in New Caledonia (together with overgrazing, invasive species and fires).



© N. Petit/WWF

In 1998 a first comprehensive assessment of New Caledonia's dry forest ecoregion was undertaken by scientists from the 'Institut de Recherche et de Développement' (IRD). Their findings were alarming: less than 1% of the dry forest ecosystem remained (Papineau, 2004). With knowledge came the call for action. In the late 1990s the need to conserve existing fragments of dry forest, and restore connections across the landscape was recognised as a priority by several stakeholders and a strategy was designed to conserve and restore the dry forest ecoregion. In 2001, WWF's dry forest programme was launched, with one component dedicated to forest landscape restoration. WWF played a catalytic role in the programme and convened the following eight public and private partners: the French State, the government of New Caledonia, the main island's two provinces (Province Nord and Province Sud), the University of New Caledonia (UNC), the 'Institut Agronomique néo-Calédonien' (IAC), the 'Centre d'initiation à l'Environnement' (CIE) and the 'Institut de Recherche pour le Développement' (IRD). Conservation International (CI) later joined the partnership in 2004.

Since it was apparent that conservation alone of the remaining fragments would not suffice to establish a viable ecosystem, the programme was designed to include not only protection of existing dry forest sites, but also active and passive forest restoration. Successfully established in 2001 and funded for five years as of 2002, the 'dry forest programme' was composed of five themes, one of which was forest restoration. By regrouping key local partners, representing public, private and research actors, the programme was in a unique position to push conservation measures for the ecoregion.

PRESENTATION OF THE LANDSCAPE

The context of 'landscape' in the New Caledonia dry forest ecoregion is applied both as a synonym with the whole ecoregion (given its size) and also as individual components ('functional landscapes') within the broader ecoregion (Figures 1 to 3).

Rates of endemism for vascular plants in the whole archipelago have been estimated at 75.1% (Munzinger *et al.*, 2016). A total of 366 plant species have been docu-

mented in New Caledonia's dry forest, of which 60.3% are endemic (Munzinger *et al.*, 2016) with numerous species listed as endangered or critically endangered in the IUCN Red List of Threatened Species. Some dry forest plants exhibit unique characteristics such as small hard leaves that enable them to withstand the long periods of drought that characterise the region. A number of dry forest species present unique global and local values. For example, a wild relative of cultivated rice, *Oryza neocaledonica*, was discovered in 1993 and found to have genes resistant to diseases which could be of great value for food security. The potential medicinal value of some plants is also worth highlighting with for example substances from dry forest plants identified as an inhibitor of the chikungunya virus (Bourjot *et al.*, 2014). And their cultural value for the indigenous population, the Kanaks, is also noteworthy (Grange, 2012). The dry forest's faunal diversity has been less researched, with interesting diversity identified among invertebrates such as the endemic giant snail *Placostylus spp.* and the ladybug *Stethorus proximus*, or vertebrates such as the gecko *Bavaya exsuccida* or the dwarf skink of Pindaï *Nannoscincus hanchisteus*.

Today much of the dry forest has been lost or degraded and what remains is composed of over 700 small fragments of between 0.02 ha and 845 ha (with only about 80 being over 50 ha in size). They are scattered over an area estimated at 17,500 ha (Rota, 2016) or about 2%, of their expanse 3,500 years ago. The majority of the forest has been converted and replaced by agriculture (mainly cattle breeding) or infrastructure.

Viability of the dry forest is at stake, with forest fragments disconnected, many of them being precariously small and none of them safe from fire, urbanisation, agriculture and invasive exotic species, such as Javan Rusa deer (*Rusa timorensis*), rats (*Rattus rattus*, *R. norvegicus* and *R. exulans*), feral pigs (*Sus scrofa*), electric ant (*Wasmanina auropunctata*), cat's claw creeper (*Macfadyena unguis-cati*), Palay rubbervine (*Cryptostegia grandiflora*), Mauritius hemp (*Furcraea foetida*), Marsh fleabane (*Pluchea odorata*) or wild mimosa (*Leucaena leucocephala*) (Bouchet *et al.*, 1995). Exotic species represent a formidable threat for dry forest species with over 2000 species of plants and over 500 invertebrate species having been introduced into the island's fragile ecosystems. Out of these, 200 (across all categories) have been identified as invasive (CEN, 2017). As a result, many indigenous species, unable to compete, are on the brink of extinction.

In 2005, GIS mapping first helped to identify potential priority landscapes for the dry forest. As a first step the dry forest was split into three major zones - north, centre and south (Figures 2 and 3) - based on the density of forest fragments in each zone and, within these, a total of 15 functional landscapes were delimited (Matthews, 2005). The functional landscapes identified in the ecoregion are made up of a core zone, a buffer zone and potential corridors.

**TODAY, MUCH OF THE
DRY FOREST HAS BEEN
LOST OR DEGRADED;
WHAT REMAINS IS
MADE UP OF SMALL
FRAGMENTS.**

Pittosporum tanianum

A native New Caledonian plant brought back from the brink of extinction is the *Pittosporum tanianum*. Its short and dramatic history starts in 1988 when it was first discovered by researchers from the IRD. Only two plants were found in the Southern Province, facing the onslaught of grazing deer and rabbits, both of which were introduced in New Caledonia by settlers. In 1994, the species was declared extinct to science.

However, in 2002 two individuals of the plant were rediscovered by a botanist from the Southern Province's Direction of Natural Resources, then a third tree. In order not to take the risk of losing the species once again, cuttings were taken for its reproduction *ex situ*. It took a few trials before scientists were able to master the plant's reproduction, but by 2004 a technical guide was designed to ensure that the plant could be reproduced in nurseries. This plant is symbolic of the precarity of the dry forest. Although removed from the list of extinct species, it remains classified as critically endangered on the IUCN Red List and the necessary measures to secure its survival in the wild on the isle of Leprédour - including managing the populations of grazing deer, rabbits and rats - have not been effective. Although hundreds or even thousands of plants of the species have been produced and replanted in the *Parc zoologique & forestier* and in private gardens, the species remains at risk of extinction on its original site.



Saved from extinction but still critically endangered:
Pittosporum tanianum



The landscape

Figure 1.
Location of New
Caledonia's dry tropical
forest ecoregion



Figure 2. Functional landscape units in New Caledonia's dry forest ecoregion
(Source: adapted from Rota, 2016)

In terms of forest area, the north zone contains 35.6% of the dry forest, the central zone 27.4% and the south zone 37%. In contrast, the split across identified priority landscapes presents a different picture, with 30.87% occurring in the north zone, 48.45% in the central zone and 20.68% in the south zone. This initial mapping exercise was updated in 2012 (Grange, 2012) and a total of 10 landscapes were identified using the following criteria: altitude, rainfall and geology. A more recent mapping exercise has also taken place (Rota, 2016) which has brought the number of priority landscapes down to seven, but, in part because this new study considers dry forests to be up to an altitude of 500m as per the Province Sud's definition, the total area of remaining dry forest has increased to 17,500ha. Within landscapes, 59 priority sites were identified in 2017 by a working group under the CEN, based on biological criteria, vulnerability and management criteria. Out of these, 22 sites were prioritised for protection and restoration interventions. Rather than seek to significantly expand fragments, priority was given to creating ecologically diverse stepping stones across this highly fragmented landscape.

↓ Tiéa (North)



© H. Géraux / WWF

↓ Gouaro Deva (Centre)



© N. Petit / WWF

↓ Ouen Toro, Nouméa (South)



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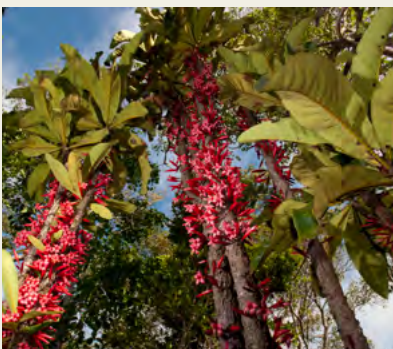
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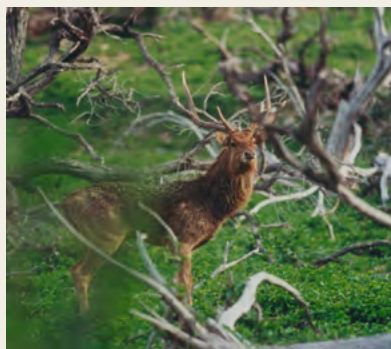
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Figure 3. The dry tropical forest landscape in a few images.

PROJECT PHASES

The dry forest programme has evolved over the course of four distinct phases. Building up from the official creation of the programme in 2001, the following milestones deserve to be highlighted (Table 1).

In the first phase (2001-2006) the overall objective was that “the dry tropical forests of New Caledonia are sustainably protected both within and outside protected areas, and natural resources that can contribute to socio economic development are managed sustainably”. Five separate components of the project focused on: 1. enhancing knowledge of the dry forest’s unique biodiversity, 2. protecting some forest fragments through fencing and agreements with landowners, 3. restoring and re-connecting degraded forest fragments, 4. raising awareness about the value of this natural heritage among local populations and 5. strengthening local capacity to better manage the dry forest. The initial five-year project was funded by the Province Nord, Province Sud, WWF International and WWF France. The French Ministry of Ecology began to provide some funding as of 2003.

Initial steps were to strengthen scientific knowledge of this unique ecosystem. Understanding the ecology and biology of the different species of the dry forest was essential as it served as a foundation for future work within the ecosystem. Two pilot projects were set up as demonstration sites (Tiéa – initially privately owned, then bought back by the Province Nord – and Mépouiri – privately owned – in Province Sud). Nékorō – the largest dry forest fragment in the Province Nord on private land - followed soon after and was fenced and protected in 2006. In these fenced sites, alternative approaches were tested for natural regeneration and active planting, and protection from fire was undertaken as an option for restoring degraded dry forest patches.

Mapping existing fragments and overlaying these with land ownership was an important component in the first phase to identify key actors with whom to engage, in particular since the majority of the dry forest is under private ownership. Understanding pressures leading to the loss and degradation of the dry forest helped to determine conservation and restoration measures (such as fencing). At the same time, efforts were undertaken to raise general awareness about the value of the dry forest, an ecosystem that was not known as such by the local population, but also to mobilise the public given the urgent need for action. Partners engaged with local stakeholders mainly through calls for mass mobilization and school projects. The wider public was engaged through ‘eco-citizen’ planting days as of 2005 with for example, the first large-scale public planting operation launched in the *Parc Forestier* in Nouméa on 6 March 2005.

In a second phase (2006-2010), the programme had the following objectives: 1. to reconnect dry forest fragments, 2. to restore degraded sites, 3. to develop the programme among local, national and international actors, and 4. to manage sustainably the dry forests of New Caledonia. During this phase, more emphasis was placed on *ex situ* reproduction of the species, notably in nurseries. In this phase, the programme was inserted into the five-year budget for overseas funding between France (Overseas Ministry) and New Caledonia. Key actions included further improving understanding of dry forest species and working with nurseries to increase their offer of these native species. Ongoing efforts with private landowners were strengthened to protect and restore dry forest fragments, including negotiating and signing new contractual agreements to secure protection and restoration on private lands. Management plans were designed for some of the key dry forest sites and pilot actions were initiated to tackle invasive species. As of 2006, pilot restoration actions (plantations) were undertaken notably in Tiéa (Province Nord) and the Pointe Maa (Province Sud).

**PROTECTING
FRAGMENTS,
RESTORING
DEGRADED SITES
AND SUSTAINABLY
MANAGING THE DRY
FORESTS OF NEW
CALEDONIA ARE THE
THREE FUNDAMENTAL
OBJECTIVES.**

Table 1. Distinct phases

Dates	Phases in the landscape	Related events
1980s-1998	<p>Pre-project phase</p> <p>Increased public awareness further to publication of an Atlas of New Caledonia, and scientific work by the ORSTOM. Discovery of the last two individual plants of the <i>Pittosporum tanianum</i> in the dry forest, one of the “most endangered forests of our planet” (Janzen, 1988). First survey of the dry forest commissioned by the Province Sud. First site protected against invasive ungulates (1994).</p> <p>Bouchet <i>et al.</i> (1995), a landmark study which motivated the mobilisation around NC’s dry forest. First survey by IRD commissioned by the Province Nord to identify priority sites for conservation (1997-99). A comprehensive analysis of the state of the ecoregion funded by German agency (BMZ), the Mac Arthur Foundation and WWF-US (1997-98).</p>	
1997-2000	<p>Programme inception phase</p> <p>A WWF delegation led by chief scientist, Eric Dinerstein (WWF-US), comes to New Caledonia to present its ecoregional strategy and discuss the plight of New Caledonia’s dry forests (1997). First efforts from WWF France and local stakeholders to develop a collaborative strategy to conserve and restore the dry forest ecoregion.</p>	
2001-2005	<p>Phase I - Dry forest ecoregional programme established. Institut Agronomique néo-Calédonien (IAC) hosts the dry forest programme. First discussions are held around the idea of a permanent structure to coordinate interventions on the dry forests (Lethier, 2004).</p>	WWF France establishes an office in Nouméa, with one full time staff dedicated to the dry forest programme.
2006-2011	<p>Phase II - The programme is inserted in the five-year budget between France and New Caledonia, thus securing its long-term support.</p>	Launch of the Bonn Challenge on Forest Landscape Restoration (2011)
2012-2016	<p>Phase III - CEN takes the dry forest programme forward (in parallel with two other priority themes: Marine World Heritage and Invasive Species).</p> <p>Legal establishment of the ‘Conservatoire d’Espaces Naturels de Nouvelle-Calédonie’ (CEN) (2011), with participation of WWF on the board of CEN.</p> <p>External evaluation of the dry forest programme supports the development of an updated strategy capitalising on experiences to date (2012).</p>	<p>- WWF reduces its financial investment in the dry forest to tackle other stakes (moist tropical forest, fires)</p> <p>- UN New York Declaration on Forests launched in 2014</p>
2017-2021	<p>Phase IV - Continuation of the CEN with a redefinition of priority sites, further funding from the governments of France and New Caledonia, local provinces and the EU through its programme Best 2.o.</p>	

First large-scale public planting operation launched in the *Parc Forestier* in Nouméa on 6 March 2005.



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**BY 2023,
THE AIM IS TO DOUBLE
THE AREA OF DRY
FORESTS UNDER
PROTECTION AND TO
MULTIPLY BY 10 THE
AREA RESTORED.**

Several communications materials were developed and broader stakeholder involvement was initiated, at a variety of levels from schools to community groups. This phase was characterised by a better understanding of the priority landscapes and the need for re-connecting fragments, supported notably by a study on the different landscapes in New Caledonia's dry forest (Matthews, 2005). By the end of Phase II, the legal status of the Conservatoire d'Espaces Naturels (CEN) was confirmed (on 28 February 2011).

Thus, by the time of the third phase (2012-2016), the programme had successfully supported the creation of the CEN and became a central part of this newly established and independent body made up of the following partners: France (represented by an Haut-Commissariat of the Republic of New Caledonia), the marine protected areas agency (Agence française pour la biodiversité since 2016), New Caledonia, the Sénat coutumier, the Province of the îles Loyauté, Province Nord, Province Sud, WWF-France, Conservation International, the Association of the mayors of New Caledonia, the French Association of the mayors of New Caledonia and the Association 'Ensemble pour la planète' (Grange, 2012). The CEN covers three priority focal themes: dry forests, marine natural heritage and invasive alien species and also has a fourth crosscutting theme. It became the 29th CEN in the French territory. The CEN represents a not-for-profit multi-stakeholder platform bringing different partners together under a formal partnership agreement (see: www.cen.nc). In this phase, the overall objective was to ensure the viability of New Caledonia's dry forests. Specific objectives identified further to the 2012 evaluation were to: 1. double the protection of dry forest, from 300 ha to 600 ha; 2. multiply by 10 the areas restored, to reach 200 ha by 2023 while reducing the costs involved, 3. coordinate and communicate, and 4. contribute to crosscutting actions. Ongoing efforts towards active and passive restoration were maintained. Many communications materials were produced, including fact sheets, flyers and posters.

The fourth phase began in 2017 and also covers a five-year period.

IMPLEMENTATION: ACTIVITIES & RESULTS

Long term FLR results build on a vast typology of actions and activities. Transdisciplinary efforts is needed to design and carry out FLR interventions. Because of the scale of interventions it is inherently more complex and multi-faceted.

Activities

To overcome the limited knowledge available on New Caledonia's dry forest, initial work centred on research, notably on ecosystem structure and composition, invasive exotic species, economic valuation and restoration methods (Oréade-Brèche-Botanic, 2012).

The scientific entities engaged in the partnership (Institut Agronomique Calédonien (IAC), Université de la Nouvelle-Calédonie (UNC), Institut de recherche et développement (IRD) led the implementation of these actions. By the time the CEN was established (2011), however, and further to an evaluation, it was felt that the time had come for more emphasis to be placed on concrete protection and restoration actions. Scientific partners continue to play a support and advisory role in the Scientific Advisory body.

In the first phase, most of the larger dry forest fragments and sites were surveyed and mapped so as to have a clear picture of their current extent and degree of fragmentation, as well as the identification of their conservation status and their owners. This exercise helped to also understand threats and therefore, to design management strategies that could be negotiated individually with landowners. Sites were prioritised for passive or active restoration based in part on their current conservation status and size. Many forest fragments are found on private land. This raised additional challenges as different strategies are needed when dealing with private owners, at times requiring extensive negotiation.

A priority has been to develop good pilot examples of restoration on public lands since it is easier to obtain the commitment of public actors because of their active participation in the dry forest partnership initially, and in the CEN more recently. For example,

Fence to protect forest from grazing Rusa deer, an invasive species introduced from Indonesia that impedes dry forest regeneration.



© P. Babin / CEN

**PILOT SITES ARE
AN INSPIRATION,
A TOOL TO LEARN
FROM PRACTICAL
EXPERIENCES.**

under the European BEST 2.0 programme, in 2016 the CEN supported the protection of the Domaine de Déva, a 400 ha area of public land. In 2015 a 75 ha plot in the Pindaï peninsula, in Province Nord, was fenced off to protect it from *Rusa* deer, while about 30 ha are being actively planted with endemic species, including the unique *Ixora margaretae*, classified as vulnerable in the IUCN Red List. Pindaï is a critical patch of forest that will help to re-connect other forest fragments and improve gene flow across the landscape. Different methods have been tested so that they may be replicated on a wider scale (CEN, 2015).

Both active and passive (fencing) restoration have been applied in the dry forest ecoregion. Mèpouiri was the first private forest to be protected already in 1994 by Province Sud (and extended in 1999 with financial support from WWF) through an enclosure enabling passive restoration on a total of 14.5 ha and the planting of 1,873 individual saplings. Securing real predator-proof fences (against feral pigs and *Rusa* deer) is essential. Although natural regeneration has been favoured, in many places active planting is a necessity to speed up the process and to tackle aggressive exotic species that block the process of natural regeneration, or in some cases, because of the particularly poor condition of the forest and the lack of seed source. For example, in the 2006-2008 period alone, a total of 17,390 plants were planted in three pilot sites (Tiéa, Maa and Malhec). Mortality rate however, was relatively high, with 4,435 plants having died, in part attributed to a drought and cicadas. The average survival rate after two years was estimated at 63% (Oréade-Brèche - Botanic, 2012). Nevertheless, more generally, insufficient follow up concerning mortality rates renders interpretation of these figures difficult. The aim has been to use all of these pilot sites as an inspiration, as examples of what can be achieved, and to learn from practical experiences.

In contrast, on private land, the largest area engaged in the project, and currently protected, covers 150 ha and represents half of the Nékoro forest (Société d'Élevage de Muéo). The cost of this endeavour amounted to 9 million CFP (about EUR 75,000) which was paid for by WWF and Province Nord.

In 2009 restoration of the Ouen Toro park in Nouméa city was launched, and 1,310 trees were planted with support from volunteers, including 220 students. Overall in the period 2012-2015, a total of 38,000 dry forest saplings were planted across the three priority sites of the *Parc Zoologique et Forestier*, the Parc du Ouen Toro and the Pindaï peninsula through a project coordinated by the CEN to support the national biodiversity strategy, with funding from the environment ministry and bringing together the Province Sud, Province Nord, WWF and the city council of Nouméa. The protected area of Ouen Toro benefits from a unique governance structure with a strong citizen movement made up of environmental associations, religious institutions, schools, sports clubs and other leisure clubs, that sponsor the restoration and management of 18 dry forest plots.

By 2010, private nurseries that were offering dry forest species had expanded and private landowners were also beginning to buy more native species from nurseries and garden centres to plant on their own properties.

Research on the role of birds in seed dispersal also helped to identify their contribution to restoration of the dry forest and to determine which trees (fruit trees in particular) could attract bird species that could play this role of seed dispersers.

Table 2. Key activities

Dates	Activities
2001-2006	<ul style="list-style-type: none"> • Survey of dry forests, mapping and development of a typology of the ecosystem; identification of priority restoration sites and functional landscape units. • Faunal and floral survey of Nékoro and Tiéa. Reptile survey in both Province Nord and Sud. Environmental analysis of Gouaro-Déva site. • Socioeconomic study; study on medicinal plants. • Collection of seeds and production of plants (72 species) in an experimental nursery. • Fencing of Pointe Maa, Beaupré, Malhec, and Nékoro (150 ha) against herbivores; protection against fire in the Pindaï peninsula; control of invasive species in Tiéa, Montagnès, Pointe Maa and Mépouiri. • Experimental plantations in <i>Parc zoologique et forestier</i>, Tiéa, Pointe Maa. Participatory plantations for awareness-raising in 7 sites. • Monitoring of dry forest structure, diversity and regeneration in Tiéa and Mépouiri. • Organisation of a regional seminar on ecological restoration of dry forests. • Design and production of educational materials, posters, panels, booklets and pamphlets on the dry forest; creation of a website; film on the dry forest. • Study on the creation of the CEN.
2006-2012	<ul style="list-style-type: none"> • Ongoing fencing work in Pic Néné, Marais Fournier and Tipenga (28 ha) • Launch of the citizen movement for the restoration of the dry forest of the Ouen Toro protected area. • Submission and registration of 67 dry forest floral species to the IUCN Red List. • Classification of the dry forest as an ecosystem of natural heritage value in the environmental code of Province Sud; classification of individual species from the dry forest in the environmental code of Province Nord. • Definition of a global plan to combat invasive species; multiplication of rare and threatened species. • Technical support, valuation of dry forest species and their promotion in landscape design. • Establishment of the CEN further to political approval.
2012-2017	<ul style="list-style-type: none"> • External evaluation of the dry forest programme, development of a new strategy and a new governance structure; new prioritisation of sites to protect and restore • Ongoing fencing (Presqu'île de Pindaï, Domaine de Déva, Tipenga, Porwi) ; ongoing effort to control invasive species in priority sites. • Restoration actions on diverse priority sites (SNB project on Ouen Toro Park, Zoological and Forestry Park of Nouméa and Pindaï Peninsula). • Completion of studies on multiplication of species, horticultural value of dry forest plants, the impact of invasive species on dry forest species, the genetics of the decollate snail and Pittosporums, and the passive restoration of the rare and endangered Ochrosia inventorum. • Establishment of an online mapping system of the dry forest. • Diversification of restoration actors through training and participatory plantation campaigns. • 6.9-hectare extension of Ouen Toro protected area.

A TOTAL OF 692 HA WERE FENCED. TIÉA IS A GOOD EXAMPLE OF FENCING ASSOCIATED WITH ENRICHMENT PLANTING AND PASSIVE RESTORATION.

Results

Between 2000 and 2017, the area of dry forest fenced and protected from grazing animals such as cattle and the invasive Rusa deer, rose from 55.9 ha (0.3%) to 692 ha (4%). The number of sites physically protected to enable natural regeneration rose from 3 to 12 between 2001 and 2017. In addition, legally established protected areas cover 127.3 ha (including a buffer zone). A good example of fencing associated with enrichment planting and passive restoration is the site of Tiéa (Figure 4).

Overall, it is a total of 178,384 saplings that were put in the ground, through plantation campaigns over the 17 years of the programme. Only 48 ha were planted, mixing plants from a dozen species (high diversity plantation, with endangered species). These were scattered across the dry forest, representing an attempt to re-create the diverse ecosystem characteristic of tropical dry forests. It also helped to establish stepping stones across the landscape for future genetic material to promote natural regeneration, and to enhance connectivity and corridors for animal species.

A list of 68 floral species from the dry forest was submitted to the Red List of Threatened Species, and 48 species saw their status revised. No species became extinct, and the *Pittosporum tianianum* was saved from extinction (secured outside its original distribution). Reproduction techniques were mastered so that 18 rare and threatened dry forest plant species could be reproduced in nurseries and planted.

In 2008 an agreement was secured with the hunters' association to manage herbivores that threaten the dry forests. Management measures concerning these invasive species (feral pigs and Rusa deer) are being undertaken on the two most important public dry forest sites (Pindai and Domaine de Déva). These actions are undertaken by local hunting associations and New Caledonia's federation of fauna and hunting in partnership with the site managers (Province Nord, Province Sud, Sem Mwe Ara).

The Province Sud changed its environmental code in 2009 to provide regulatory protection of the dry forest via its integration into the environmental code as an ecosystem of heritage importance. Table 3 highlights key results.

Propagating endemic tree seedlings of endemic species. Here Captaincookia tree (*Ixora margaretae*), an extremely rare tree species saved from extinction by the programme.



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Table 3. Key quantitative results (2001-2017)

	Key Priority Indicator	Results	
Inventory	Percentage of dry forest whose avifauna was identified	86%	
	Number of dry forest species studied, mapped and submitted to IUCN Red List	68	
Protection	Area of legally protected dry forest (official protected area status)	127 ha, including a buffer zone (0.7%) of remaining dry forests	
	Total area fenced or legally protected to allow natural regeneration	819 ha (4.7% of the remaining dry forests)	
Passive and active restoration	Number of sites under restoration	25	
	Area fenced for passive restoration	692 ha (4% of remaining dry forests)	
	Number of saplings planted	178,384	
	Number of rare and threatened dry forest plant species reproduced in nurseries and planted	18	
	Number of individuals of rare plant species reproduced in nurseries	9,800	
	Area of active restoration (planting)	48 ha	
Communication and Education	Number of views of New Caledonia's CEN You Tube channel	93,662	Out of 268,767 inhabitants
	Number of individuals who participated in educational activities in the dry forest	13,781	

Focus on Tiéa dry forest



A. Dry forest patch of Tiéa is under continuous threat

In 1982, the patch of dry forest of Tiéa was already isolated in the region (Pouenbout valley, Northern province) but still held significant patches in good conservation status. However, the deforestation and fragmentation already occurred in the site, mainly due to the development of grazing and orchard plantations. Endemic and endangered species, like Captaincookia tree (*Ixora margaretae*) were discovered in 1971. Tiéa forest is also the place where an endemic species of rice (*Oryza neocaledonica*) was first discovered in 1993. Its value to genetically improve current rice varieties for cultivation in dry zones could be important.



B. Highest degradation stage of the site was reached in the late 1990s

In 1999, pioneering conservation of dry forests in the Northern Province, the administration signed a contract with a private owner to conserve the Tiéa forest. A larger landscape approach was difficult; the priority was to save and restore the remaining patches. The forest was fenced (32.5ha) protecting remaining patches ; some stands were not yet well stocked and included exotic species.



C. Conservation status is improved by restoration activities

Within the fence perimeter, natural regeneration slowly began to restore forest cover. In 2010, the Northern Province bought the forest patch. Some enrichment plantings and management activities were undertaken or funded by the project, some with the help of local high school students. Today, Tiéa forest is home to 178 native plant species, including 74 endemic species, 9 species of reptiles, 41 species of birds... Captaincookia tree population (*Ixora margaretae*), a critically endangered species in 1998, was increased through enrichment planting. Together, Northern Province and CEN are looking after conservation of Tiéa's unique natural heritage.

0 200 400m

Figure 4. Tiéa dry forest protection and restoration: a 35 year-long perspective.

PARTNERS AND MAIN ACTORS

The rich and complex social and political history of New Caledonia reflects on its ecological history. The Kanaks are the indigenous peoples of New Caledonia and make up 35-40% of the population. Despite their long history dating back to about 1100BC (Terrier, 2010), many Kanak communities were displaced during the 1887-1946 'period of the natives', and retreated back into the mountain chain as settlers established themselves on the plains of the west coast. It has probably resulted in a

cultural loss for indigenous populations as concerns their links to the dry forest. Despite this, the dry forest programme has placed significant effort in engaging the local population so that they better understand the value of their natural heritage. For example, a cornerstone of the programme has been regular public information campaigns, including organising volunteer days to plant trees.

**OUT OF 59 PRIORITY
REMNANTS IDENTIFIED,
MOST ARE ON MIXED
PUBLIC/PRIVATE OR
PUBLIC LAND.**

Today, out of 59 priority sites identified, only one is exclusively on private or customary land, while 31 are on land that is mixed public/private and 27 are on public land. As contracts with landowners are negotiated for a limited time period, the challenge of convincing landowners and ensuring that they commit to a follow up period, arises once again after 5 or 10 years depending on the contract duration.

In addition to the local population, key actors in the programme have been the 10 partners. As noted earlier, research by the IRD was instrumental early on in launching the dry forest programme and they are also responsible for holding the database of New Caledonia's unique floral species (<http://herbier-noumea.plantnet-project.org/>). The New Caledonian Agronomic Institute (IAC) provides scientific and technical support on nurseries, follow up on active and passive restoration methods, evaluation of deer impact and advice for seed collection. Importantly, until 2012 the dry forest programme was hosted by the IAC. In 2015, six key studies were published by the IAC (CEN, 2015):

- Genetic study of the *Pittosporum* of New Caledonia;
- Study on impact of controlling introduced rodents on the demography of the *Placostylus* snail;
- Genetic study of the decollate snail of the dry forest;
- Statistical analysis of data from 2009-2010 on the impact of deer and rodents on the critically endangered *Ochrosia inventorum* (in Pointe Maa);
- Statistical analysis of data from 2009-2010 on the monitoring of natural regeneration in Pointe Maa.

Scientific partners (IAC, IRD and UNC) were particularly active in the first phase of the project when a lot of research was being undertaken to better understand the dry forest ecosystem and its species. Today under the CEN structure, the scientific actors (which include IAC, IRD, UNC and IFREMER) form part of an advisory 'scientific committee' which supports the CEN Secretariat to define its programme and actions, ensure coherence, and provide punctual advice and support, as and when necessary. Representatives from the scientific committee are also on the technical committee which provides guidance and prepares recommendations for the board, and assists the CEN management and thematic coordinators in the implementation and follow up of the strategy. Nonetheless, their role has been substantially diminished as they are no longer among the main partners of the programme. More recently, there have been calls to better tap into the scientific committee of the CEN concerning research on the broader ecosystem, restoration and individual species, in particular as recent developments have described new species such as *Podonophelium davidsonii* and *P. parvifolium*, *Codia xerophila*.

Meeting with partners co-organised by the Dry Forest Programme and WWF in 2004, led by Christian Papineau, project leader from 2002 to 2010.



© D. Villiers / WWF

Political and financial support from the Province Nord and Province Sud have been fundamental to the programme. As forest owners, both provinces have played an active role in restoring the dry forest on public sites. For example, the Province Sud harbours the *Parc Zoologique et Forestier*, a 36 ha protected area that contains one of the few fragments of dry forest in the city of Nouméa. It also mobilised significantly for the largest public site harbouring dry forest fragments, the *Domaine de Déva*, together with the managers of the site: Sem Mwe Ara. The Province Nord is also engaged in restoration in the Pindaï forest, the second largest public dry forest in New Caledonia, as well as in protecting and restoring the conservatoire de Tiéa (which was bought from a private landowner specifically for dry forest conservation and restoration - see Figure 4).

Many of the awareness raising and environmental education actions conducted in different schools were led by the New Caledonia Environmental Awareness and Education Centre. The centre also provides educational and awareness-raising activities at the community level and has produced many of the training materials (such as leaflets, posters, games etc.). Other local associations involved in awareness raising activities also include the Mocamana and CaledoClean.

As representatives of international conservation organisations, both WWF and CI have played, and continue to play, an active role to maintain the pressure for the dry forest ecoregion to be sufficiently protected and restored. Both organisations are also now seeking to ensure that a more comprehensive approach is taken across Grande-Terre's two forest ecosystems: dry forests on the west coast and moist tropical forests in the main range. Improving connectivity between the two ecosystems would improve their overall resilience. The long-term financial support provided by the French government (first through the overseas budget and later through the CEN) enabled WWF to phase out its critical initial financial support. Instead, as of 2011 WWF was able to focus its role on technical support, strengthening demonstration sites and engaging diverse actors in active restoration. The new governance structure for the programme also encourages the collaborative role between public actors and civil society.

Increasingly, over the course of the programme, the communes have become more involved in the management of dry forests, particularly the commune of Nouméa which manages the site of Ouen Toro.

WWF AND CI ARE NOW SEEKING TO ENSURE THAT A MORE COMPREHENSIVE APPROACH IS TAKEN ACROSS BOTH DRY AND MOIST TROPICAL FOREST ECOREGIONS IN GRANDE-TERRE.



Members of boards and members of scientific committee



GOVERNANCE

Broader governance matters have influenced the programme directly or indirectly over the years. On the one hand, issues of land rights have plagued New Caledonia like many other colonial territories around the world. Territorial claims by indigenous Kanaks are a result of land appropriation by settlers starting in the 19th century.

Kanaks held and managed land for centuries under customary law, however, with the introduction of French legislation, the lack of official deeds meant that these lands were considered unclaimed and available for new owners. Since 1978, a land redistribution agency, the *Agence de Développement Rural et d'Aménagement Foncier* (ADRAF) was set up to deal with land redistribution (Mansourian et al., under review). As a result of land reforms, approximately 130,000 ha of private land (880 private properties) and 30,000 ha of public land were transferred to Kanaks (either to tribes, clans or directly to individuals) (ADRAF, 2010). Clarifying ownership helps to identify partners with whom to engage in restoration. On the other hand, the process has led to a greater number of smaller plots, and therefore, a 'governance fragmentation' reflecting the physical fragmentation of the dry forest. Ownership of the dry forest falls primarily under private individuals (52%), with the public sector (government of New Caledonia, provinces and communes) owning 37% and indigenous communities, 11%.

The restoration effort engages an increasingly diverse community of actors. Citizen-led restoration campaigns play a valuable role in inter-ethnic, inter-cultural and inter-generational exchanges.



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Concerning environmental policy in New Caledonia, each province has a different framework. This has proven a challenge for the dry forest programme with the ecoregion straddling two provinces with distinct environmental policies. Thus, for example, in Province Sud, dry forests are designated as natural heritage and as such have stricter protection laws, something lacking in Province Nord where the regulation does not protect an ecosystem as such but only a list of 36 species. This dissonance in legislation makes it more difficult to assess island-wide damage to the dry forest.

Individual private owners hold 52% of dry forest. Here, in 2009, Serge Orru (former CEO of WWF-France, on the left) meets Claude Mezdorf (private owner, centre) in his dry forest remnant, with Christian Papineau (dry forest programme manager, right).



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POLITICAL VISIBILITY OF THE PROGRAMME WAS SECURED WHEN IT WAS CONVERTED INTO A LEGAL STRUCTURE, THE CEN.

The governance structure for the programme has significantly evolved over the last 20 years. Starting as a research/conservation project and a small partnership, with a project leader funded by WWF but based at the IAC, the programme obtained a more official status in 2006 when it entered into a partnership funding between France and New Caledonia's local governments. Later, in 2011, political visibility of the programme was secured when it was converted into a legal structure, the CEN. This required the creation of a specific regulatory framework (with the passing of law no 2009-970 of 3 August 2009 and the subsequent implementation decree n°2010-254 of 10 March 2010).

As a territorial body that transcends provincial borders, the CEN helps to tackle the challenges of different environmental policies in each province. The CEN has a board made up of seven public sector entities¹ and five civil society ones², and decisions are taken collectively. The president of the CEN board is a representative of either one of the three provinces or of the government of New Caledonia and is elected for a two-year renewable period. Associate members may also be invited to participate by the CEN in a consultative capacity. The CEN's mandate extends beyond the dry forest, with three main themes being led by a different manager at the secretariat of the CEN: marine heritage, invasive alien species and the dry forest programme (as well as a fourth crosscutting theme).

A scientific committee advises the CEN secretariat and is made up of representatives from the Institut pour la Recherche et le Développement (IRD), IFREMER, Institut Agronomique néo-Calédonien (IAC), Université de Nouvelle-Calédonie ; the project manager for research and technology with the Haut-Commissariat de la République and the CEN director. Its role is to assist the CEN secretariat design its programmes and workplans to be submitted to the board, and to provide scientific input into the CEN's work. Technical committees are established for each of the three themes of the CEN and made up of one or two technical representatives from each of the board member institutions and representatives from the scientific committee. While the technical committees have no decision-making power, they provide advice to the board and support the management of the CEN.

¹ The French state (represented by the High-Commissioner), the marine protected area agency (*Agence Française pour la biodiversité* since 2016), the government of New Caledonia, the 'Sénat coutumier', and the three provinces.

² WWF, Conservation International, The Association des maires de Nouvelle-Calédonie, the *Association française des maires de Nouvelle-Calédonie* and the association *Ensemble pour la planète*.

CAPACITY BUILDING

EXPANDING THE KNOWLEDGE BASE AND SHARING EXPERIENCES WITH OTHER TROPICAL DRY FORESTS IS BOTH NECESSARY AND VALUABLE.

Participatory planting by volunteers mobilised by WWF. Everybody is welcome: here a team from Direction Générale de l'Aviation Civile and Météo France.

The comprehensive dry forest programme builds capacity at two levels: firstly, a central part of the programme has been to improve scientific knowledge among programme partners and other scientists in New Caledonia, and beyond, about the dry forest's unique ecosystem, its threats and options to conserve and restore it. For example,

the ecology and management of many dry forest plant species were unknown until the start of the programme. Equally, the interactions between different species, native and invasive, were not clearly understood until experts hired under the programme were able to study these interactions. As a result, many more nurseries, public developers and private landowners are now better able to plant and tend these dry forest species.

Secondly, part of the programme has been to deliver specific training on and raise awareness of the value of the dry forest. Several target groups benefitted from the capacity building work: from students, to scientific experts, garden centre and nursery staff, local NGOs and the general public. The programme also engaged with schools to target younger generations. As part of their general education, school children were invited to take part in tree planting campaigns. A sign of success, over the course of the programme, schools began to approach the programme spontaneously, asking to participate in tree planting campaigns. Between 2001 and 2017 a total of 13,781 individuals had participated in some sort of training (mainly in the context of schools) related to dry forests. Other local NGOs have also engaged in planting campaigns, such as Mocamana, CaledoClean and SOS mangrove.

To expand the knowledge base and share experiences with other tropical dry forests, a lesson learning and exchange workshop was organised in 2004. It brought experts from Hawaii, New Caledonia and mainland France together. One useful outcome of the workshop for example was that it helped to support the design of more detailed guidelines for restoration of dry forest ecosystems but also to move from the site to the landscape scale. The dry forest programme also participated in other conferences, such as for example, the dryland forest ecoregion workshop in Cape Town in 2002 or the Australian chapter of the Society for Ecological Restoration (SER) in 2014. These represent opportunities to share New Caledonia's experience, but also to learn from those of others. Since 2012 the CEN regularly attends the annual congress of the federation of CENs (<http://www.reseau-cen.org/>) where it has the opportunity to present and share its achievements. Links have also been established since 2009 with the EU LIFE+ supported dry forest programme in the island of Reunion (<http://www.foretseche.re/>) and exchange visits have taken place (in 2016 and 2017).



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COMMUNICATION

Responding to a general lack of awareness among the population about its natural heritage, the dry forest programme sought from its very early days to engage local communities, from school children, to families and decision-makers. A website was first established in 2003 and has now been replaced by the CEN website since 2015 (<http://www.cen.nc/foret-seche/>). Printed materials produced include several fact sheets on different species, flyers, posters and other exhibition materials. However, more importantly, and in order to reignite a sense of pride among the population concerning their natural heritage, over the years, the programme, as well as its members (e.g. WWF) has organised many volunteer tree-planting events to raise awareness and mobilise a large part of the population. These are family events, which provide an opportunity for a fun half day out while also bringing in some educational elements concerning the value of the dry forest and its unique species. Due to their high visibility, many of these events have been emulated by other actors outside of the dry forest programme.

Sports as an important medium to raise awareness among kids. Bernard Laporte,

President of the French Rugby Federation, officially opens the restoration plot managed by the Rugby Girls of Ouen Toro Stadium (8-14 years old) in 2018. Girls will take care of the dry forest plantation during the year.

Bernard Laporte planted himself a seedling of *Croton insularis* under their attentive supervision.



© M. Pardi / WWF

Educational tools have been designed for schools for the most part by the 'Centre d'Initiation à l'Environnement' (CIE) which include models of the dry forests and games to engage school children and improve their understanding of the value and importance of the dry forest. Some tools are centred on classroom activities, while others are more practical and field-based enabling school children to participate actively in field observations, such as identifying dry forest plant species (see <http://www.cen.nc/documents/foret-seche/information-et-sensibilisation>).

Technical fact sheets for different dry forest species have been designed to disseminate information, notably among private nurseries and garden centres, to provide information about the species and their requirements. These have proven very useful and fill a clear gap. As a result, several more nurseries and garden centres are now selling native species and demand for native plants is growing. A beautifully-illustrated book published by the IAC researcher Gildas Gâteblé, 'Ornamental Flora of New Caledonia : Horticulture, Botany and History' includes dry forest species whose research was partially funded by the

SUSTAINABILITY

While initially planned for a five-year period, the dry forest programme continues, even if each phase has evolved significantly, notably in its funding, management and governance arrangements.

Knowledge of dry forest species has been expanded thanks to the dry forest programme. This programme has taken a comprehensive approach to restoration working on several fronts: increasing understanding of the rare dry forest species and their unique genetic features, as well as mastering their reproduction, tackling underlying drivers of forest loss, protecting remaining fragments, raising awareness about the value of this natural capital, promoting natural regeneration and working on actual planting of trees. Such a comprehensive approach increases the sustainability of the effort as some milestones and achievements (e.g. increasing understanding of the species) are a long term investment.

From a financial perspective, the programme sought early on to limit its reliance on external donors, and instead to become a central part of New Caledonia's development. Thus, as of 2007, funding was secured through a partnership funding including the French government and New Caledonia's local governments for the following five years (inter-government development contract); and this was renewed again for another five years.

THE AVERAGE COST OF RESTORATION IS HIGH, WHICH IS A MAJOR CHALLENGE CURRENTLY BEING ADDRESSED BY THE CEN.

The average cost in New Caledonia for protection and active restoration of one hectare of dry forest, was estimated at EUR 27,000 (Oréade-Brèche-Botanic, 2012). This high cost reflects the complexity involved with returning a diversity of unique species in the context of severe competition from both invasive exotic species and humans. Limited understanding of the ecology of many of the floral species used in restoration, further inflates the cost of their re-establishment. A major challenge has been to bring this cost down in order to be in a position to expand restoration activities across the dry forest. Some trials are underway notably, in the Pindaï peninsula under the Best 2.0 project to that effect.

Inserting the dry forest programme within plans at the level of communes (urban development master plans) helps to ensure that concrete actions can be effectively undertaken. These plans cover areas that are physically the closest to the landscapes in which the dry forest programme is being implemented.

The partnership approach chosen for the programme has been an important means of bringing all key stakeholders on board. While at times, it may have appeared to have slowed implementation, in the long term it proved fundamental to the sustainability of the programme by integrating the dry forest conservation and restoration programme into key decision-making milestones.

Institutionally, the programme became an independent and legal entity as of 2011 with the establishment of the CEN. This has secured the long-term sustainability of the programme as it became an established legal entity rather than a project dependent on donor cycles and insecure funding.

Table 4. Overall budget of the dry forest programme (in EUR - source: CEN)

Phase	Year	Budget (in-kind contribution excluded)	
I	2001	142,538	1,996,908
	2002	248,513	
	2003	349,778	
	2004	277,298	
	2005	457,228	
	2006	521,554	
II	2007	497,218	2,496,003
	2008	517,816	
	2009	513,391	
	2010	474,332	
	2011	493,246	
III	2012	426,222	2,253,070
	2013	485,446	
	2014	432,367	
	2015	255,918	
	2016	418,335	
	2017	234,782	
Total (2001-2017)		6,745,981	

OVERARCHING LESSONS LEARNT

Over the years, several lessons for FLR practitioners have been discussed in New Caledonia. Today, they are important for the country itself, but reflecting on the more significant lessons learnt is also crucial for FLR success in other degraded landscapes worldwide. The purpose of this section is to focus on lessons that are of value to other projects worldwide. The following lessons stand out:

1 Causes of degradation and values of forest types need to first be defined

Conservation and restoration cannot take place without an understanding of the values of specific forests and the underlying causes of their degradation and loss.

Dry forests were not only poorly researched in New Caledonia (as in other locations), but were also perceived as harbouring little value on land that could be put to seemingly better economic use. In this respect the role of science in identifying the multiple values of the forests, and improving knowledge and understanding, eventually served to mobilise local actors to conserve and restore this ecologically important ecosystem. This process takes time, however, as witnessed by the experience in New Caledonia.

2 Ground implementation in scientific knowledge

Solid knowledge of the ecological elements of the landscape and ecoregion provides the starting point for implementing forest landscape restoration interventions.

The role of scientific actors was central in the first phase of the project, with many studies being conducted. In just a few years the research expertise of French organisations (IRD, IAC) and international partners revealed key elements of dry forest ecology. In later phases, however, this role was minimised. This was a conscious choice as a result of the programme's periodic reappraisal and evaluation, which emphasised the need to move to concrete actions. Knowledge about socioeconomic parameters is also important if local stakeholders are to be effectively engaged, particularly in New Caledonia where about half of the dry forests are on private land. For example, in this particular context, given the pressure on the dry forest, an exclusive emphasis on tree planting would have been a fruitless exercise. Instead a comprehensive understanding of pressures, and options to work together with local stakeholders to minimise these pressures was essential for the long term future of the dry forest.

3 A hierarchical strategy for intervention is needed

Restoration is much more than only planting trees. It is a matter of scales (time and space) and strategy.

In New Caledonia, the degradation context and local perception of the problem by stakeholders forced the project to start by saving first remaining fragments of dry forest and highly endangered species. Fencing, enrichment planting and passive restoration were used on a limited area but produced significant results. Plantations were developed under different restoration pathways: enrichment and undercover planting, reintroduction of endangered species, plantation of high tree diversity plots ('stepping

stone' strategy). Although a comprehensive understanding of the stakes at landscape and ecoregional levels was developed among partners, challenges remain to scale-up and to try to restore connectivity and the area of dry forest. To achieve that goal in a financially affordable way, new restoration pathways need to be developed (e.g. using dry forest pioneer species on a large scale to reconnect patches and establish the conditions for full restoration of dry forest diversity in the long term).

4 Advancing practical implementation

While understanding the ecology of species and the socio-economic dynamics within the landscape are key foundations, it is important to couple this understanding with pilot interventions for stakeholders to better appreciate the practical application of the science.

Better linking research and practice serves not only to build practical implementation on sound science, but it also enables science to learn better from practice. A divide between the two can be counterproductive as it may delay implementation and alienate some stakeholders. It underlines the tension between achieving a solid understanding of ecosystems, individual species and their interactions and needs in order to better inform restoration, and the desire to achieve concrete and visible actions on the ground. Furthermore, it fails to recognise that although a focus on understanding individual species is important, so is an integrated and ecosystem-wide approach in the context of FLR. In New Caledonia, because of limited knowledge on the dry forest and its species, some actions, notably related to combatting exotic invasive species, took a few years before they were implemented and visible on the ground.

5 Commit to the long term

Restoration requires long term efforts. In New Caledonia, early public sector engagement in the programme helped to secure the necessary long term commitment.

Long term engagement is particularly important in the New Caledonia dry forest case. While initially established for five years, 17 years later the programme is still ongoing, and the dry forest remains under threat. Although many achievements can be highlighted, the ecosystem is far from being in recovery. Forest landscape restoration champions, such as WWF, play an important role in ensuring that this long-term perspective is applied, and that there are mechanisms in place to ensure that the effort can be sustained.

6 Consider scale and the mosaic of land use across a landscape

Linkages in the landscape promote resilience and sustainability. Because of the highly fragmented nature of New Caledonia's dry forest, it was particularly important to consider connections across larger scales and the viability of different forest patches.

A larger perspective may be appropriate to help buffer the smaller fragments of dry forest, particularly in the context of a relatively small (and narrow) territory as is the case in New Caledonia. While the dry tropical forest perspective is important given its unique species, thinking and acting beyond the ecosystem in this particular instance, is important. In the case of New Caledonia, in a proven context of climate change and

possible altitudinal migration of ecological niches, considering the linkages with the mesophyllous and moist tropical forests along the centre and eastern coast of Grande-Terre would contribute to the resilience of the dry forest.

7 Partner for sustainability

Bringing diverse stakeholders together around an FLR programme supports multiplication and continuity. A partnership approach was initiated early on in New Caledonia and proved an essential foundation for all future work on restoration.

Although in some respects, it proved to be a longer process, the partnership approach in New Caledonia served to establish important foundations for the long term sustainability of the programme. It brought diverse actors together, all of whom were important stakeholders. For example, the research institutes had a stake in better understanding the ecosystem, the local government is a large landowner and had a stake in securing the dry forest while the NGO actors were also concerned about the state of the ecosystem and could mobilise additional stakeholders – such as private landowners and youth - and catalyse action. Equally, successful collaboration with communes shows the importance of broadening the partnership base. This enlargement continues since WWF's philosophy is to share the role of recovering the unique dry forest with the greatest number of actors and in particular with the users of these forests and neighbouring areas who should be co-managers.

8 Citizen involvement leads to stronger ownership

The role of individual citizens is important in large scale restoration initiatives as they can support actions at different levels. This is particularly true where land ownership is largely private, as is the case in New Caledonia, but also on heavily used public forests.

In New Caledonia, citizens were actively engaged in tree-planting operations, thus improving their understanding and sense of pride in their natural heritage. As a result, a multiplier effect took place with additional tree planting initiatives spawned from the programme leading to replication of restoration activities across New Caledonia (often without any financial support from the programme). These citizen initiatives also occur at the level of the individual with more and more people favouring native plants, including dry forest species, to the exotic species traditionally favoured by garden centres (some of which are at the origin of severe biological invasions).

9 High restoration costs call for alternative approaches

The high per hectare costs involved in restoration generally, and in the case of New Caledonia's dry forest specifically, hamper wide-scale implementation. Other technical alternatives may be tested (e.g. passive restoration, invasive species control) for long term and larger benefits.

While natural regeneration is frequently cited as the cheaper option, evidence in New Caledonia demonstrates that the cost of keeping alien invasive species out and promoting natural regeneration in combination with enrichment planting can severely constrain wide-scale restoration. Alternative solutions are necessary to bring these costs down so as to make them accessible more widely, viable in the long term, and to justify setting land aside for restoration. Such solutions include investing in ecological engineering (e.g. promoting pioneer species, sowing or planting under cover of invasive species, etc.) to allow the return of the native forest structure at lower cost.

10 Landscape-level thinking requires a shift in mindset

Small, individual sites tend to fit with private ownership, and in the case of New Caledonia, with the highly fragmented nature of remaining forests. Restoration actions therefore, tend to be implemented around these sites, even if there may be a wider landscape-scale planning or desire to integrate restoration in land use planning tools.

Concretely, in New Caledonia, the cultural and tenurial contexts of landscape planning constrained the development of restoration to small sites in the first years of the project. It is only recently that stakeholders are willing to truly plan at large scale.

11 Design an exit strategy

Due to the long-term nature of FLR, the leading organisation carries an important responsibility and should be willing to commit for at least 10-15 years. Furthermore, it should ensure it makes appropriate plans for its exit strategy. The role of the public sector in New Caledonia has been paramount in securing an efficient transition.

While WWF played a key role at the start of the dry forest restoration programme, the new structure, the CEN, presents a success story for the sustainability of the programme. The restoration of the dry forest of New Caledonia is clearly a long-term endeavour. However, the specific role of WWF (early warning, engaging partners, influencing institutionalisation of FLR and dry tropical forest conservation...) enabled the organisation to gradually reduce its involvement. Today, although WWF plays a critical role when it comes to maintaining pressure on political actors and raising the bar of ambition for the programme, it no longer plays a central financial role.

CONCLUSION AND FUTURE PROSPECTS

The dry tropical forest of New Caledonia is a unique ecosystem yet it is dangerously close to disappearing. Over the last 20 years, WWF and its partners have managed to maintain some dry forest fragments and start restoring others, raising awareness among local populations about the fate of this exceptional natural heritage. While the area of dry forest has stabilised, much remains to be done to restore this threatened ecosystem. Many of the threats, in particular invasive alien species, fire in

a proven context of climate change and ecological isolation by urban or agricultural development, continue to challenge the survival of this fragile ecosystem. Accurate monitoring and follow up are essential to better inform management actions. Scaling up the area restored remains a challenge.

Degraded and eroded land in the dry forest ecoregion.



© D. Vallières

**WHILE THE AREA OF
DRY FOREST HAS
STABILISED, MUCH
REMAINS TO BE DONE.
SCALING UP THE AREA
RESTORED REMAINS A
CHALLENGE.**

Political will exists, notably with the active participation of public actors in the partnership initially and in the CEN latterly, however, more stringent policies are required if rapid improvements are to be made, particularly with regard to the inclusion of residual forest and their ecological connectivity in community development plans (at the level of municipalities and provinces). Currently, and since 2016, urbanisation plans ('Plans d'Urbanisme Directeur' or PUDs) consider a buffer zone immediately around dry forest fragments, and to a certain extent small-scale connectivity. Future PUDs should consider the wider landscape connectivity.

The partnership approach applied to the programme to conserve and restore New Caledonia's dry forest was successful, but may need to be broadened in future to include more of the grassroots actors that need to participate in direct action on the ground, such as the communes, developers, the chamber of agriculture, and various civil society associations. Ongoing research in what remains the rapidly evolving field of restoration can help feed into implementation and vice versa: research may need to be defined by implementation challenges. For this two-way process to happen effectively requires adequate monitoring and flexibility to allow adaptive management. Additionally, further research would be necessary for example in the fields of taxonomy, of invasion biology and restoration for both flora and fauna etc. as tools for improved management of the dry forest.

Despite the fact that this unique collaboration across sectors and geographical scales started 17 years ago, no new protected area has been established for the benefit of this ecosystem (unlike in the moist tropical forest) and the only existing two protected areas are located in Nouméa. Due to their large surface area, the efforts of communities already engaged and their high recreational and educational potential, the provincial forests of Gouaro-Deva in the south and Pindaï in the north would be the most emblematic and the most strategic to protect via an official protected area classification.

Long-term and sustainable financing remains a constant concern. While the CEN provides an established institution that reflects a political commitment, it will require additional funding beyond public funds and measures to engage the private sector may need to be designed.

WWF's role today emphasises scaling up the ambition for New Caledonia's dry forest through:

- incorporation of the conservation, restoration and valuation of these high conservation value forests in the activities of a wide sphere of dry forest users and land managers;
- support for successful examples of the above three actions that can inspire and spread throughout the west coast (leverage effect);
- creation of new protected areas that can help to perpetuate efforts to date to preserve, restore and enhance specific dry forests considered as priority on provincial, territorial or communal lands;
- calling for the urgent rescue of endemic species that are close to extinction in the short term if nothing is done (with a goal of 0% biodiversity loss);
- broadening of the conservation approaches in the dry forest to other forest ecosystems (notably, moist tropical forests), ideally carried out by the CEN to benefit from this multi-stakeholder forum and especially its trans-provincial nature.

Plerandra (or *Schefflera*) *veitchii* is an endemic tree species of New Caledonia. It is vulnerable according to the IUCN Red List due to habitat reduction. Planted in Ouen Toro, Nouméa (enrichment planting) in March 2015 by Elouan, a young volunteer (left), the tree is growing well (>2 m high) two and a half years later, which makes Elouan proud (right).



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17

In years the duration of WWF and all partners' commitment to initiate a sustainable FLR programme, led since 2012 by a dedicated legal entity that is publicly funded.

68

The number of plant species from the dry forest that were studied, mapped and submitted to the IUCN Red List.

692

The area (in ha) of dry forest fenced to enable passive restoration (4% of the remaining dry forests). 178,384 seedlings have been also planted in 25 active restoration sites.



6,745,981

The amount of money (in EUR) invested in the activities over the 17 years (in-kind contributions excluded).

13,781

The number of participants in various educational and awareness-raising activities related to the dry forest.



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