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Nineteenth meeting
Montreal, 2-5 November 2015
Item 4.3 of the provisional agenda*

WWF LIVING FORESTS REPORT

Note by the Executive Secretary

1. The Executive Secretary hereby provides, for the information of participants in the nineteenth meeting of the Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), the World Wide Fund for Nature Living Forests Report. The information is provided by the Executive Secretary in the language and format in which it was received.

* UNEP/CBD/SBSTTA/19/1.

WWF
REPORT
INT
2011

WWF LIVING FORESTS REPORT: CHAPTER 1

FORESTS FOR A LIVING PLANET

FORESTS: WHAT FUTURE DO WE WANT?

A world rich with healthy, vibrant forests, pulsing with life.

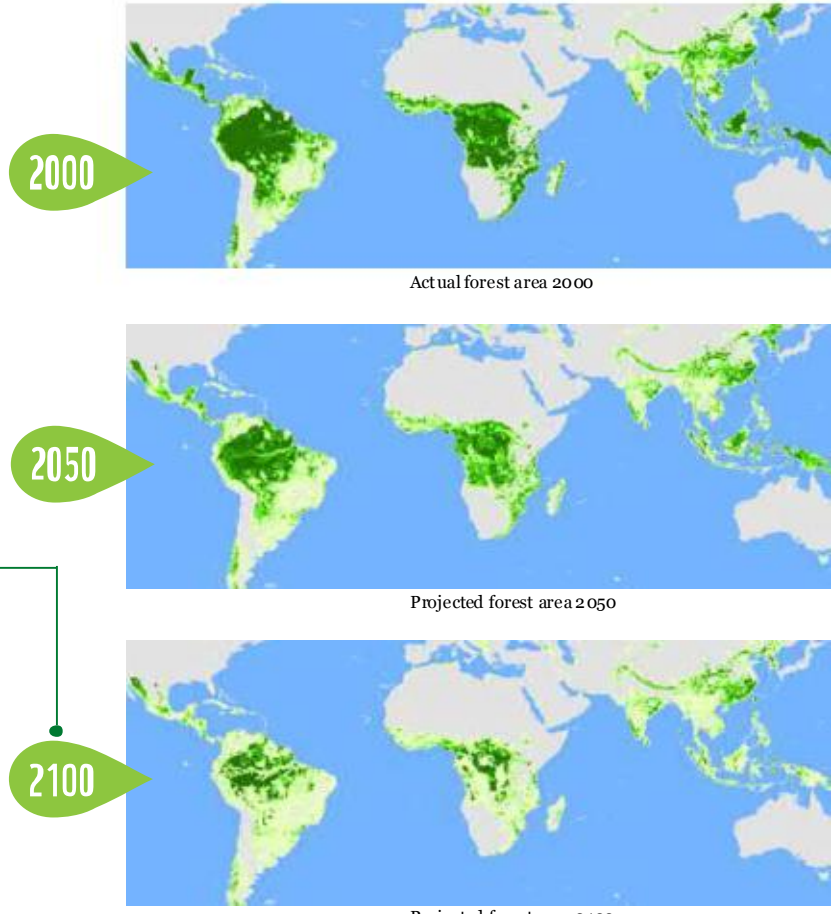
Many forests are ancient, living monuments to the Earth's long history. Others are still young, growing quickly over once-degraded land, holding deserts at bay. Pure rivers run through them. A proportion of the world's forests are managed, sustainably and with care, for timber, food, medicines, as sources of livelihoods and as places to relax, or valued for their rich cultural and spiritual associations. Throughout the world, secure and healthy forests have helped stabilize the climate. Responsibly managed **plantations**, supplying fibre for materials and energy and delivering important **ecosystem services**, share the landscape with wild forests, towns, productive farms, and nature reserves. Maintaining forests is a cornerstone of national and international policies.

Forests are central and essential to life, supporting wild species and providing countless goods and vital ecosystem services, like clean water and carbon storage. Their future is in our hands.

Or consider the reverse.

Most of the Amazon, Asia-Pacific, and Congo forests are a distant memory, and the crops that replaced them have been destroyed by droughts and fires[1]. The world's poorest billions struggle for food and water; rich and poor alike are battered by extreme weather[2]. Deserts encroach on farmland and towns. Lists of extinct species grow longer by the day. Energy crises cripple industry and isolate communities. Huge swathes of **boreal forest** have died, further accelerating **climate change**. Wars over natural resources are affecting half the nations on the planet[3].

DURING THE 2011 INTERNATIONAL YEAR OF FORESTS, WWF'S LIVING FORESTS REPORT IS PART OF A YEAR-LONG CONVERSATION WITH PARTNERS, POLICYMAKERS, AND BUSINESS ABOUT HOW TO PROTECT, CONSERVE, SUSTAINABLY USE, AND GOVERN THE WORLD'S FORESTS IN THE 21ST CENTURY.



Actual forest area 2000

Projected forest area 2050

Projected forest area 2100

Forest area in 2000 and projected forest area in 2050 and 2100, as calculated by the Living Forests Model under a Do Nothing Scenario, in which demand for land increases to supply a growing global population with food, fibre and fuel, and historical patterns of poorly planned and governed exploitation of forest resources continue.

THE LIVING FORESTS VISION

The *Living Forests Report* is the centrepiece of WWF's Living Forests Campaign. The campaign does not start by knowing all the answers and seeking to impose a solution. Rather, it aims to convene a conversation among people who are sympathetic to the idea of halting forest loss, but who may be concerned about potential implications for human well-being, economic development, and the wider environment.

1.5 YEARS
TO GENERATE THE RENEWABLE RESOURCES USED IN 2007

WWF aspires to a future where humanity's global footprint stays within the Earth's ecological limits and the planet's natural resources are shared equitably. People everywhere can lead happy, healthy lives using their fair share of the Earth's resources, leaving space for wildlife and natural landscapes.

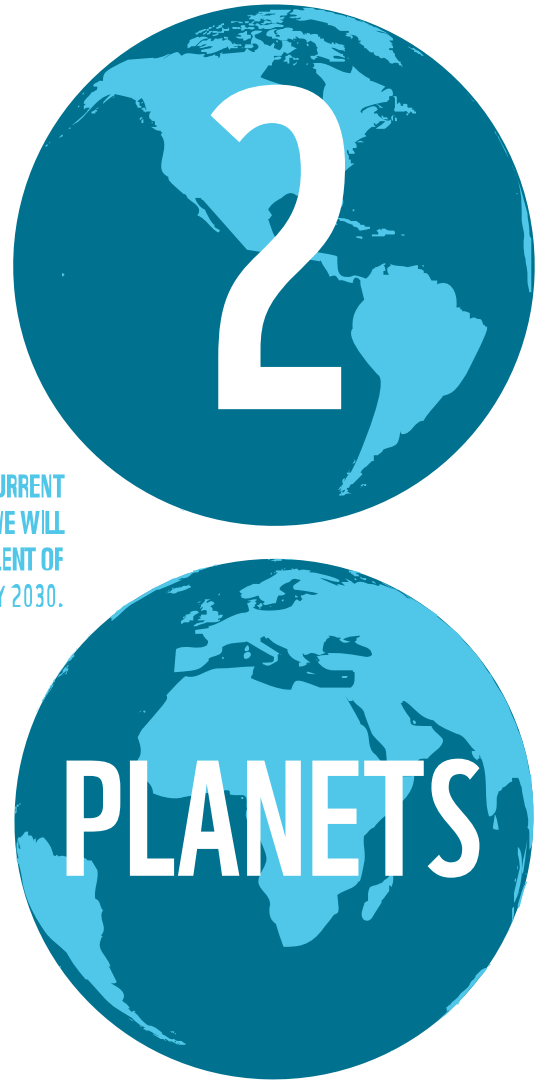
According to the **Ecological Footprint**, we are currently exceeding the Earth's **biocapacity** – the area available to produce renewable resources and absorb CO_2 – by 50 per cent. To eliminate this ecological overshoot, we need to balance human demand with the regenerative capacity of the planet.

Rich nations and individuals will need to find ways to live more lightly on the Earth.

The Living Forests Campaign envisions allocation of a greater share of the world's food, energy, and materials to meet the needs of the poor. Rich nations and individuals will need to find ways to live more lightly on the Earth. Emerging economies will need to find new models for sustainable growth that allows them to continue to improve the well-being of their citizens in ways that the planet can sustain.

The Living Planet Report: Two indicators used by WWF and partners to measure the health of the planet show that we are asking too much from nature. The **Living Planet Index**, which measures changes in ecosystem health by studying trends in 2,500 animal species, shows that **biodiversity** is declining. The *Ecological Footprint*, which tracks humanity's competing demands on resources, currently exceeds **biocapacity**, meaning our lifestyles are unsustainable. If we maintain current resource use, we will need the equivalent of two planets by 2030.

IF WE MAINTAIN CURRENT RESOURCE USE, WE WILL NEED THE EQUIVALENT OF TWO PLANETS BY 2030.



THE LIVING FORESTS VISION

We believe forests make a vital contribution to this vision. However, their full potential will only be realized if we halt **deforestation** and forest **degradation**.

FORESTS

FULL POTENTIAL WILL ONLY BE REALIZED IF WE HALT DEFORESTATION AND FOREST DEGRADATION

We advocate "**Zero Net Deforestation and Forest Degradation (ZNDD) by 2020**" as a target that reflects the scale and urgency with which threats to the world's forests and climate need to be tackled. Achieving ZNDD will stem the depletion of forest-based biodiversity and ecosystem services, and associated **greenhouse gas** (GHG) emissions. It addresses many targets of the **Millennium Development Goals**, **Convention on Biological Diversity** and **UN Framework Convention on Climate Change**.

We recognize that achieving ZNDD presents challenges, needs huge political will and requires great care if it is to be achieved equitably and sustainably, while protecting livelihoods of forest-dependent peoples. It will also require development of strategies that are environmentally and socially appropriate to national and local contexts.

Degradation: Changes within the forest that negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or ecosystem services[45].

sion of forest to another land use or the long-term reduction Deforestation also implies the long-term or permanent loss transformation into another land use. Such a loss can only be a continued human-induced or natural perturbation; 2) includes agriculture, pasture, water reservoirs and urban areas and 3) where the trees have been removed as a result of harvesting orest is expected to regenerate naturally or with the aid of ss logging is followed by the clearing of the remaining logged-over forest for the introduction of alternative land uses, or the maintenance of the clearings through continued disturbance, forests commonly regenerate, although often to a different, secondary condition. In areas of shifting agriculture, forest, forest fallow and agricultural lands appear in a dynamic pattern where deforestation and the return of forest occur frequently in small patches. To simplify reporting of such areas, the net change over a larger area is typically used[44].

Convention on Biological Diversity (CBD): A comprehensive, binding agreement covering the use and conservation of biodiversity signed by 193 governments.

ACHIEVING ZNDD WILL STEM THE DEPLETION OF FOREST-BASED BIODIVERSITY AND ECOSYSTEM SERVICES, AND ASSOCIATED GREENHOUSE GAS EMISSIONS.

Any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration.

What is Zero Net Deforestation and Forest Degradation?

WWF defines ZNDD as **no net forest loss through deforestation and no net decline in forest quality through degradation**. ZNDD provides some flexibility: it is not quite the same as no forest clearing anywhere, under any circumstances. For instance, it recognizes peoples' right to clear some forests for agriculture, or the value in occasionally "trading off" degraded forests to free up other land to restore important biological corridors, provided that biodiversity values and net quantity and quality of forests are maintained. In advocating ZNDD by 2020, WWF stresses that: (a) most **natural forest** should be retained– the annual rate of loss of natural or semi-natural forests should be reduced to **near zero**; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest **restoration**. In this accounting, plantations are not equated with natural forests as many values are diminished when a plantation replaces a natural forest.

Natural forest:

Near zero: In the context of forest

Restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed[62].

reduction in loss of such forests from 13 million ha/year to less than 650,000 ha/year.

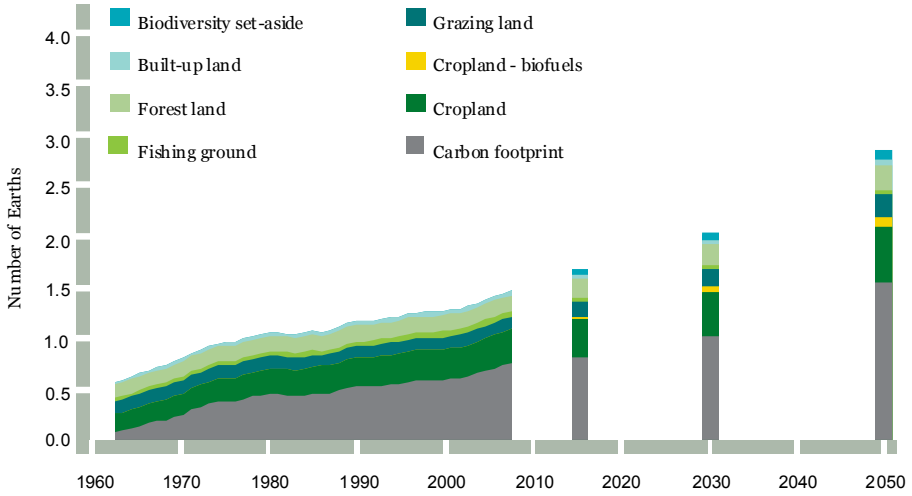
THE LIVING FORESTS CHALLENGE

To understand what ZNDD would mean in practice, WWF developed the Living Forests Model with the International Institute for Applied Systems Analysis (IIASA), which forms the basis for the *Living Forests Report*.

ZNDD IS BOTH POSSIBLE AND URGENT

The Living Forests Model finds that achieving ZNDD is both possible and urgent. But it will not be easy. The *Living Forests Report* looks at a series of challenging and sometimes difficult questions that the Model identifies, or that arise when applying the Model's theoretical options to the real world. These are:

1. Can we sustain ZNDD as the human population rises?
2. Does producing more on less land mean increased agricultural pollution and water stress?
3. How will ZNDD affect food prices?
4. What role do diet and lifestyle choices play in achieving ZNDD?
5. How will ZNDD affect the forest products industry?
6. Can we achieve 100% renewable energy without deforestation?
7. Will ZNDD keep enough carbon out of the atmosphere?
8. Will saving forests increase the pressures on biodiversity outside forests?
9. Can we halt deforestation and safeguard people's livelihoods?



Projected change in humanity's Ecological Footprint between now and 2050 under "business as usual," as calculated by the Ecological Footprint Scenario Calculator[4]. Using the 1961–2007 Ecological Footprint as a baseline, the Calculator estimates how the Ecological Footprint and biocapacity will change based on future projected changes in human population, land use, land productivity, energy use, diet and climate change. This figure was produced by the Global Footprint Network, 2010[5].

TOUGH TRADE-OFFS UNDERLIE THESE QUESTIONS. THIS FIRST CHAPTER PRESENTS AN OVERVIEW OF THESE; LATER CHAPTERS TO BE PUBLISHED THROUGHOUT 2011 WILL INVESTIGATE THE COSTS AND BENEFITS OF POTENTIAL PATHWAYS TO ZNDD IN MORE DETAIL.

FORESTS BY NUMBERS

*UNLESS OTHERWISE NOTED, THE INFORMATION ON THIS PAGE COMES FROM THE FAO[6]

Temperate forests in much of the northern hemisphere are expanding Tropical forests and forests in some temperate regions of the southern hemisphere are shrinking

31% OF THE WORLD'S LAND SURFACE IS FOREST

OVER HALF OF THE WORLDS FORESTS ARE IN 5 COUNTRIES: CANADA, THE USA, BRAZIL, RUSSIA AND CHINA

1.31 Billion hectares of forests (around one-third of the world's forest cover) are classified as **intact forest landscapes**[8]

Indigenous peoples: Peoples in independent countries who are regarded as indigenous on account of their

Intact natura extent and la viable maintained.

Sub tropical forest: These are found to the sound and north of the tropical forests. The trees here are adapted to resist the summer drought[63].

FORESTS SUPPLY **ECOSYSTEM SERVICES**: carbon sequestration; protection against floods, landslides, avalanches, ocean surges, and desertification; provision of clean water, medicines, crops, and fish; space for recreation and exercise; and places sacred to the world's various faiths[9]

7%

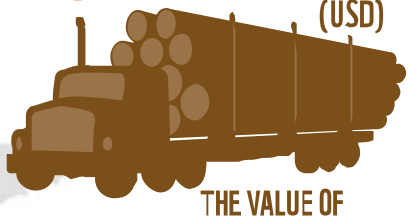
OF TOTAL FOREST COVER IS PLANTED, YET THIS COULD PROVIDE AROUND TWO-THIRDS OF GLOBAL INDUSTRIAL WOOD PRODUCTION[7]

ARE SUPPORTED BY FORESTS

300 MILLION PEOPLE LIVE IN FORESTS INCLUDING 60 MILLION INDIGENOUS PEOPLE

10 MILLION WORK IN FOREST MANAGEMENT AND CONSERVATION

$100 BILLION (USD)



THE VALUE OF WOOD REMOVED FROM FORESTS PER YEAR 2003-2007

ABOUT 47% OF FORESTS ARE TROPICAL, 9% SUBTROPICAL, 11% TEMPERATE & 33% ARE NORTHERN BOREAL

THE TEN COUNTRIES WITH THE LARGEST ANNUAL NET LOSS OF FOREST AREA, 2000–2010 ARE 1.BRAZIL 2.AUSTRALIA 3.INDONESIA 4.NIGERIA 5.UNITED REPUBLIC OF TANZANIA 6.ZIMBABWE 7.DEMOCRATIC REPUBLIC OF THE CONGO 8.MYANMAR 9.BOLIVIA 10.VENEZUELA

THE LIVING FORESTS MODEL

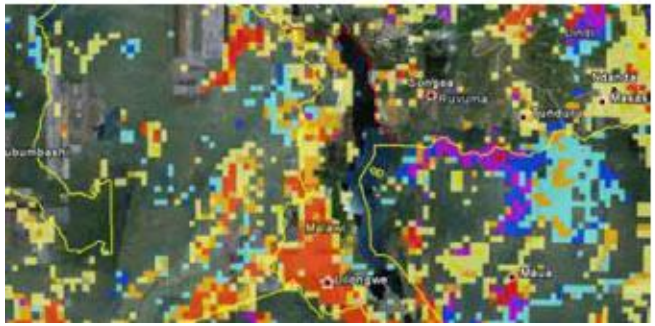
Models help us to develop and compare different future scenarios, look at the implications of particular policies, test assumptions and start conversations. Models are not perfect representations of reality: they inform the debate rather than make exact predictions.

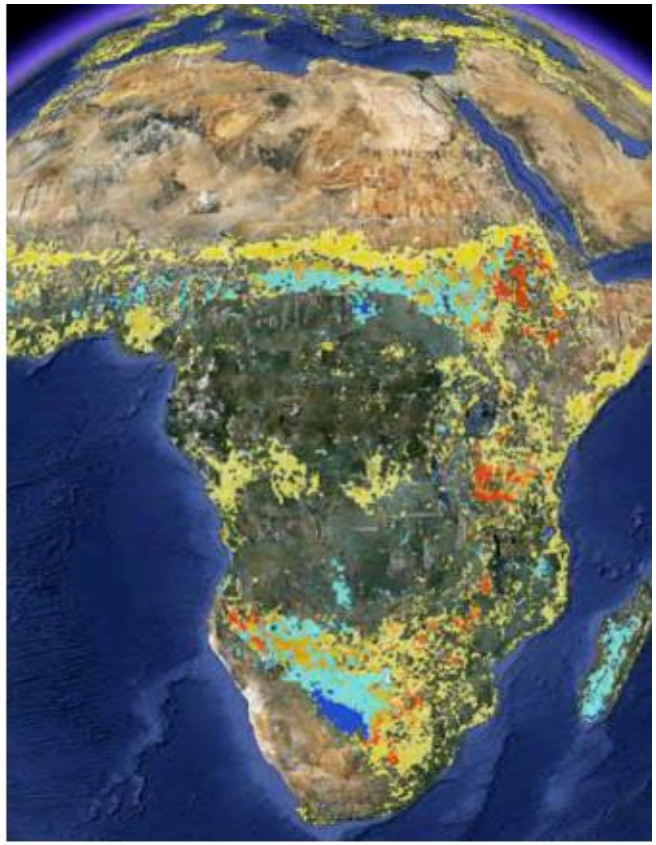
The Living Forests Model draws on IIASA's G4M and GLOBIOM models[3a] to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, GDP and infrastructure. GLOBIOM is an economic model that allocates land and resources optimally based on projected commodity and ecosystem service demands under future GDP, population, and policy scenarios.

DO NOTHING SCENARIO

The Living Forests Model features a reference **Do Nothing Scenario** and shows how this would change if measures were introduced to rein in deforestation and forest degradation. It also features other scenarios that change key assumptions in the Do Nothing Scenario.

Throughout this year-long conversation on the options and opportunities for achieving the Living Forests Vision, WWF and IIASA will use the Living Forests Model to explore current and potential future land-use trends, including how growing global consumer demands affect what we produce, the knock-on effects on GHG emissions and the impacts of these trends on resources and prices.





All data in the IIASA models are spatially explicit, i.e. each data point is anchored to a point of reference on a 1-50 km grid of the Earth's surface. The models' projections of changes in forest cover are based on "layers" of data, including the distribution of Earth's ecosystems and land use patterns. Land cover information can come from a number of different sources and areas of disagreement between maps are shown on these regional and country scale maps in yellow or orange. The maps are constantly updated through initiatives such as the Geo-Wiki project, a global network of volunteers who review land cover data quality. Some countries such as Malawi (shown to the left) contain large areas of disagreement so where possible data is confirmed through photos; this information will eventually be used to create improved maps. All images were previously published and are based on data from www.geo-wiki.org. The background imagery was provided by Google Earth.

THE LIVING FORESTS MODEL

The Living Forests Model features the following scenarios:

The reference Do Nothing Scenario: A projection of what the world could look like if our behaviour continues in line with historical trends (see below). The Do Nothing Scenario anticipates land-use change due to: (a) demands for land to supply a growing global human population with food, fibre and fuel; and (b) continuation of historical patterns of poorly planned and governed exploitation of forest resources. Key assumptions[10] in this scenario are:

- by 2050, world population reaches 9.1 billion and per-capita GDP almost triples
- demand for commodities is driven by changes in affluence (measured by GDP) and human population growth
- aggregate historical trends in agricultural productivity gains continue[11]
- the average human diet in a country changes according to historically observed relationships with per-capita GDP
- forestry and agricultural production does not expand into **protected areas**, but unprotected natural habitats can be converted to timber plantations, cropland and pasture
- total primary energy use from land-based **biomass** feedstocks doubles between 2010 and 2050 due to projected energy demand and the competitiveness of **bioenergy** technologies and supply chains

2050
WORLD POPULATION REACHES 9.1 BILLION AND PER-CAPITA GDP ALMOST TRIPLES

3
SCENARIOS WERE DEVELOPED FOR REDUCTIONS IN FOREST LOSS AND DEGRADATION

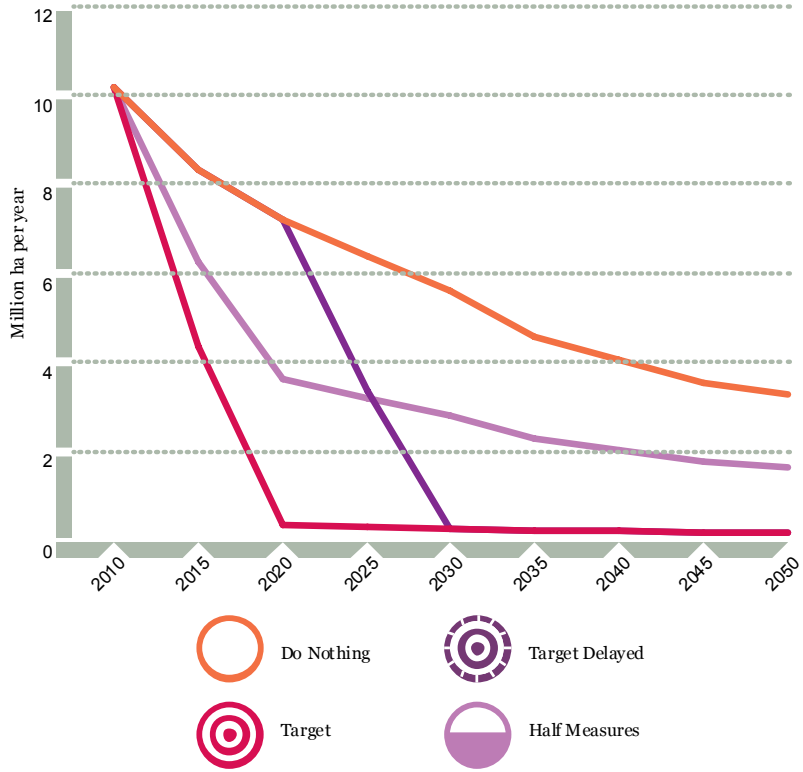
Three scenarios were developed for reductions in forest loss and degradation.

Target Scenario: ZNDD (with near zero gross rate of loss of natural and semi-natural forest[12]) by 2020 and maintained at that level indefinitely.

Target Delayed Scenario: ZNDD (with near zero gross rate of loss of natural and semi-natural forest) by 2030 and maintained at that level indefinitely.

Half Measures Scenario: Gross deforestation rate declines by at least 50 per cent from the reference rate by 2020 and is maintained at that level indefinitely.

Protected area: A clearly defined geographical space that is recognized, dedicated and managed through legal or other effective means in order to achieve the long-term conservation of nature with associated ecosystem services and cultural values[61].



Gross deforestation rates from 2010 to 2050 under the Do Nothing Scenario, Target Scenario, Target Delayed Scenario and Half Measures Scenario.

THE LIVING FORESTS MODEL

Additional scenarios were developed to explore the impact of variations in the projected demand for **animal calories** and bioenergy. These affect how much forest or agricultural land the Model assigns to pasture and growing feed for livestock or biofuel crops, and how much wood from forests will be used to generate energy.

Animal calories: Calories in food from meat, seafood, dairy products and eggs.

2

THERE ARE TWO VARIATIONS ON PROJECTIONS WITHIN THE DO NOTHING SCENARIO.

Diet Shift: The total global consumption of animal calories is maintained at the 2010 global average with convergence in per capita consumption across regions[13] (i.e., those now below the global average consume more in the future, while those now above the global average consume less). This scenario means less future demand for animal calories than the Do Nothing Scenario.

Bioenergy Plus: Bioenergy feedstock demand is consistent with the 100% renewable energy vision calculated by the Ecofys Energy Model[14]. This contrasts with the Do Nothing Scenario in that it assumes a higher carbon price. This makes bioenergy more competitive relative to fossil fuels, although this is tempered by higher bioenergy feedstock prices as more bioenergy is used.

2

FURTHER SCENARIOS WERE DEVELOPED TO EXPLORE THE IMPACT OF STRICTER BIODIVERSITY PROTECTION.

Pro-Nature: Remaining natural ecosystems are protected (i.e., no further conversion of these ecosystems to cropland, grazing land, plantations or urban settlement) in areas identified as important for biodiversity by at least three separate conservation mapping processes. This scenario assumes that current land uses (e.g., cropland or forestry) in these areas remain constant and continue to produce food or timber.

Pro-Nature Plus: Remaining natural ecosystems are protected (as defined in the Pro-Nature Scenario) in areas identified by any one of the conservation mapping processes (see pages 10 and 11).

Brazil's Cerrado is one of the largest savanna-forest ecosystems in the world. It is threatened by expanding soy production.

IMPORTANT AREAS FOR BIODIVERSITY CONSERVATION

Conservation scientists have used different approaches to identify areas of global importance for biodiversity conservation. Each depends on assessing the distribution of particular components of biodiversity, and many incorporate measures of threat, irreplaceability or vulnerability.

The UNEP World Conservation Monitoring Centre (UNEP-WCMC) created a global dataset for the *Carbon and biodiversity: a demonstration atlas* by combining data from six different global conservation prioritisation schemes (see map on next page). The Living Forests Model uses this information in its Pro-Nature Scenarios.

The dataset combines information from:

Conservation International Hotspots: areas with large numbers of endemic plant species, and < 30% of the natural habitat remaining.

WWF Global 200 Ecoregions: the most biologically distinct terrestrial and freshwater ecoregions of the planet, selected for exceptional levels of biodiversity.

Birdlife International Endemic Bird Areas (EBAs): areas where two or more bird species with ranges smaller than 50,000 km² co-occur.

WWF/IUCN Centres of Plant Diversity: areas of key significance for global plant biodiversity.

Amphibian Diversity Areas: areas of significance for amphibian diversity.

Alliance for Zero Extinction (AZE) sites: identified as critical for the survival of one or more globally identified endangered and critically endangered species.

In addition to these six biodiversity layers, the Model also includes data from the UNEP-WCMC **World Database on Protected Areas**. It uses data from the 2009 database and no land conversion is allowed within these areas, even under the Do Nothing Scenario.

World Database on Protected Areas (WDPA): A database managed by the UNEP World Conservation Monitoring Centre listing protected areas from around the world. Entries include information relating to the IUCN management category and governance type: protected areas on the WDPA range from strictly protected areas to protected landscapes including human settlements and managed land, and from state protected areas to lands managed by indigenous peoples and local communities.

Sources of underlying data:

Conservation International Hotspots: Mittermeier, R.A., et al (Eds). (2004). *Hotspots Revisited: Earth's Biologically Richest and Most Endangered Terrestrial Ecoregions*. CEMEX, Mexico City.

WWF Global 200 Ecoregions: Olson, D.M. and Dinerstein, E. (2002). The Global 200: Priority ecoregions for global conservation *Annals of the Missouri Botanical Garden* 89: 199–224.

Birdlife International Endemic Bird Areas (EBAs): BirdLife International.(2008). *Endemic Bird Areas*: BirdLife International. November 2008.

WWF/IUCN Centres of Plant Diversity: WWF/IUCN. (1994). *Centres of Plant Diversity: A Guide and Strategy for their Conservation*. WWF/IUCN, Cambridge, UK

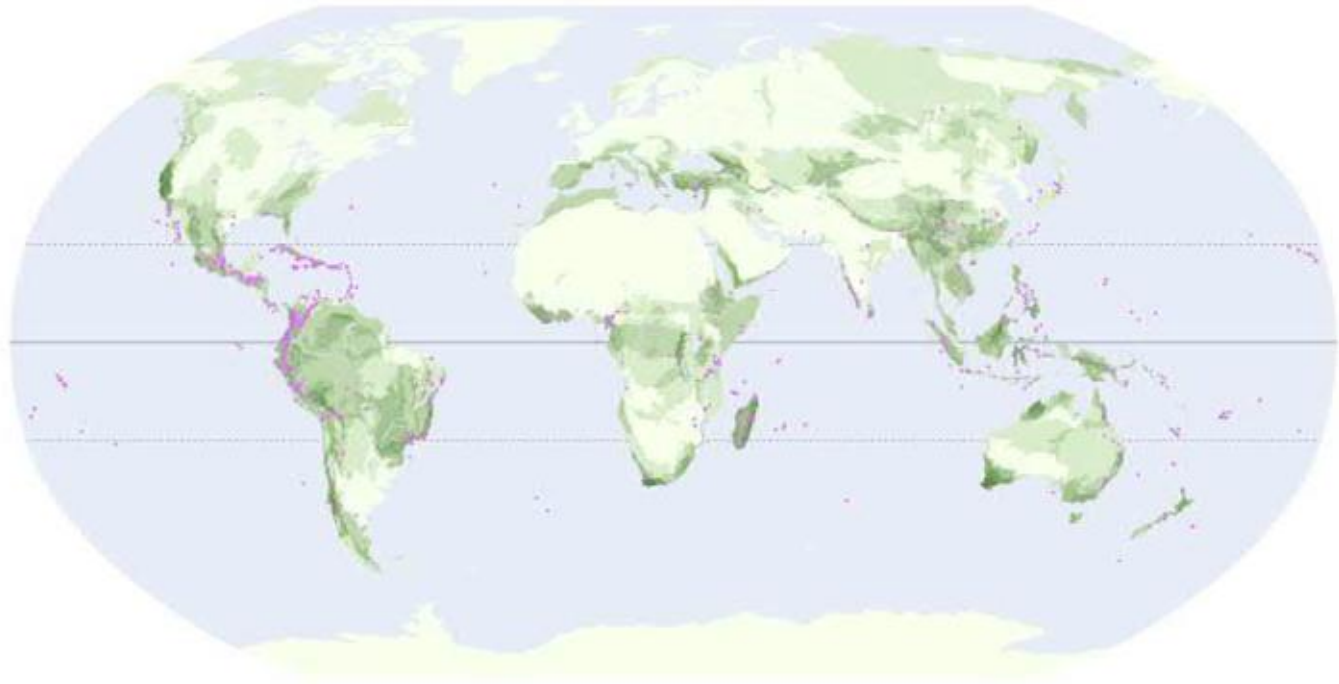
Amphibian Diversity Areas: Duellman, W.E. (ed) (1999). *Patterns of distribution of amphibians: a global perspective*. John Hopkins University Press, Baltimore, USA.

Alliance for Zero Extinction (AZE) sites: Ricketts, T.H., et al (2005). Pinpointing and preventing imminent extinctions. *Proceedings of the National Academy of Sciences* 102, 18497-18501.

For a more comprehensive list of prioritisation schemes see: Brooks, T. M., et al (2006). Global biodiversity conservation priorities. *Science* 313:58-61.

IMPORTANT AREAS FOR BIODIVERSITY CONSERVATION

What does this map show us? The areas where the largest numbers of these priority schemes overlap are those with the greatest degree of consensus as to their importance for conservation, and could therefore be regarded as of high importance for biodiversity. However, this is not a map of the distribution of biodiversity itself, such as a map of species richness or ecosystem diversity. Neither were all global conservation prioritisation schemes considered.



Map Source:

Kapos V., Ravilious C., Campbell A., Dickson B., Gibbs H., Hansen M., Lysenko I., Miles L., Price J., Scharlemann J.P.W., Trumper K. (2008) *Carbon and biodiversity: a demonstration atlas*. UNEP-WCMC, Cambridge, UK.

THE LIVING FORESTS MODEL IN CONTEXT

The stark **Millennium Ecosystem Assessment** conclusion that 60 per cent of the world's ecosystem services are degraded has led to the development of models and strategies to put us on a different path.

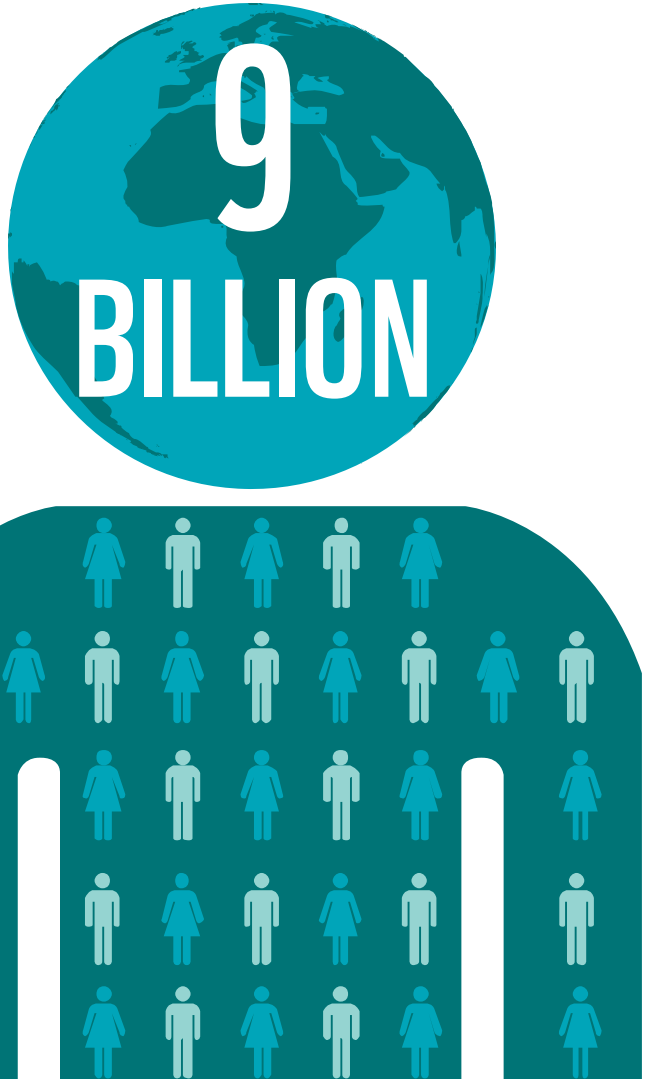
Millennium Ecosystem Assessment: A UN initiative assesses the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being[56].

Many offer complementary findings to the Living Forests Model, and all face the challenge of balancing a growing, high-consuming human population with the resources of a single planet. Some of the biggest decisions of the 21st century will be about finding acceptable trade-offs. Below we highlight key projections from various influential models and reports:

70%
MORE FOOD WILL BE NEEDED BY 2050

- The global population will surpass 9 billion by 2050[15]
- This will require expanding food supplies by 70 per cent[16]
- Climate change will reduce crop yields in many countries[17]
- After 2030 food, fibre and fuel will compete intensively for limited land and water resources[18]
- Demand for wood and fibre products will continue to increase[19]
- 100% renewable energy would need bioenergy from an additional 250 million ha of crops and tree plantations by 2050 plus 4.5 billion m^3 of wood from multiple sources[20]
- Global warming can be kept below 2°C through strategies including reduced emissions from forestry and agriculture; the costs and investment needed are fairly low, but implementation is highly challenging[21]
- Substantial increases from the current approximately 13 per cent of forests in protected areas are projected to have the greatest positive impact of all potential conservation strategies by 2050[22]

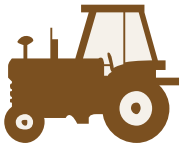
THE GLOBAL POPULATION WILL SURPASS 9 BILLION BY 2050



THEORY AND REALITY

WWF uses the Living Forests Model to raise questions; our answers must take account of local, national, and international realities.

Safeguards are vital to ensure ZNDD does not result in unintended, harmful side effects on people and the environment. WWF identifies five crosscutting issues that are critical to ZNDD. These cover many underlying causes of forest loss and degradation and highlight equity concerns that need to be safeguarded in ZNDD strategies.



strategies should never be at the expense of biodiversity conservation; examples of this would include agricultural expansion in highly biodiverse grasslands to take pressure off forests.

1. **Biodiversity:** ZNDD strategies should never be at the expense of biodiversity conservation; examples of this would include agricultural expansion in highly biodiverse **grasslands** to take pressure off forests or replacing pristine natural forests with heavily managed secondary forests or plantations. Strategies should also prioritize the conservation of forests with the highest biodiversity values through government, community, or private sector initiatives, so these are not lost during the time it takes to achieve ZNDD.

2. **Governance:** ZNDD is only possible under good governance: i.e., forests with secure **land tenure**, effective and well-enforced laws backed by policies that encourage sustainability, and empowered and committed local communities. ZNDD strategies should protect hard-won rights to access and **benefit-sharing**, ensure traditional communities **give free prior informed consent** to activities affecting their territories, and ensure communities receive fair compensation for conservation introduced for the global good.

3. **Market demand for commodities:** Much destructive forest use is encouraged by market demand, but markets can also drive better management. Positive measures include responsible sourcing and investment policies that reward producers who perform to the standards required by those policies, voluntary **certification** standards, incentives for consumers to choose sustainably managed goods, and the prohibition of trade in **illegally sourced timber**.

PROHIBIT TRADE IN ILLEGALLY SOURCED TIMBER

WASTEFUL OR EXCESSIVE CONSUMPTION SWELLS DEMAND FOR COMMODITIES LINKED TO FOREST LOSS.

Grassland: A plant community in which grasses are dominant, shrubs are rare, and trees absent[51].

Free prior informed consent (FPIC): The principle that a community has the right to give or withhold its consent to proposed

Certification: The procedure by which an independent body (e.g., a Forest Stewardship Council accredited

Illegally sourced timber: Timber that was illegally harvested or traded.

4. **Lifestyle and consumption:** Wasteful or excessive consumption swells demand for commodities linked to forest loss. ZNDD strategies must recognize the imperative for incentives to make sustainable consumption choices and systems to reduce over-consumption and equitably distribute the world's food, energy, and materials to meet everyone's needs.

5. **Local livelihoods:** Activities that rank as threats to forests on a global scale can be local necessities: **fuelwood** use or consumption of wild foods, for example, in regions where affordable alternatives are scarce. Plans based on global scenarios must recognize local needs, and there will be trade-offs between the ideal and the possible. ZNDD strategies need to be sensitive to diverse perspectives at national, local and community scales, to ensure that conservation does not decrease people's welfare.

Fuelwood: Wood used as fuel for heating or cooking.

Responsible timber trading is a key element of the Living Forests Vision.

THE NEED FOR URGENT ACTION

The immediate drivers of deforestation and forest degradation are complex. They include demand for food, fuel and fibre, but also pollution, human-induced disturbances (e.g., fires) and **invasive species**. Those clearing forests vary from individual families to some of the world's largest corporations. **Illegal logging** operations target valuable timber, including from protected areas.

Illegal logging: The harvesting or removal of timber (a) without a legal right to harvest timber in the forest management unit in which the timber was grown, or (b) in breach of national or sub-national laws governing the management and harvesting of forest resources.

Bushmeat: Also called wild meat; the harvesting of wild animals in tropical and sub-tropical forests for food and for non-food purposes, including for medicinal products[39].

Empty forests: Apparently intact forests that no longer maintain their original community of fauna and flora due to human disturbances (such as hunting, harvesting and others)[48].

Invasive species: An alien (i.e., non-native) species whose introduction and/or spread threaten biodiversity[53].

Forest degradation creates ecologically simplified, less resilient and less productive forests: in some countries these impacts can be more significant than deforestation. Degraded forests encourage invasive species. The **bushmeat** trade, where unsustainable and/or illegal, respects no laws or boundaries and creates "**empty forests**" where trees remain but the wildlife is gone. Degradation often begins a slippery slope to deforestation: large canopy gaps can dry out rainforests leaving them vulnerable to fire; abandoned logging roads provide access to settlers; and authorities are often more willing to grant conversion permits in heavily logged forests.

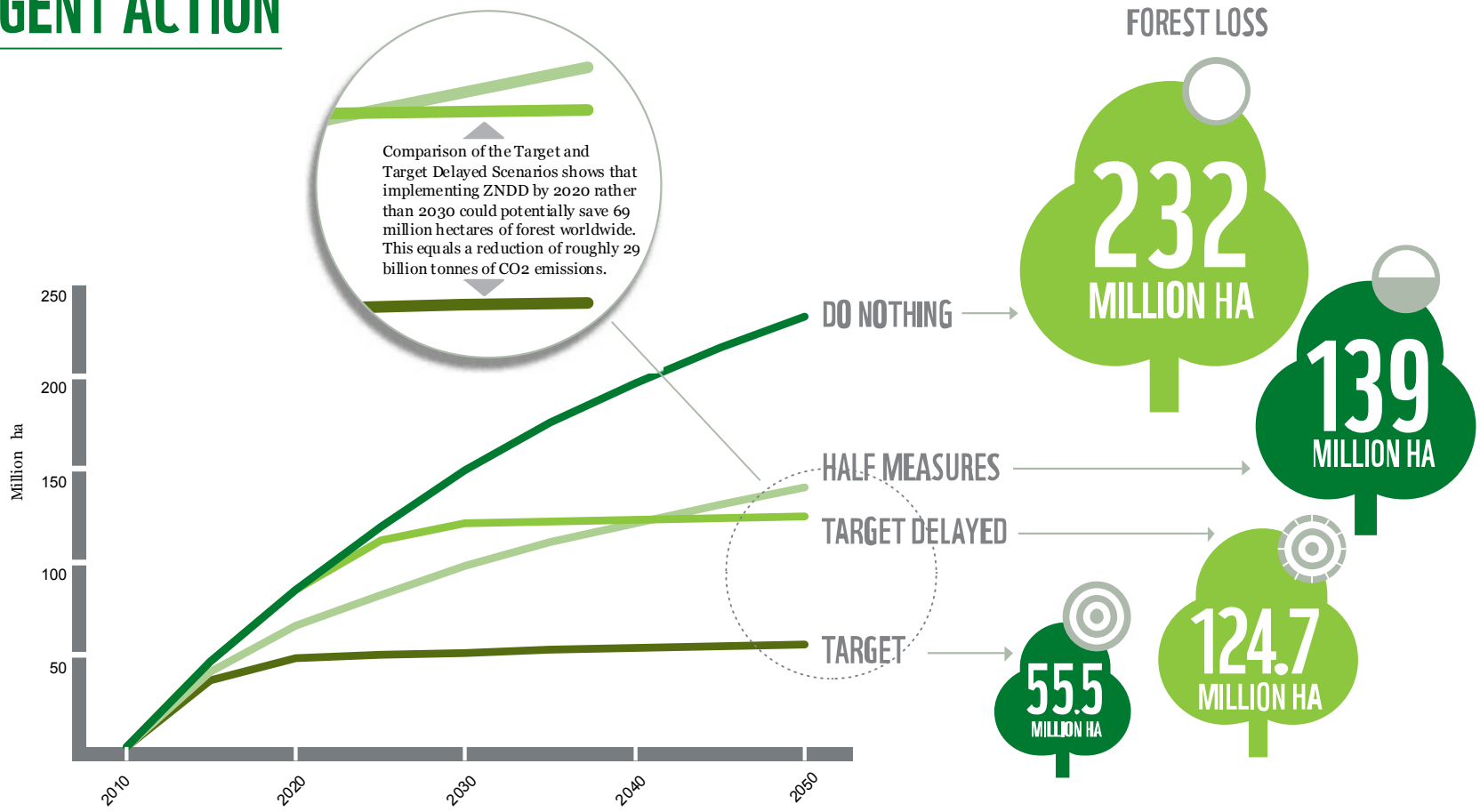
LARGE CANOPY GAPS CAN DRY OUT RAINFORESTS LEAVING THEM VULNERABLE TO FIRE

With all the factors working against forests, we must act fast. WWF used the Living Forests Model's Target Scenario to explore the costs and benefits of fast action to cut deforestation and degradation compared to the Do Nothing Scenario. We also used the Target Delayed Scenario to explore the effects of delaying the achievement of ZNDD from 2020 to 2030. The results are shown in the figure on the next page. Compared to the Target Scenario, doing nothing, delaying, or taking half measures all result in more forest loss and associated GHG emissions, irreversible impacts on biodiversity, and declines in ecosystem services.

ZNDD can also help address climate change by reducing GHG emissions from deforestation: an area deforested today can continue to release soil carbon for many years afterwards. An early peak and decline in total GHG emissions is needed to prevent runaway climate change. Many forests will not have the resilience to store carbon or provide ecosystem services in the face of radical climate change. WWF concludes that a 10-year timetable for achieving ZNDD is a maximum.

COMPARED TO THE TARGET SCENARIO, DOING NOTHING, DELAYING, OR TAKING HALF MEASURES ALL RESULT IN MORE FOREST LOSS AND ASSOCIATED GHG EMISSIONS, IRREVERSIBLE IMPACTS ON BIODIVERSITY, AND DECLINES IN ECOSYSTEM SERVICES

THE NEED FOR URGENT ACTION



Comparison of gross deforestation under the Do Nothing Scenario, Target Scenario, Target Delayed Scenario and Half Measures Scenario. The Figure shows cumulative deforestation between 2010 and 2050. Under the Do Nothing Scenario, the area deforested is greater than the current total forest area of the Democratic Republic of Congo, Peru and Papua New Guinea combined.

Tens of thousands of tigers once roamed the forests of Asia. Today, with huge swaths of their habitat lost to agriculture, timber plantations and human settlement, wild tigers number only 3,200. Achieving ZNDD by 2020 will curb the current alarming loss of species and address the looming climate crisis.

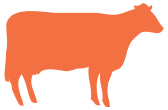
SQUANDERED FORESTS

The Living Forests Model suggests that between now and 2030, around 55 per cent of deforestation in the Do Nothing Scenario can be classified as "**unnecessary**" – i.e., deforestation resulting from failing to optimize land use in ways that the Model suggests are technically possible.

Unnecessary deforestation: Deforestation anticipated in the Do Nothing Scenario other than deforestation calculated by GLOBIOM as necessary to meet global demand for land other than natural or semi-natural forest for fuel, fibre and food.

These forests are "squandered" because social and political constraints mean that not all the optimized land uses proposed by the Model will be achieved. Constraints include lack of knowledge, conflict, poor governance, perverse incentives, shortage of capital and poverty. The resulting sub-optimal land uses include:

- **Poor forest management:** destructive harvesting and poor silviculture leading to declining timber yields, poor regeneration or vulnerability to disease, fire or encroachment
- **Inefficient livestock production:** either low-stocking density causing more forests to be cleared, or high-stocking density in or near forests leading to degradation
- **Unregulated forest conversion:** to secure land for crops or settlement, often due to absence or weak enforcement of planning laws and inequitable or insecure land tenure and user rights
- **Low-yield crop production:** some forms of subsistence or swidden ("slash and burn") farming on marginal land or using less productive land to avoid reliance on imported commodities
- **High-impact fuelwood collection:** over-harvesting for domestic use or for commercial trade in charcoal
- **Reluctance to use idle, yet suitable land:** due to armed conflicts, unresolved land disputes, insecure tenure, and dysfunctional zoning or permit allocation processes

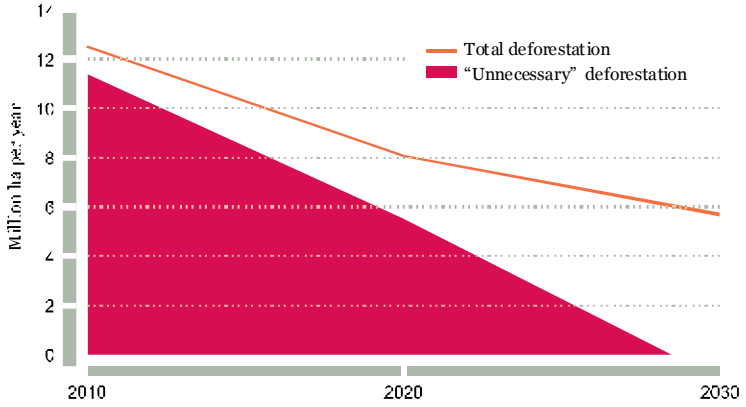


INEFFICIENT LIVESTOCK PRODUCTION

HIGH-IMPACT FUELWOOD COLLECTION

Swidden agriculture: Agriculture that involves the clearing of forest areas by cutting and burning for temporary crop cultivation[64].

Projected gross deforestation rates from 2010 to 2030 under the Do Nothing Scenario



Squandered forests – the area shaded in red represents the portion of total projected deforestation that results from failing to optimize land use in ways the Model suggests are technically possible.

FOREST LOSS THAT THE MODEL REGARDS AS UNNECESSARY FROM A GLOBAL STANDPOINT MAY BE ESSENTIAL TO COMMUNITIES WHO RELY ON FORESTS FOR FIREWOOD OR WHO NEED TO CLEAR FORESTS TO PLANT STAPLE CROPS

The Model shows that eliminating the causes of these sub-optimal land uses is the first priority of ZNDD. But this will not be easy. Forest loss that the Model regards as unnecessary from a global standpoint may be essential to communities who rely on forests for firewood or who need to clear forests to plant staple crops.

Many countries would need to eradicate the corruption that turns a blind eye to illegal or destructive logging or allows ranchers, planters, or settlers to clear-fell and burn forests to acquire land. Better governance in these countries and renewed commitments by donors can help attract the investments needed to improve forestry and agriculture. Preventing the squandering of forests requires a massive global mobilization of investment and support to improve governance.

CAN WE SUSTAIN ZNDD AS HUMAN POPULATION RISES?

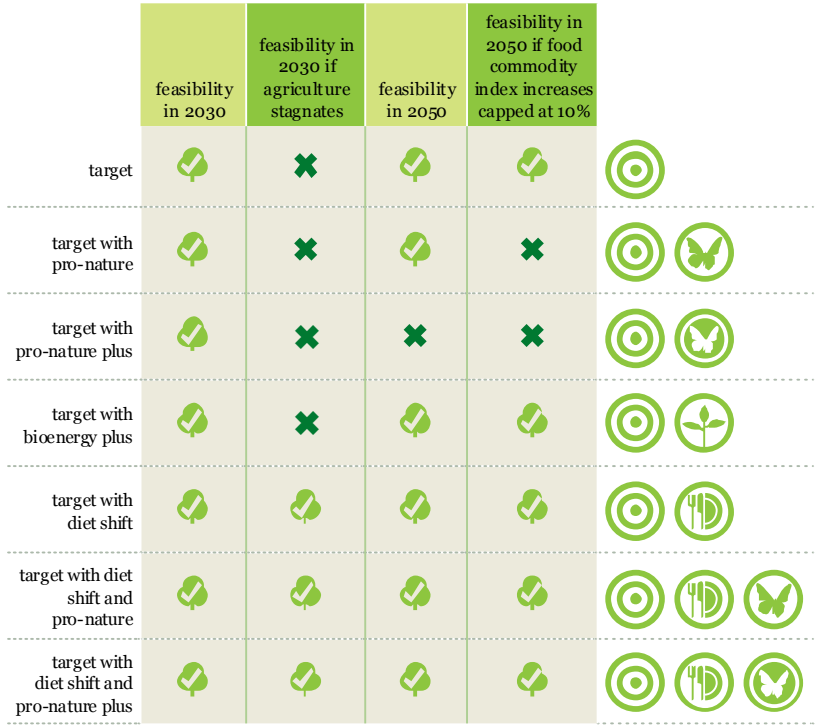
Although the Living Forests Model shows that in the immediate future, deforestation could be halted while meeting global demand for food, materials, and bioenergy, rising populations mean this is no longer true after 2030.

Food security: Defined by the 1996 World Food Summit as: "*...when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*"[49].

The Living Forests Model suggests that maintaining ZNDD beyond 2030 will require higher productivity across large, often sub-optimal, areas of land with hundreds of millions of farmers and foresters changing to more sustainable and productive practices – a task of an unprecedented scale.

The Do Nothing Scenario shows that land required for crops and, particularly, livestock will eat into forests, even with a continuation of historical increases in crop productivity and improved livestock efficiency. Post 2030, even if illegal and wasteful land uses disappear, the Target Scenario requires significant increases in the efficiency of crop and livestock production systems to meet expanding demand for food. Thus, our first question emphasizes the interplay between **food security** and forest conservation.

Agricultural productivity: The Living Forests Model suggests that maintaining ZNDD beyond 2030 will require higher productivity across large, often sub-optimal, areas of land with hundreds of millions of farmers and foresters changing to more sustainable and productive practices – a task of an unprecedented scale. In theory, a mix of better management, crop breeding, efficient irrigation, and agrochemicals could dramatically boost crop productivity in many regions. Productivity gains could reduce the need for agricultural activity that degrades forests or converts them to farms. But improved productivity can bring its own environmental costs, including salinization, erosion, depleted aquifers, increased energy use, pollution and biodiversity loss. We need to explore whether a transition to higher productivity could avoid unacceptable environmental side effects, perhaps through low-input, knowledge-based intensification, and offset predicted productivity losses due to climate change.



Feasibility of selected scenarios – A scenario is feasible when it can be achieved while meeting projected global demand for commodities (e.g., food, timber, bioenergy). Feasibility is assessed for each scenario in 2030, 2030 if agricultural productivity stagnates (i.e., from 2010, no annual growth in input neutral crop productivity and livestock systems cannot become more productive), 2050 and 2050 with a cap on the increase in the food commodity index.

Food Distribution: Efficient and hygienic food distribution and storage systems are essential to meeting nutrition and health needs. Yet much of the world's meat and grain spoils or is contaminated before it can be eaten: some estimates suggest that wastage from harvest onwards reaches 50 per cent[23]. This vital global food security issue affects demand for land, and is thus one of the most critical influences on the feasibility of ZNDD.

Options for agriculture and food distribution in a ZNDD world will be discussed in a later chapter.

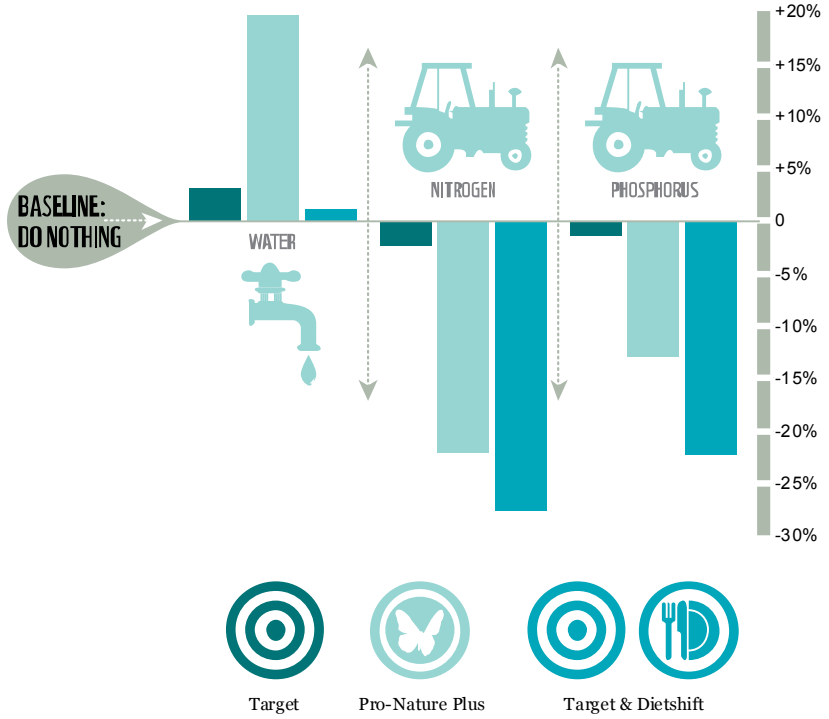
DOES PRODUCING MORE ON LESS LAND MEAN INCREASED AGRICULTURAL POLLUTION AND WATER STRESS?

Biodiversity conservation is one of the main reasons for WWF to advocate ZNDD. Our Model and others[24] also suggest a high degree of synergy between strategies to reduce biodiversity loss and those to cut GHG emissions from forests: reducing deforestation and degradation is good for wildlife and for mitigating climate change. But this apparently win-win scenario depends on reducing pressure on forests through agricultural intensification, meaning less land is available for farming. The Living Forests Model suggests that the consequences of this could be:

- Freshwater withdrawals rising as irrigation increases substantially under high biodiversity protection scenarios, unless efficiencies are introduced along with choice of crops with lower water requirements
- Nitrogen and phosphorus[25] fertilizer use increasing rapidly, although they are already used at levels that create environmental problems, particularly in freshwater and coastal habitats
- Pesticide use increasing as a response to intensification, leading to contamination of soil, water, and wildlife

INCREASED FERTILIZER USE WILL CREATE ENVIRONMENTAL PROBLEMS, PARTICULARLY IN FRESHWATER AND COASTAL HABITATS

All these carry social and environmental costs, which have side effects on biodiversity and people's health. Forest conversion could be replaced by problems such as damaging levels of nitrate and phosphate enrichment of water and pesticide spray drift. Some analysts[26] have characterized these issues in terms of their impact on "planetary boundaries", which will be explored in later chapters. We need to develop a better understanding of the trade-offs between risk from forest loss and risk from agricultural intensification and to look at alternative ways to increase agricultural productivity sustainably. The types of intensification involved, and associated environmental controls, will be a key issue. Crop breeding needs to focus on productivity increases that are less dependent on high water and agrochemical use (fertilizers and pesticides) and more resilient to climate change and pests. The lifestyle changes and reduction in consumption that could help avoid these side effects will need rapid promotion.



Relative change in projected water, nitrogen and phosphorus use in 2050 under selected scenarios compared to the Do Nothing Scenario. Under the Target and Pro-Nature Plus Scenarios, less land is available to grow crops, so more irrigation and fertilizer is needed to produce sufficient food. However, total fertilizer (nitrogen and phosphorus) use decreases even though more fertilizer is used per hectare, because less land is cultivated. The Diet Shift Scenario reduces water, phosphorus and nitrogen use because demand for animal feed and grazing land decreases.

HOW WILL ZNDD AFFECT FOOD PRICES?

A ZNDD strategy will have important implications for commodity prices: halting deforestation generally results in higher food prices. However, cost implications vary greatly with particular scenarios in the Living Forests Model.

WE HAVE NOW ENTERED A PERIOD OF DEMAND-DRIVEN AGRICULTURE AS A RESULT OF GROWING PROSPERITY IN MANY COUNTRIES

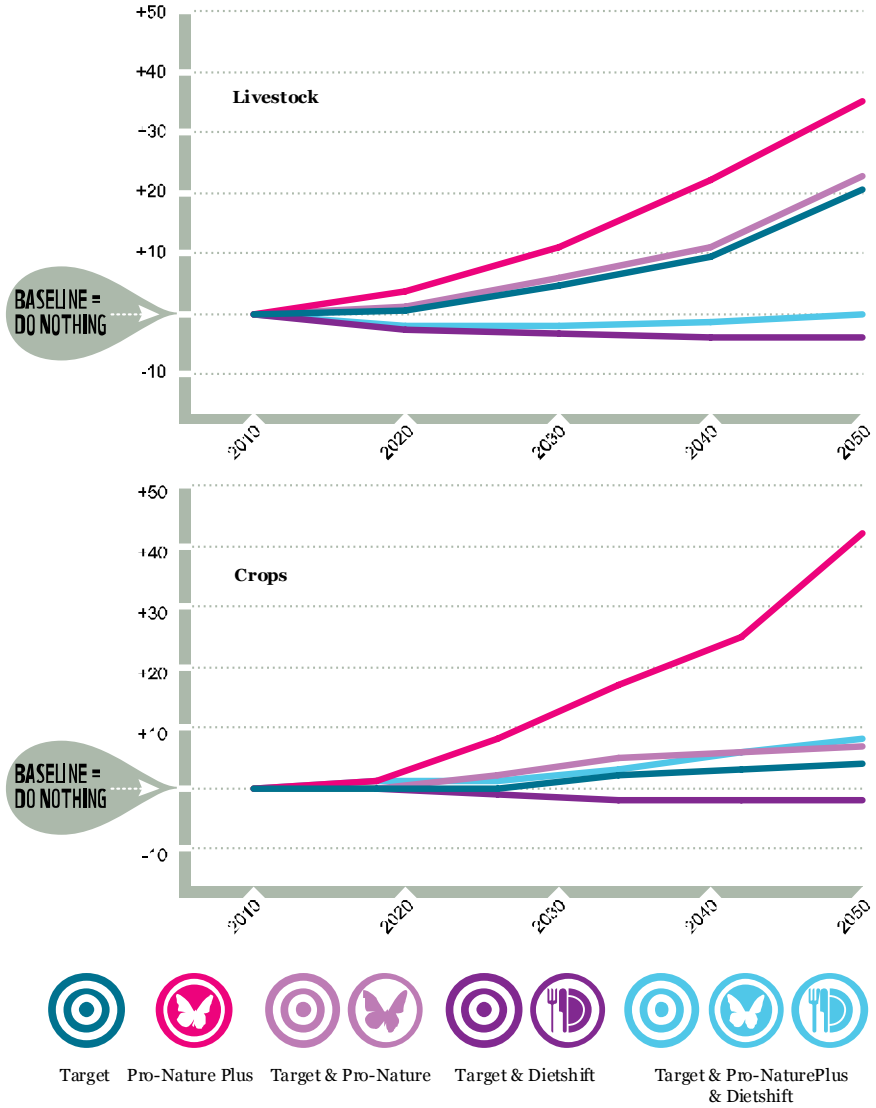
The Target Scenario alone makes little overall difference to crop prices, though the base price of meat is projected to rise by just over one-third (35 per cent) between 2010 and 2050. However, the Target Scenario coupled with the Pro-Nature Plus Scenario, the strictest biodiversity conservation scenario, projects significant increases in both crop and livestock prices. Price differentials are also heavily influenced by changes in crop productivity, efficiency of livestock production and the proportion of animal calories in the average diet.

The implications should not be exaggerated, however. We have now entered a period of demand-driven agriculture as a result of growing prosperity in many countries and these price variations are likely to be dwarfed by other far more important factors that affect prices, such as crop failures, inaccessibility of markets, and speculative trading.

In the short term it will often be cheaper to continue to clear forest to create agricultural land than to make the investments needed to intensify agriculture onto a smaller area. Increased efficiency on existing land will therefore in many cases need to be encouraged by incentives or laws.

Focusing crop and livestock production on the most productive land implies greater trade in commodities, which will in turn influence local economies and food processing, GHG emissions and possibly biofuel requirements associated with transport and storage.

These trade-offs, along with alternatives such as more locally produced food, will be examined in greater detail in a later chapter.



Percentage change in commodity price index for crops and livestock under different combinations of scenarios, relative to the Do Nothing Scenario for the period 2010 – 2050

WHAT ROLE DO DIET AND LIFESTYLE CHOICES PLAY IN ACHIEVING ZNDD?

As the world's population continues to increase, future biocapacity will depend on, among other things, our lifestyle choices, our ability to consume responsibly and our ability to increase agricultural sustainability and land productivity. The question is: Can we achieve this in the Living Forests Vision?

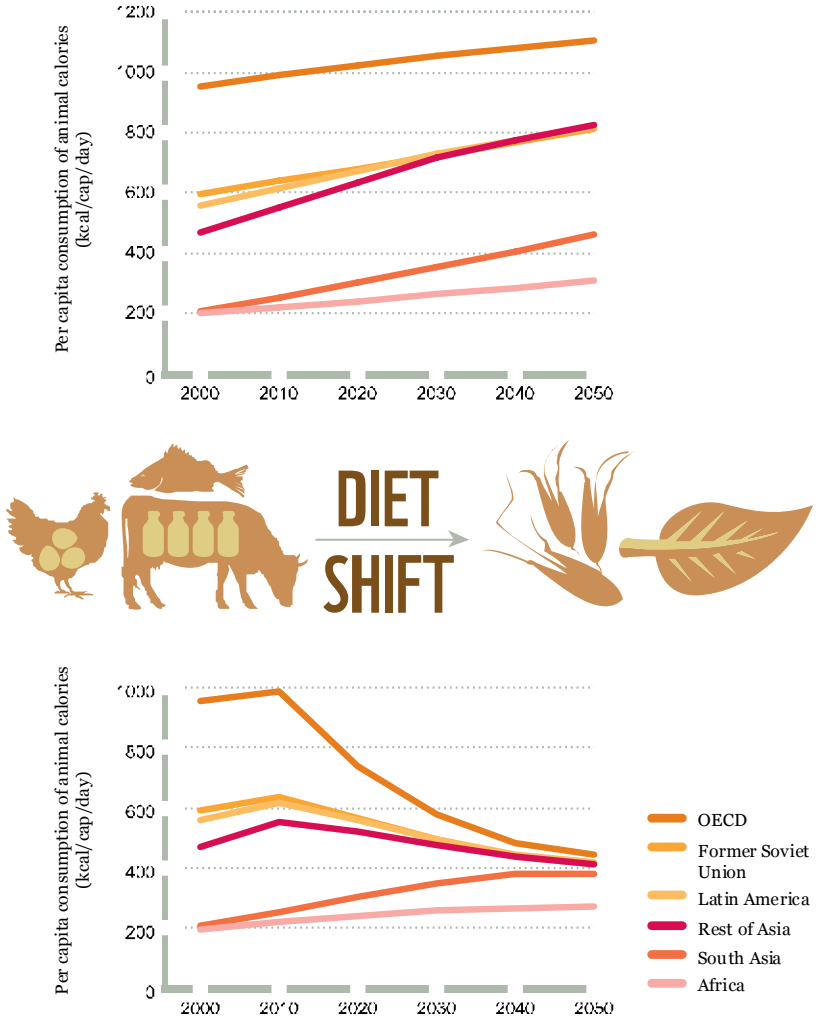
WE NEED A CHANGE IN GLOBAL POLICY AND ECONOMIC INCENTIVES THAT DRIVE FOOD CONSUMPTION PATTERNS, WHICH ALLOW MANY TO GO HUNGRY WHILE OTHERS CONSUME TO EXCESS

To get back within the planet's sustainable limits, individuals, businesses and governments need to assess and reduce their Ecological Footprints. In particular, the way the richest proportion of the global population lives will have to change. This does not mean forgoing all the little luxuries of life, but some will become more expensive and others less available. We need a change in global policy and economic incentives that drive food consumption patterns, which allow many to go hungry while others consume to excess.

In particular, the amount of meat and dairy products that affluent people consume will have to change. Compared to plant-based foods, meat and dairy generally require more land (for grazing or feed production) to produce the same amount of calories or protein. Over-grazing leads to land degradation and consequent GHG emissions and livestock, particularly cattle, contribute to climate change through methane emissions[27]. On the other hand, extensive and sustainable livestock production in some places helps to protect grassland biodiversity and carbon storage.

Reining in food waste is also critical. The FAO diet projections used in the Living Forests Model include the food wasted as well as the food eaten; therefore if we reduce waste, our Ecological Footprint will go down. The reduction of postharvest losses within food insecure regions will also help increase food availability and reduce hunger[28].

Working out the feasibility of such changes, and fair and achievable ways to modify consumption patterns, will be discussed in later chapters.



Projected animal calorie consumption per day between now and 2050 in different regions under the Do Nothing Scenario (top graph), where per capita consumption continues to follow the current path predicted by the FAO and the Diet Shift Scenario (bottom graph), where in OECD countries a gradual reduction is achieved through dietary changes and waste reduction, while allowing per capita consumption in other regions, such as South Asia and Sub-Saharan Africa, to increase.

HOW WILL ZNDD AFFECT THE FOREST PRODUCTS INDUSTRY?

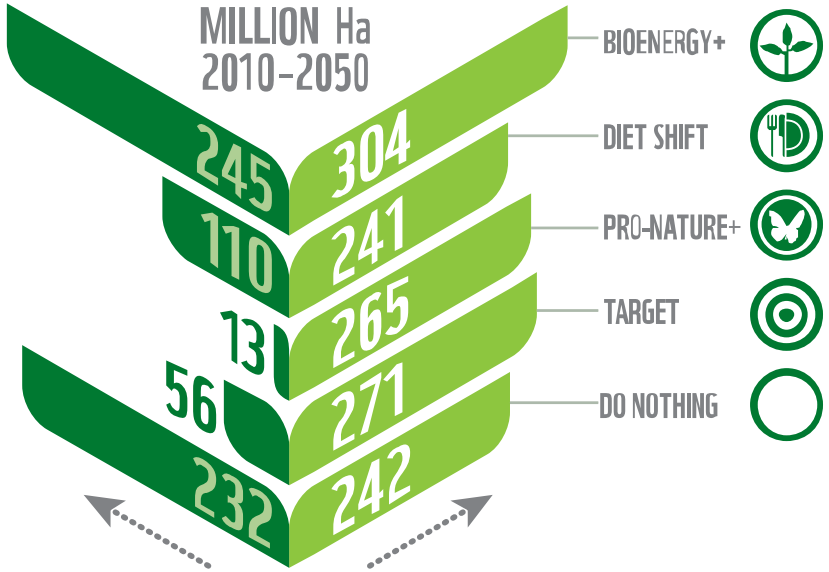
The dual imperatives of ZNDD and meeting global demand for materials and energy pose both challenges and business opportunities for the forest products sector.

FORESTRY HAS A KEY ROLE IN MAINTAINING THE PLANET'S NATURAL CAPITAL

Forest products are renewable and, when sourced from well-managed native forests and plantations, tend to have a lower footprint than alternatives like steel, concrete and plastic based on fossil sources. In the future, "second-generation" biofuels from wood and other plant fibres could supply significant portions of the world's energy demand, although questions remain about the sourcing of these materials. Forestry has a key role in maintaining the planet's natural capital and responsible companies could expect to benefit.

ZNDD is predicated on legality and best practice in forest management, through strong and effective national laws and policies and a range of voluntary certification schemes. Although poor forestry is still widespread, the momentum for responsible forest management is building, and a range of management tools are available and increasingly applied by good forest managers.

The role of plantations: The Living Forests Model anticipates increasing reliance on high-yield plantations for timber, pulpwood, and biomass for energy. A new generation of plantations would need to be established at a rate of 4-6 million ha per year on land that is currently grassland, shrubland, or highly degraded forest. More research is required on the environmental and social consequences of such plantations. WWF leads a **New Generation Plantations Project** to identify and promote better management practices, strong policies, and legal controls, basing sound management around carbon storage and maintenance of water, biodiversity and soils[29].



Area of natural forest lost or converted to managed forest under selected scenarios between 2010 and 2050.

Tools for sustainable forest management

- Forest Stewardship Council, the most credible forest certification system
- WWF's Global Forest & Trade Network promotes responsible forest management and trade in forest products
- High Conservation Value Resource Network provides tools and resources to identify and conserve the most valuable forests from environmental and social perspectives

CAN WE ACHIEVE 100% RENEWABLE ENERGY WITHOUT DEFORESTATION?

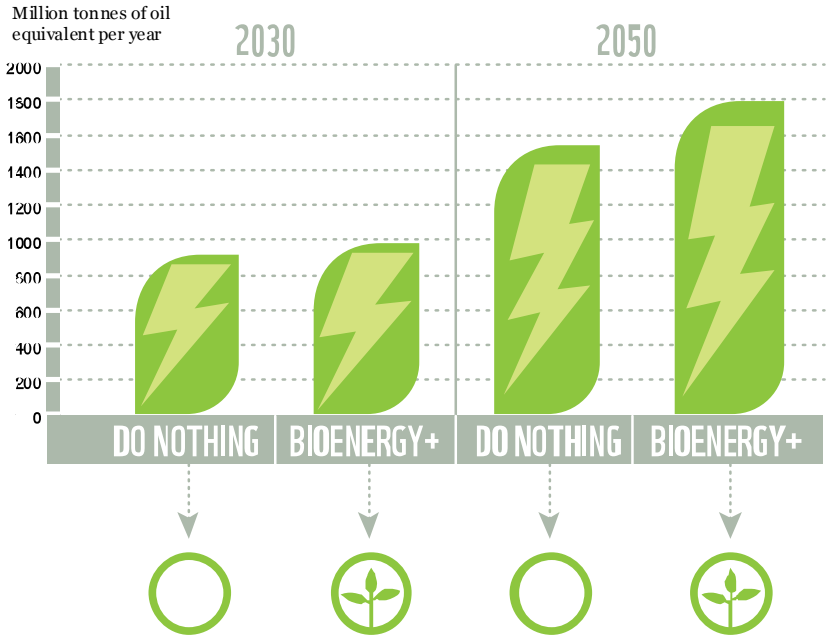
ZNDD will affect global energy markets and policies, through its impact on land availability for bioenergy crops and fast-growing tree plantations and the supply of wood from existing natural or semi-natural forests. Bioenergy is being promoted as an inevitable component of future energy supplies, but carries significant environmental and social risks.

WOOD-BASED BIOENERGY CAN BE PRODUCED FROM FORESTS OR PLANTATIONS

Wood-based bioenergy can be produced from forests or plantations. Where bioenergy is supplied from fast-growing plantations on degraded lands, using best practice as elaborated by the New Generation Plantations concept, it can provide climate-friendly fuel and increase carbon storage. However, the climate benefits of wood-based bioenergy depend on the current baseline of standing biomass, age distribution, growth rate and intensity of harvesting including disturbance of soil carbon. Intensive management practices, like whole tree harvesting and use of fast-growing exotic species and fertilizers, all have ecological consequences.

CROP-BASED BIOENERGY WILL COMPETE FOR A SHARE OF THE WORLD'S PRODUCTIVE ARABLE LAND

Crop-based bioenergy will compete for a share of the world's productive arable land. To ensure that GHG savings from biofuels are not eclipsed by emissions associated with their cultivation, land for planting will need to be secured without conversion of forests. To prevent an added irrigation burden, this land should be rain-fed. Caution is needed to avoid the diversion of crops that underpin food security into bioenergy, or for crops displaced by biofuel production to expand into forests and other ecosystems. Some current bioenergy products are having serious environmental and social costs. A sustainable future requires a careful balancing of increased use of bioenergy to substitute fossil fuels with the need for environmental and social safeguards and greater energy efficiency. These issues will be examined in a later chapter.



Bioenergy consumption in 2030 and 2050 under the Do Nothing and Bioenergy Plus Scenarios.

The Energy Report: In 2011 WWF published a report, based on the Ecofys Energy Model, outlining a scenario for a world powered by 100% renewable energy, drawing on solar, wind and other technologies. By 2050, the scenario requires more than 4.5 billion m^3/year of wood for bioenergy and an additional 250 million ha of land allocated globally to biofuel crops. The Bioenergy Plus scenario reflects the Ecofys Energy Model, and will be used in later chapters to examine the potential role of bioenergy within ZNDD more deeply.

WILL SAVING FORESTS INCREASE THE PRESSURES ON BIODIVERSITY OUTSIDE FORESTS?

An all-out effort to protect forests could have the unintended side effect of shifting the impacts of development into other biomes containing important biodiversity.

Moist forest: Generally found in large, discontinuous patches centered on the equatorial belt and between the Tropics of Cancer and Capricorn, Tropical and Subtropical Moist Forests are characterized by low variability in annual temperature and high levels of rainfall (>200 centimeter annually). Forest composition is dominated by semi-evergreen and evergreen deciduous tree species[57].

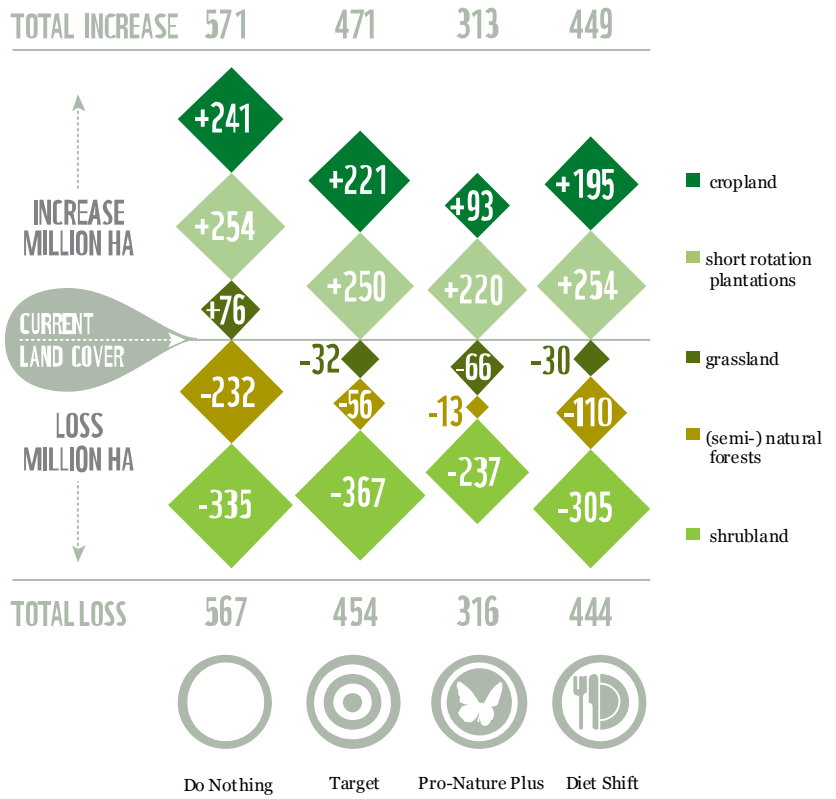
The Target Scenario suggests a significant decline in grasslands and evergreen and **deciduous shrub** habitats, as agriculture shifts away from replacing **closed forests** to replacing these habitats. The Pro-Nature Scenarios reduce but do not eliminate this by restricting the expansion of agriculture into important areas for conservation; however they introduce environmental costs associated with more intensified agriculture (see page 20) and could push up food prices (see page 21).

Efforts to halt deforestation could lead to other ecosystem losses unless we can find ways to increase agricultural productivity sustainably, with effective environmental safeguards, and reduce over consumption and waste of food. For instance, grassland is less protected than forests: only 5 per cent of temperate grassland is protected compared to 23 per cent of tropical **moist forest**[30], and many associated species are at risk.

5%
OF TEMPERATE GRASSLAND IS PROTECTED COMPARED TO 23 PER CENT OF TROPICAL MOIST FOREST

Such trade-offs may also take place *within* forests: forests differ in their carbon storage and logically conservation efforts for emissions reductions would start in the highest-carbon forests. However, efforts to protect these could push development into relatively low-carbon forests, which nonetheless have significant biodiversity and endemism and low resilience to environmental pressures.

In practice, crop choices and land-use patterns cannot be moved around the globe as easily as in a computer model. But vigorous efforts to reduce forest loss could have side effects on other ecosystems that need to be addressed in any overall ZNDD strategy.



The total area change in (semi-) natural forest, plantations, cropland, grassland[33] and shrubland under each scenario between now and 2050. This analysis provides an overview of the degree of land-use change under each scenario, and allows us to look at leakage. For example, under the Target Scenario there is substantially higher loss of shrub land and grassland because conservation measures focusing on forests have forced the conversion of other land types to cropland.

WILL ZNDD KEEP ENOUGH CARBON OUT OF THE ATMOSPHERE?

$GtCO_2e$: Billion metric tonnes of CO_2 equivalent; describes the amount of CO_2 that would have the same global warming potential as a given mixture and amount of greenhouse gas.

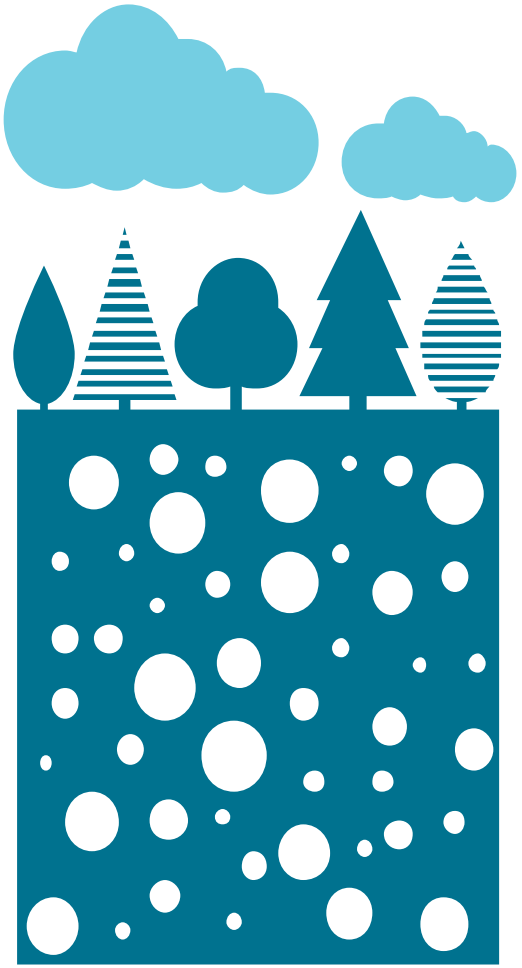
Forests are the largest terrestrial store of carbon and deforestation is the third-largest source of GHG emissions after coal and oil.

Forests have a vital role to play in the fight against global warming, being the largest terrestrial store of carbon and deforestation being the third-largest source of GHG emissions after coal and oil. Loss and degradation of natural vegetation, particularly forests and tropical peat, contributed 7.4 GtCO2e/year of GHG emissions–16 per cent of the global total – in 2005[31]. Halting these emissions is a key climate change mitigation strategy.

Net deforestation rates (measured by hectares of forest) are not synonymous with net GHG emission rates (measured in CO_2 equivalent tonnes); indeed there is a complex relationship between forests loss or gain and net GHG emissions. However there is no doubt that ZNDD by 2020 would make a huge contribution to transforming the forest sector from a net source of GHG emissions to a net carbon sink.

Prioritizing forest conservation could increase GHG emissions from other vegetation by diverting land clearance into other ecosystems. However, the Target Scenario shows that this could be compensated by increased crop and livestock productivity that reduce overall GHG emissions from agriculture.

Forest carbon accounting issues will be examined more deeply in a later chapter. This will also review the circumstances in which forests are carbon sinks or sources and explore the degree to which carbon-driven forest conservation can be aligned with biodiversity conservation priorities and the aspirations of forest-dependant peoples, while meeting global demand for forest products.



THERE IS NO DOUBT THAT ZNDD BY 2020 WOULD MAKE A HUGE CONTRIBUTION TO TRANSFORMING THE FOREST SECTOR FROM A NET SOURCE OF GHG EMISSIONS TO A NET CARBON SINK

CAN WE HALT DEFORESTATION AND SAFEGUARD PEOPLE'S LIVELIHOODS?

Steps to achieve ZNDD start from a global perspective, with success depending on more than just voluntary actions – although these are also important.

It will require new policies and laws, better implementation of existing laws, tough crackdowns on corruption, and probably some unpopular decisions. But extreme care is required to reconcile a top-down vision of a world without deforestation with bottom-up perspectives reflecting the legitimate needs and wishes for self determination and well-being of the 300 million people living in forests and the over 1 billion more directly dependent on forests[32].

The Target Scenario, for instance, assumes that people will exchange swidden agriculture or a **nomadic pastoralist** lifestyle for more efficient settled agriculture, but this will not always be true (and some traditional agriculture may be more efficient and sustainable than alternatives). Agricultural improvements can backfire and increase inequality if they lead to powerful community members gaining control of new technologies and out-competing their neighbours. Equity issues need to be prioritized under ZNDD strategies, and impacts on livelihoods will be a constant theme throughwout the *Living Forests Report*.

Local strategies must be negotiated and the results will often be a trade-off between the needs of forests and people: halting deforestation in many places means finding alternative livelihood options for local people. One of the issues discussed across all *Living Forests Report* chapters will be the need to gain a better understanding of the trade-offs and synergies between rural livelihood activities and the Living Forests Vision. Existing policies can provide a framework to help these decisions — for instance the UN's *Declaration on the Rights of Indigenous Peoples* or WWF's *Position Paper on Poverty and Conservation*.

Nomadic pastoralist: One who practices a form of agriculture where livestock is herded either seasonally or continuously in order to find fresh pastures on which to graze.

Bibiane is a member of the WWF-supported Women's Health and Conservation Society in Cameroon. Many families in the area rely on forest products for their livelihoods – in Bibiane's case, honey production is an important source of income. WWF helps ensure these activities are sustainable and profitable.

THE LIVING FOREST REPORTS: CHAPTER 1 CONCLUSIONS

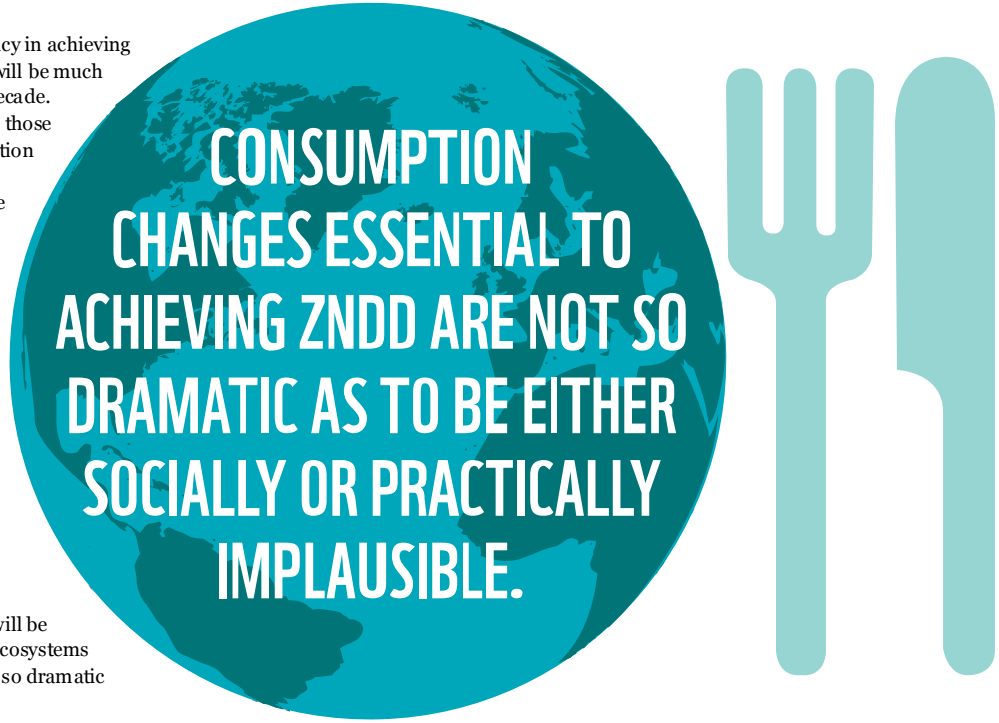
The Living Forests Model Target Scenario suggests ZNDD is technically possible by 2020, without food and material shortages, but with some sacrifices. There are many challenges, especially in reducing forest loss without undermining biodiversity or the livelihoods of vulnerable people.

ACHIEVING AND MAINTAINING ZNDD IS CRITICAL TO WWF'S CONSERVATION EFFORTS.

The Model provides compelling evidence of the need for urgency in achieving ZNDD. Some benefits, particularly reducing GHG emissions, will be much harder to attain if deforestation runs unchecked for another decade. With vision and action, the stewards of the world's forests and those with political and economic power can eliminate net deforestation in this period. Achieving and maintaining ZNDD is critical to WWF's conservation efforts. WWF applauds the fact that some countries are aiming to cut deforestation before 2020 and others aim to expand their natural forest cover.

Over the next 40 years, the challenge of achieving ZNDD will expand from being primarily social and political to demanding a stronger technical component, with scientists seeking ways of meeting any food and energy shortfalls without clearing more natural forest. Governance of these processes and of who controls the means of improvement will be of critical importance.

ZNDD rests on a strong social component. ZNDD strategies should not disregard the rights and livelihood needs of rural communities nor exclude them from land-use decisions and governance. The Living Forests Model shows that changes in consumption patterns, particularly among the most affluent, will be essential to achieving ZNDD without excessive costs to other ecosystems or threats to food security. Such consumption changes are not so dramatic as to be either socially or practically implausible.



All these issues will be addressed in more detail in further analyses of the Living Forests Model and in subsequent chapters of the *Living Forests Report*, released throughout 2011.

GLOSSARY AND ACRONYMS

Ancient forest: (1) The oldest seral stage in which a plant community is capable of existing on a site, given the frequency of natural disturbance events, or (2) a very old example of a stand dominated by long-lived early- or mid-seral species[33].

Animal calories: Calories in food from meat, seafood, dairy products and eggs.

Benefit-sharing: Sharing of whatever accrues from the utilization of biological resources, community knowledge, technologies, innovations, or practices. It also means all forms of compensation for the use of genetic resources, whether monetary or non-monetary[34].

BIOCAPACITY

Biocapacity: The area of biologically productive land and water on Earth available to produce renewable resources and absorb CO_2; i.e., cropland, grazing land, coastal and inland fishing grounds, and forests. The capacity of ecosystems to produce useful biological materials and to absorb waste materials generated by humans, using current management schemes and extraction technologies. Within the Ecological Footprint, biocapacity is measured in global hectares[35].

Biodiversity: The variability among living organisms from all sources including, *inter alia,* terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems[36].

BOREAL FOREST

Bioenergy: Energy derived from biomass. This energy can be used to generate electricity, supply heat and produce liquid biofuels[37].

Biomass: Organic material both above-ground and below-ground, and both living and dead, e.g., trees, crops, grasses, tree litter, roots animal wastes[38].

Boreal forest: A belt of coniferous forest that encircles the northern hemisphere, running through North America, Europe and Asia.

Bushmeat: Also called wild meat; the harvesting of wild animals in tropical and sub-tropical forests for food and for non-food purposes, including for medicinal products[39].

CO_2: Carbon dioxide.

Certification: The procedure by which an independent body (e.g., a Forest Stewardship Council accredited certification body) gives written assurance that a product, process or service conforms with specified requirements[40].

Climate change: The slow variations of climatic characteristics over time at a given place. Usually refers to the change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is, in addition to natural climate variability, observed over comparable periods[41].

Closed forests: Formations where trees of various storeys and undergrowth cover a high proportion of the ground or open forest[42].

Convention on Biological Diversity (CBD): A comprehensive, binding agreement covering the use and conservation of biodiversity signed by 193 governments.

Deciduous shrub: Woody perennial plants that are leafless for a certain period during the year, with persistent and woody stems[43].

Deforestation: The conversion of forest to another land use or the long-term reduction of the tree canopy cover; 1) Deforestation also implies the long-term or permanent loss of forest cover and implies transformation into another land use. Such a loss can only be caused and maintained by a continued human-induced or natural perturbation; 2) includes areas of forest converted to agriculture, pasture, water reservoirs and urban areas and 3) specifically excludes areas where the trees have been removed as a result of harvesting or logging, and where the forest is expected to regenerate naturally or with the aid of silvicultural measures. Unless logging is followed by the clearing of the remaining logged-over forest for the introduction of alternative land uses, or the maintenance of the clearings through continued disturbance, forests commonly regenerate, although often to a different, secondary condition. In areas of shifting agriculture, forest, forest fallow and agricultural lands appear in a dynamic pattern where deforestation and the return of forest occur frequently in small patches. To simplify reporting of such areas, the net change over a larger area is typically used[44].

Degradation: Changes within the forest that negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or ecosystem services[45].

Ecological Footprint: The impact of human activities measured in terms of the area of biologically productive land and water required to produce the goods consumed and to assimilate the wastes generated[46].

Ecosystem services: The benefits people obtain from nature. These include provisioning services such as food and water; regulating services such as regulation of floods, drought, land degradation, and disease; supporting services such as soil formation and nutrient cycling; and cultural services such as recreational, spiritual, religious and other non-material benefits[47].

Empty forests: Apparently intact forests that no longer maintain their original community of fauna and flora due to human disturbances (such as hunting, harvesting and others)[48].

FAO: UN Food and Agriculture Organization

Food security: Defined by the 1996 World Food Summit as: "*...when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life*"[49].

Free prior informed consent (FPIC): The principle that a community has the right to give or withhold its consent to proposed projects that may affect the lands they customarily own, occupy or otherwise use.

Fuelwood: Wood used as fuel for heating or cooking.

Greenhouse gases (GHG): Those gaseous constituents of the atmosphere, both natural and artificial, that absorb and reemit infrared radiation and that are responsible for global warming[50].

GDP: Gross Domestic Product.

Grassland: A plant community in which grasses are dominant, shrubs are rare, and trees absent[51].

$GtCO_2e$: Billion metric tonnes of CO_2 equivalent; describes the amount of CO_2 that would have the same global warming potential as a given mixture and amount of greenhouse gas.

Illegal logging: The harvesting or removal of timber (a) without a legal right to harvest timber in the forest management unit in which the timber was grown, or (b) in breach of national or sub-national laws governing the management and harvesting of forest resources.

Illegally sourced timber: Timber that was illegally harvested or traded.

Indigenous peoples: Peoples in independent countries who are regarded as indigenous on account of their descent from the populations that inhabited the country, or a geographical region to which the country belongs, at the time of conquest or colonization or the establishment of present state boundaries and who, irrespective of their legal status, retain some or all of their own social, economic, cultural and political institutions[52].

Intact forest landscapes: An unbroken expanse of natural ecosystems within the zone of current forest extent, showing no signs of significant human activity, and large enough that all native biodiversity, including viable populations of wide-ranging species, could be maintained.

Invasive species: An alien (i.e., non-native) species whose introduction and/or spread threaten biodiversity[53].

IUCN: International Union for Conservation of Nature.

Land tenure: The relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land[54].

Living Planet Index: An indicator of the state of global biological diversity based on trends in populations of vertebrate species from around the world.

Millennium Development Goals (MDGs): Eight goals set by the UN to reverse the poverty, hunger and disease affecting billions of people[55].

Millennium Ecosystem Assessment: A UN initiative assesses the consequences of ecosystem change for human well-being and the scientific basis for action needed to enhance the conservation and sustainable use of those systems and their contribution to human well-being[56].

Moist forest: Generally found in large, discontinuous patches centered on the equatorial belt and between the Tropics of Cancer and Capricorn, Tropical and Subtropical Moist Forests are characterized by low variability in annual temperature and high levels of rainfall (>200 centimeter annually). Forest composition is dominated by semi-evergreen and evergreen deciduous tree species[57].

Natural forest: Forest composed of native species (a species that naturally exists at a given location or in a particular ecosystem, i.e., has not been introduced there by human activities[58]) with natural ecosystem functions.

Near zero: In the context of forest loss, WWF interprets this to mean less than 5 per cent of the current gross rate of loss, based on the FAO's most recent statistics; this equates to a reduction in loss of such forests from 13 million ha/year to less than 650,000 ha/year.

New Generation Plantations: As defined by WWF, maintain ecosystem integrity and high conservation values, are developed through effective stakeholder participation processes and contribute to economic growth and employment.

Nomadic pastoralist: One who practices a form of agriculture where livestock is herded either seasonally or continuously in order to find fresh pastures on which to graze.

Non-timber forest products: A product of biological origin other than wood derived from forests, other wooded land, and trees outside forests[59].

Plantation: Forest stands established by planting or/and seeding in the process of afforestation or reforestation. They are either of introduced species (all planted stands), or intensively managed stands of native species, which meet all the following criteria: one or two species at plantation, even age class, regular spacing[60].

Protected area: A clearly defined geographical space that is recognized, dedicated and managed through legal or other effective means in order to achieve the long-term conservation of nature with associated ecosystem services and cultural values[61].

Restoration: The process of assisting the recovery of an ecosystem that has been degraded, damaged, or destroyed[62].

Sub tropical forest: These are found to the sound and north of the tropical forests. The trees here are adapted to resist the summer drought[63].

Swidden agriculture: Agriculture that involves the clearing of forest areas by cutting and burning for temporary crop cultivation[64].

Tropical forest: Closed canopy forests growing within 28 degrees north or south of the equator. Such forests are found in Asia, Australia, Africa, South America, Central America, Mexico, and on many of the Pacific Islands.

Temperate forest: Found in such places as eastern North America, northeastern Asia, and western and eastern Europe, temperate forests are a mix of deciduous and coniferous evergreen trees. Usually, the broad-leaved hardwood trees shed leaves annually. There are well-defined seasons with a distinct winter and sufficient rainfall[65].

UN Framework Convention on Climate Change (UNFCCC): International treaty aiming to stabilize greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous human interference with the climate system.

UN: United Nations

UNEP: United Nations Environmental Programme

Unnecessary deforestation: Deforestation anticipated in the Do Nothing Scenario other than deforestation calculated by GLOBIOM as necessary to meet global demand for land other than natural or semi-natural forest for fuel, fibre and food.

World Database on Protected Areas (WDPA): A database managed by the UNEP World Conservation Monitoring Centre listing protected areas from around the world. Entries include information relating to the IUCN management category and governance type: protected areas on the WDPA range from strictly protected areas to protected landscapes including human settlements and managed land, and from state protected areas to lands managed by indigenous peoples and local communities.

ZNDD: No net forest loss through deforestation and no net decline in forest quality through degradation. Zero net deforestation and degradation acknowledges that some forest loss could be offset by forest restoration. Zero net deforestation is thus is not synonymous with a total prohibition on forest clearing. Rather, it leaves room for change in the configuration of the land-use mosaic, provided the net quantity, quality and carbon density of forests is maintained. It recognizes that, in some circumstances, conversion of forests in one site may contribute to the sustainable development and conservation of the wider landscape (e.g. reducing livestock grazing in a protected area may require conversion of forest areas in the buffer zone to provide farmland to communities). Managing forests to avoid degradation is often a key strategy to prevent deforestation.[66]

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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.

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Contributors
Editor in Chief: Rod Taylor
Technical Editors: Nigel Dudley, Michael Obersteiner, Sue Stolton
Editorial Team: Rosamunde Almond, Gretchen Lyons, Emma Duncan

With special thanks for review and contributions from: Mauro Armelin, Jean BaKouma, Maria Ximena Barrera, Linda Berglund, Alex Bjork, Rodrigo Catalan, Kerry Cesareo, Sandra Charity, Chen Hin Keong, Andre Silva Dias, Cristina Eghenter, Monique Grooten, Lasse Gustavsson, Lisa Hadeed, Han Zheng, Helen van Hoeven, Peter Kanowski, Andrea Kohl, Isabelle Laudon, Lifeng Li, Colby Loucks, Claudio Maretti, Laszlo Mathe, Liz McLellan, Roland Melisch, Mariana Napolitano, Richard Perkins, Jorgan Randers, Juan Carlos Riveros, Peter Roberntz, Alison Rosser, Carlos Alberto Scaramuzza, Susanne Schmitt, Kirsten Schuyt, Luis Neves Silva, Gerald Steindlegger, Bryan Weech, George White, Ivy Wong, Sejal Worah, Mark Wright, Julia Young

IIASA's modeling team: Michael Obersteiner, team leader; with Petr Havlik and Kentaro Aoki, Juraj Balkovic, Hannes Boettcher, Stefan Frank, Steffen Fritz, Sabine Fuss, Mykola Gusti, Mario Herrero, Nikolay Khabarov, Georg Kindermann, Florian Kraxner, Sylvain Leduc, Ian McCallum, Aline Mosnier, Erwin Schmid, Uwe Schneider, Rastislav Skalsky, Linda See, Hugo Valin

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WWF International
Avenue du Mont Blanc
1196 Gland, Switzerland
www.panda.org

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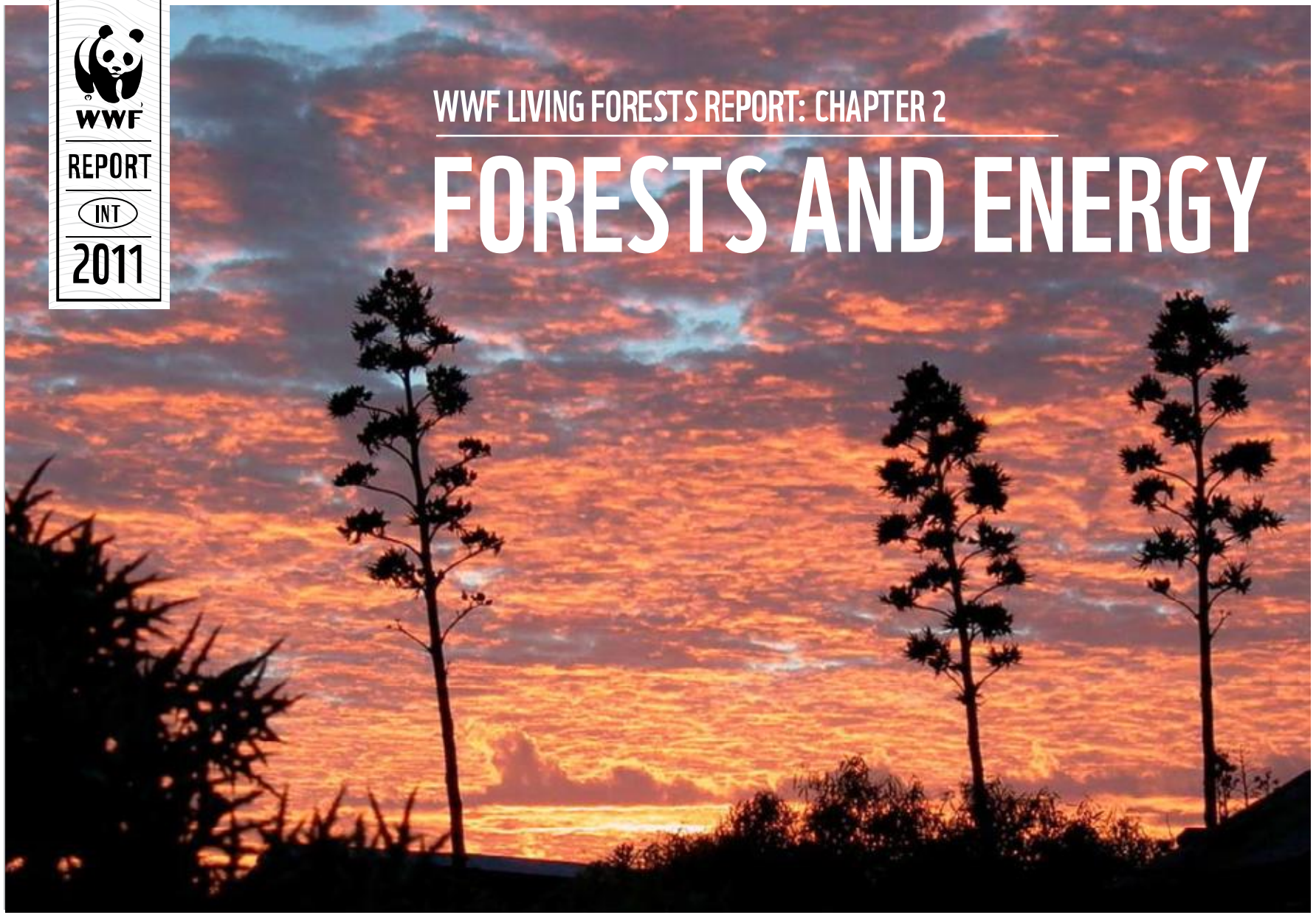


WWF LIVING FORESTS REPORT: CHAPTER 2

FORESTS AND ENERGY

SUSTAINABLE ENERGY FOR 10 BILLION PEOPLE[1]

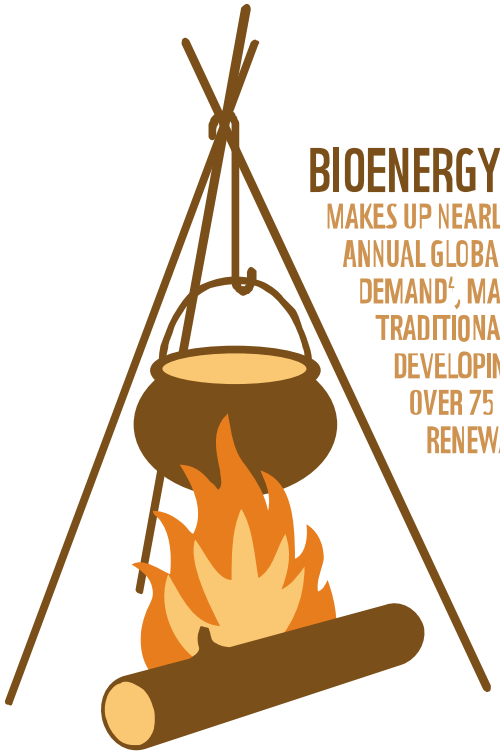
For millennia we have managed forests and harvested wood for energy.

Although much of the world still relies on wood for cooking and heating, most of the energy we use comes from highly concentrated fuels formed from organisms that lived millions of years ago. This reliance on fossil fuels is unsustainable – cheap, easily accessible oil, coal and gas are running out and their use also releases huge amounts of **greenhouse gas (GHG)** into the atmosphere, driving climate change and acidifying oceans. Nuclear power, often cited as a climate-friendly alternative, is expensive, relies on exhaustible uranium supplies and poses heavy environmental, health and security risks.

WWF envisions a world where energy consumption is reduced and supplied 100 per cent from renewable sources by 2050. A scenario detailed for WWF's *Energy Report* suggests that, to achieve this vision, 40 per cent of energy demand will need to be met with **bioenergy**[2].

Bioenergy can provide diverse sustainable alternatives to fossil fuels, plus new incomes and increased energy security for rural communities. However, for these benefits to be realized, its use must be carefully planned, implemented and monitored for environmental and social sustainability. Expanding bioenergy **feedstock** production has the potential to compound food and water shortages and accelerate natural habitat loss. Managing these risks will require strong social and environmental safeguards. Future technologies may allow energy to be produced from feedstocks that use less of the world's finite land and water resources and are viable for a wide range of uses[3].

This chapter of the *Living Forests Report* explores the land-use implications of a growing bioenergy sector, looking at the main trends projected over the next few decades.



BIOENERGY

MAKES UP NEARLY 15 PER CENT OF ANNUAL GLOBAL PRIMARY ENERGY DEMAND[4], MAINLY THROUGH TRADITIONAL FUELWOOD USE IN DEVELOPING COUNTRIES, AND OVER 75 PER CENT OF ALL RENEWABLE ENERGY[5]

WWF aspires to a future where humanity's global footprint stays within the Earth's ecological limits and the planet's natural resources are shared equitably. During the 2011 International Year of Forests, WWF's Living Forests Report is part of a year-long conversation with partners, policymakers and business about how forests can contribute to this vision. The report uses the Living Forests Model to explore pathways to achieve and maintain WWF's target of Zero Net Deforestation and Forest Degradation (ZNDD) by 2020. Our goal is to compare different future scenarios, look at the implications of policies and inform debate. Find out more about the Living Forests Report, ZNDD and the Living Forests Model.

BIOENERGY: TRADITIONAL AND FUTURE USES

WWF is committed to environmentally, socially and economically sustainable renewable energy.

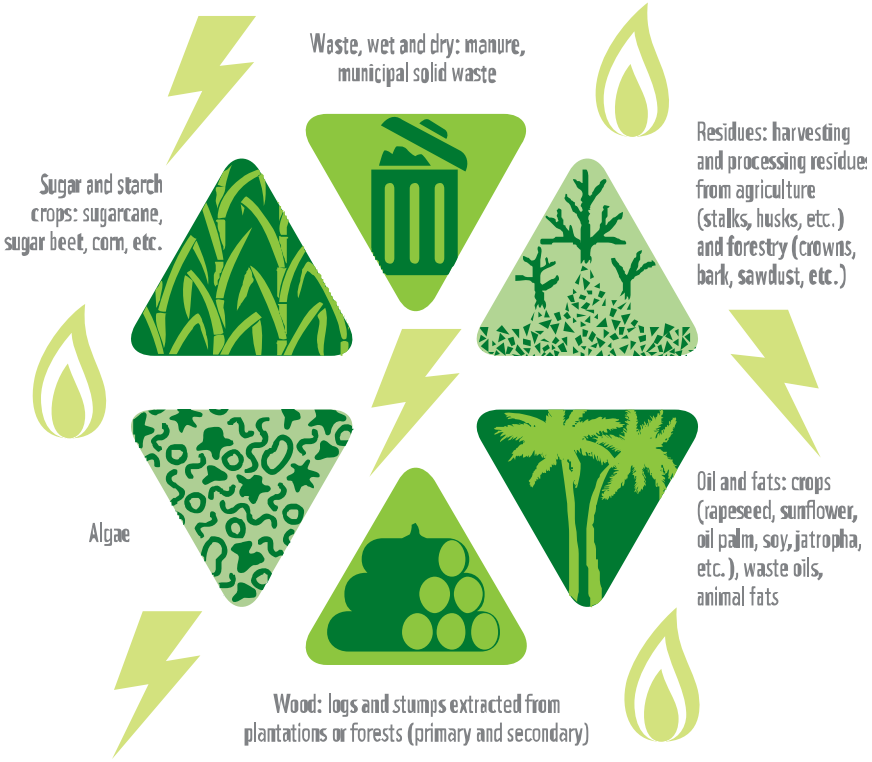
LEARN MORE ABOUT WWF'S VISION OF A WORLD POWERED 100% BY RENEWABLE ENERGY

Bioenergy is a term used to describe all energy derived from biological sources (**biomass**) – from a simple wood fire to complex technologies that turn algae into fuel. The way biomass is used, i.e. **conversion methods**, differs significantly depending on where people live and their economic status:

Traditional uses: According to the Food and Agriculture Organization (FAO), wood is the main source of energy for well over 2 billion people living in developing countries[6]. More than 70 per cent of wood harvested in Asia and the Pacific, and 90 per cent in Africa, is used for fuel[7], compared to about 20 per cent in Europe[8].

New technological uses: In recent years, industrialized countries have turned back to using biomass, but with new and emerging technologies, to produce heat, electricity and liquid fuels (**biofuels**).

As technology evolves, an increasing variety of biomass feedstocks will become suitable for conversion to bioenergy; wood, however, is likely to remain one of the most important[9]. In the EU today over half of all biomass-based electricity production uses wood and wood waste[10]. Whether the net environmental, social and climate impacts of bioenergy are positive or negative will depend largely on what policy and market safeguards are put in place.



THE LIQUID BIOFUEL CHALLENGE

Using more biofuels is a priority for many countries.

WWF's vision of a world powered 100 per cent by renewable energy depends on a major expansion of bioenergy, including liquid biofuels in sectors without other renewable alternatives[11].

LAND ACQUISITION ASSOCIATED WITH FOOD PRODUCTION AND BIOFUELS IS ALREADY CREATING ENVIRONMENTAL AND SOCIAL PROBLEMS

Biofuel development has been characterized in terms of 'generations' to illustrate its technological sophistication. **First generation biofuels** convert sugar starches and oils into fuel – an already proven technology. **Second generation biofuels** convert plant **lignin** and **cellulose** into fuels – either by using enzymes or through the gasification of biomass material followed by a gas-to-liquid process. Biomass that could be used in this process includes all types of trees, grasses and organic wastes. Second generation biofuels are not currently commercially viable at scale, but their development could significantly expand the volume and variety of bioenergy feedstocks in the future. Third[12] and fourth generation biofuels are being researched; the former are made from algae while the latter is a vaguer description of hypothetical production methods including genetic manipulation of organisms.

Large-scale commercial first generation biofuel production is growing rapidly – and encouraging a global 'land grab' as companies and governments acquire land for feedstock production. Rapid land acquisition associated with food production and biofuels is already creating environmental and social problems[13]. If biofuel is to be part of a sustainable and ethical renewable energy solution, enabling measures are needed. These should include careful land-use planning, good governance and industry standards to ensure production does not threaten food and water supplies or biodiversity, displace vulnerable people, or increase atmospheric carbon[14].

EFFICIENCY, EQUITY AND ENERGY DEMAND

Development of bioenergy must be viewed within social and political contexts. While the rich world squanders energy, many poor people do not have enough.

One-and-a-half billion people in developing countries lack access to electricity. Worldwide, 2.6 billion people use traditional biomass, mainly wood and charcoal, for cooking. Most, almost three-quarters, do not have access to efficient stoves; in sub-Saharan Africa, only 6 per cent of those using traditional biomass have stoves. The result is wasteful fuel use; significant time and effort spent collecting firewood; forest degradation; and serious health effects from wood smoke, which along with coal smoke kills almost 2 million people a year[15].

Efficient, sustainable bioenergy could help address these disparities and be a major contributor to the global energy supply. Sustainable local bioenergy sources could provide energy and income to some of the world's poorest or most remote communities.

While higher oil prices make renewable energy a more attractive option to governments and investors, the recent shift to bioenergy has mostly been driven by subsidies and mandated government targets (see appendix)[16]. In both local and export markets, bioenergy can help to even out fluctuations in power generation due to variability in other renewable sources such as wind and solar.

But bioenergy poses serious social and environmental risks that need to be managed. Poorly planned and implemented bioenergy feedstock production could result in more inequity, such as further concentration of land ownership; displacement of small farmers and forest-dependent peoples; polluting cultivation methods; higher food prices, and additional pressure on the food supply in places that can least afford it[17]. The rich should not continue to expand and outsource their energy footprint at the expense of poor people and high biodiversity ecosystems.

SUSTAINABLE LOCAL BIOENERGY SOURCES COULD PROVIDE ENERGY AND INCOME TO SOME OF THE WORLD'S POOREST OR MOST REMOTE COMMUNITIES

EFFICIENT WOODSTOVES AND FUELWOOD PLANTATIONS IN THE CONGO

In many parts of the world, wood-fired cooking and heating technologies are inefficient and contribute to unsustainable fuelwood harvesting.

Inefficient fuelwood use damages forests and human health. Women are hardest hit as they often collect firewood and have to cover longer distances as nearby forests are depleted. They also usually do the cooking, so are most exposed to smoke.

To reduce the environmental and health impacts of traditional fuelwood use, people need access to alternatives, such as renewable energy sources, local fuelwood plantations, and efficient, affordable stoves and heating systems. Such efforts must be balanced by respect for cultural traditions. The challenges should not be underestimated – efficient woodstove projects have been attempted since the 1970s and many have failed.

The Eco-Makala project aims to supply sustainable wood energy to the population of Goma, a city near the southwest borders of Virunga National Park in the Democratic Republic of Congo, while also reducing rural poverty and protecting the national park. The biggest threats to Virunga are an influx of refugees and illegal logging in the southern part of the park. The project plans to replant 4,200ha of forest within five years. For the rural populations, investment in legal fuelwood plantations could reduce poverty and contribute to development.

Today, 2.6 billion people worldwide use traditional biomass, mainly wood and charcoal, for cooking. Access to efficient, sustainable bioenergy could reduce time spent collecting firewood, decrease forest degradation and reduce mortality caused by wood smoke. © Kate Holt / WWF-UK

INCENTIVES AND CONTROLS

As of 2010, at least 119 countries had some type of national renewable energy target or support policy[18].

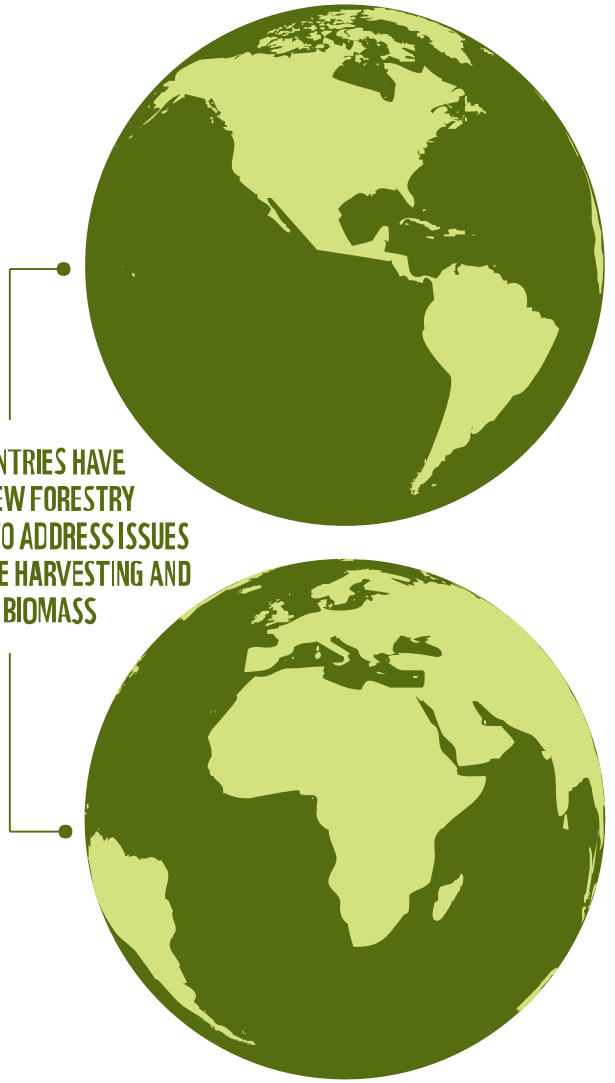
Government support for bioenergy, which is mostly focused on biofuels, was around US$20 billion worldwide in 2009. The International Energy Agency estimates that support to biofuels will rise to US$45 billion (2009 dollar value) by 2020 and US$65 billion by 2035[19]. The primary motives for support include climate change mitigation, energy security and protecting national industries.

WWF reviewed a selection of policy frameworks for bioenergy, primarily biofuel, development in producer and consumer countries (see page 27). Even in this limited sample, there is huge variation in required GHG savings and how compliance is assessed. Similarly, there is little consistency in the scope and strength of social and environmental safeguards on production of feedstocks.

Very few countries have introduced new forestry regulations to address issues specific to the harvesting and use of forest biomass for new energy generation technologies[20].

A 2007 study of developing countries observed that many had ambitious bioenergy targets, but lacked supporting legislation. Where legislation existed, it was often confused, failed to address **leakage** and created **perverse incentives**[21]. Additional action is needed in consumer countries, including financial and technical support for developing countries.

Most current policy incentives focus on first generation biofuels. The prospect of greater climate benefits from second generation biofuels suggests a need to create new policy incentives to support their research and development[22].



VERY FEW COUNTRIES HAVE INTRODUCED NEW FORESTRY REGULATIONS TO ADDRESS ISSUES SPECIFIC TO THE HARVESTING AND USE OF FOREST BIOMASS

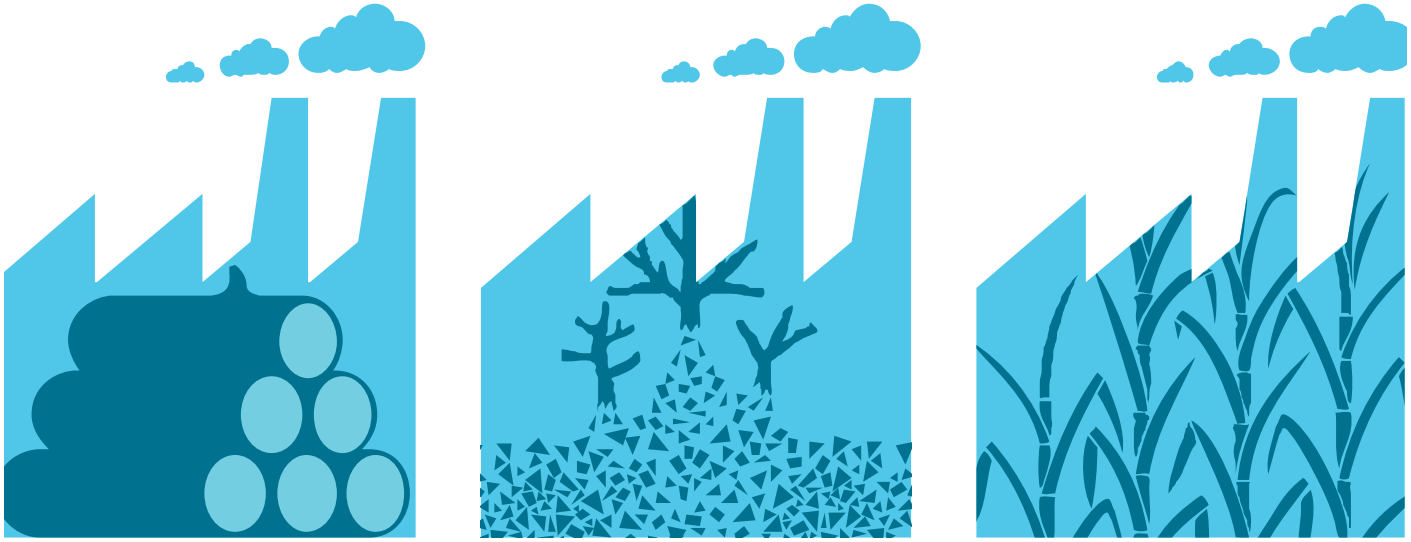
BALANCING BIOENERGY AND SUSTAINABILITY IN SWEDEN

Forest biomass is an important source of energy in Sweden – but can increasing demand be met sustainably?

In 1970, Sweden produced about 43 [23] of energy from biomass; by 2010 bioenergy production was up to 122 TWh[24]. More than 80 per cent of bioenergy feedstock is estimated to come directly or indirectly from forests, with 70 per cent from mill residues (e.g. bark, sawdust and black liquor) and the remainder as fuelwood and residues directly from the forest.

Sweden's renewable energy action plan estimates an increase in gross energy consumption of 14 per cent by 2020 compared to 2005[25], and it has an EU obligation to meet nearly half its energy needs through renewable sources by 2020. Part of the government strategy to meet these targets is to use more wood fuels and to introduce practices such as stump removal to increase biomass harvest per hectare[26]. This presents a difficult trade-off between using all a tree's biomass (stumps, branches, etc.), which removes valuable nutrients and habitat such as deadwood, or leaving residues in the forest but harvesting a greater area.

The lack of ambitious energy-saving plans may further boost demand and thus undermine the long-term sustainability of forests. WWF-Sweden is promoting measures to reduce energy consumption, achieve sustainable forest management and make biomass part of the solution.



HOW COULD BIOENERGY AFFECT ZNDD TARGETS?

Increasing use of bioenergy could cause additional forest degradation and loss.

BIOENERGY FEEDSTOCK PRODUCTION COULD HINDER THE ACHIEVEMENT OF ZNDD IF NATURAL FORESTS ARE DEGRADED BY MORE INTENSIVE BIOMASS HARVESTING

Bioenergy feedstock production could hinder the achievement of ZNDD if natural forests are degraded by more intensive biomass harvesting. Forests could also be converted to make space for bioenergy crops and plantations, or for farming displaced by bioenergy production.

Crop-based bioenergy for biofuel production is well established. Some 90-100 billion litres of **bioethanol** and at least 18-20 billion litres of **biodiesel** are produced annually, primarily in the United States, Brazil and Germany and mainly for the transport sector[27]. More than one-third of US corn production was used for ethanol in 2008[28]. Yet liquid biofuels, bioethanol and biodiesel, accounted for less than 2 per cent of global transport fuels in 2007[29]. Projections suggest this share will rise fast; the International Energy Agency suggests that biofuels could provide 27 per cent of total transport fuels by 2050[30]. Finding land to grow feedstocks will increase pressure on forests and other natural ecosystems.

Forests are the main sources of firewood and charcoal wood. Projected population growth in regions reliant on traditional wood energy, as well as demand for wood for new bioenergy production technologies, could expand or intensify the harvesting of forest wood. Increased reliance on forest biomass could either motivate better forest stewardship or drive high-impact extraction practices that lead to degradation and eventually deforestation.

Fast-growing tree plantations are increasing in Europe and North America, often using poplar and willow. In the tropics and the southern hemisphere, eucalyptus, acacia and pine plantations produce raw materials, mainly for timber and fibre. Increasing bioenergy demand could expand these plantations. Planted forests in Southeast Asia increased from 10 million ha in 1990 to 14.5 million ha in 2010[31]. Much of this has been established through clearing natural forests[32]. In other parts of the world, recent expansion has mainly been on degraded grazing land or grassland and shrub habitats; these may also have high biodiversity and social values.

The scale of future deforestation and forest degradation associated with bioenergy will depend on policies governing production and use of bioenergy in agriculture and forestry. Preventing extra forest loss or degradation demands policies that require genuine GHG savings, protect biodiversity, prevent leakage and include strong social safeguards.

PREVENTING FOREST LOSS DEMANDS POLICIES THAT REQUIRE GENUINE GHG SAVINGS, PROTECT BIODIVERSITY, PREVENT LEAKAGE AND INCLUDE STRONG SOCIAL SAFEGUARDS

Practices such as stump removal could increase biomass harvest per hectare, but would remove valuable nutrients and habitat such as deadwood.
The alternative is leaving residues in the forest, but harvesting a greater area. © Wild Wonders of Europe /Pete Oxford / WWF

PROJECTING BIOENERGY FUTURES

WWF has developed the Living Forests Model with the International Institute for Applied Systems Analysis (IIASA) to compare future scenarios and analyse policies related to reducing deforestation.

FOR MORE INFORMATION ON THE LIVING FORESTS MODEL AND SCENARIOS PLEASE SEE CHAPTER 1

The Living Forests Model draws on IIASA's G4M and GLOBIOM models[33] to show geographically explicit land-use change under different scenarios, as described in chapter 1 of the *Living Forests Report*. The Model lets us explore the implications of projected changes in bioenergy use.

As discussed in the first chapter, the Living Forests Model shows that it is possible to achieve ZNDD by 2020 through better governance, a shift to sound forest stewardship and more productive use of arable non-forest land. If we fail to make that shift, we squander valuable forests. To prevent runaway climate change, we need to cut emissions from deforestation and forest degradation now; the longer we leave this, the harder it will become.

MAINTAINING ZNDD AFTER 2030 WITHOUT SHORTFALLS IN FOOD, TIMBER, BIOMATERIALS OR BIOENERGY REQUIRES FORESTRY AND FARMING PRACTICES THAT PRODUCE MORE WITH LESS LAND AND WATER, AND NEW CONSUMPTION PATTERNS THAT MEET THE NEEDS OF THE POOR WHILE ELIMINATING WASTE AND OVER-CONSUMPTION

The scenarios that provide the main analysis for this chapter are:

Do Nothing: assumes our behaviour continues along historical trends. Primary energy from **land-based biomass feedstock** is projected to more than triple from 2010 to 2050 due to energy demand and competitiveness of bioenergy. Land is made available through productivity gains in agriculture, planting on degraded land[34] and conversion of natural habitats outside protected areas.

Target: ZNDD (with near zero gross rate of loss of natural and semi-natural forest) reached by 2020 and maintained at that level indefinitely.

Bioenergy Plus: described on the next page.

Pro-Nature: including two scenarios (Pro-Nature and Pro-Nature Plus) in which natural ecosystems identified as important for biodiversity in several conservation mapping processes are excluded from conversion.

Diet Shift: total global consumption of animal calories is maintained at 2010 global level, with convergence in per capita consumption across regions.

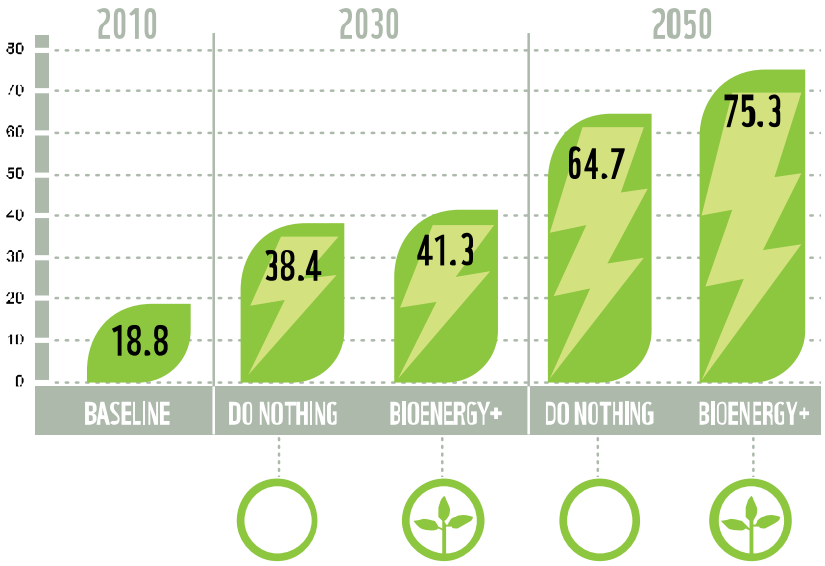
THE BIOENERGY PLUS SCENARIO

The Bioenergy Plus Scenario builds a picture of the relationship between forests and bioenergy under more ambitious GHG emission mitigation and renewable energy policies.

The projected demand for bioenergy in Bioenergy Plus is based on the "global 2°C scenario" derived from the POLES (Prospective Outlook for the Long-term Energy System) model[35]. The scenario projects demand for bioenergy from land-based feedstocks (excluding those not competing for land, such as municipal solid waste, industrial waste and algae) of 75.3EJ final energy supply in 2050, of which 16.9EJ are liquid biofuels.

This approximates the projected bioenergy demand in the Ecofys scenario developed to assess the feasibility of WWF's vision of 100 per cent renewable energy by 2050[36].

HIGHER CARBON PRICES, MORE AMBITIOUS GHG REDUCTION AND MORE EFFICIENT ENERGY CONVERSION DISTINGUISH BIOENERGY PLUS FROM THE DO NOTHING SCENARIO



Final energy supply based on bioenergy from land-based feedstocks in 2010 and in 2030 and 2050 under the Do Nothing Scenario and the Bioenergy Plus Scenario, in EJ

THE BIOENERGY PLUS SCENARIO

The Bioenergy Plus Scenario helps explore implications for global land availability and productivity of producing sufficient bioenergy feedstocks to meet future demand.

Some important assumptions of the Bioenergy Plus Scenario include:

- A higher carbon price (i.e. above today's price of US$40/tonne of CO_2) and more ambitious GHG emission reduction targets than the Do Nothing scenario. This makes bioenergy more competitive relative to fossil fuels, provided it delivers genuine, full life-cycle carbon savings. This competitiveness is tempered, however, by higher bioenergy feedstock prices as more bioenergy is used.
- The land-based bioenergy feedstocks are produced in natural forests managed jointly for biomass and timber production, timber plantations and croplands. Harvesting in natural forests is modelled on a **sustained yield basis**.
- Tree tops, branches and stumps (harvesting residues) are not removed from forests, to protect soils and long-term fertility.
- Traditional fuelwood is harvested on a sustained yield basis, phasing out current uses that cause forest loss or degradation. This shift is achieved, despite population growth, by increasing fuelwood sourced from dedicated plantations and reducing per capita fuelwood demand through more efficient stoves and heating systems that are less detrimental to human health.

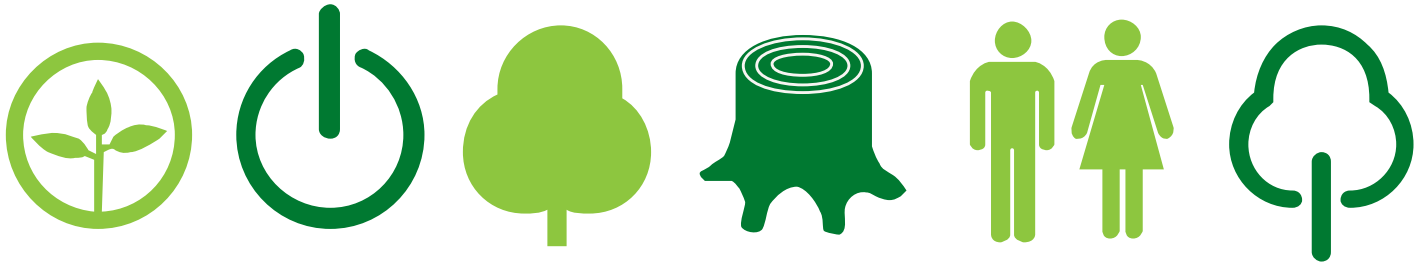
The Do Nothing and Bioenergy Plus Scenarios assume four main processes of bioenergy conversion

Traditional uses

- **Wood heat:** primary energy from wood turned into heat for domestic cooking and heating.
- **Heat from other biomass:** primary energy from sources such as dung and crop residues turned into heat for domestic cooking and heating.

New technological uses

- **First generation biofuels:** mainly bioethanol and **FAME** (fatty acid methyl esters) produced from starchy and oily agricultural crops. The main crops are sugarcane, corn, rapeseed, soya and oil palm.
- **Polygeneration:** primary energy from mostly woody biomass turned into electricity and heat (i.e., combined heat and power) or second generation biofuels produced mainly from wood, turned into transport fuel, gas, electricity and heat.



Development of bioenergy in community-managed forests and grasslands could be an important source of income for rural families. The Roundtable on Sustainable Biofuels stresses that free, prior and informed consent should be the basis of all consultations with communities. © Simon de TREY-WHITE / WWF-UK

WHAT THE MODEL SHOWS US

Bioenergy use will not be a major cause of forest loss, assuming more natural forests are managed sustainably for timber and biomass production. However, this could cause conversion of other natural ecosystems, unless appropriate safeguards are in place.

Deforestation

SOME EXPANSION OF BIOENERGY WILL BE DRIVEN BY PUBLIC POLICY INCENTIVES NOT LINKED TO CLIMATE CHANGE – SUCH AS ENERGY SECURITY GOALS

Without additional policies in place to halt deforestation and forest degradation, both the Do Nothing and Bioenergy Plus Scenarios project bioenergy leading to some increased deforestation. Bioenergy is, however, not a major direct driver of forest loss[37]. (See graphic on following page.)

In theory, deforestation due to the expansion of bioenergy feedstock production should be limited in the Bioenergy Plus Scenario, as this assumes energy and climate policy frameworks will require reduced GHG emissions. This prompts a move from the production of first generation crop-based biofuels to second generation biofuels derived from wood harvested in managed natural forests or plantations established on non-forest land. However, the Model projects that these frameworks are not enough to stem deforestation completely, as some expansion of bioenergy will be driven by public policy incentives not linked to climate change – such as energy security goals – or markets that do not require compliance with environmental safeguards.

DO NOTHING AND BIOENERGY PLUS SCENARIOS PROJECT BIOENERGY LEADING TO SOME INCREASED DEFORESTATION

Natural Ecosystems

2040-2050 LAND COMPETITION BECOMES MOST ACUTE.

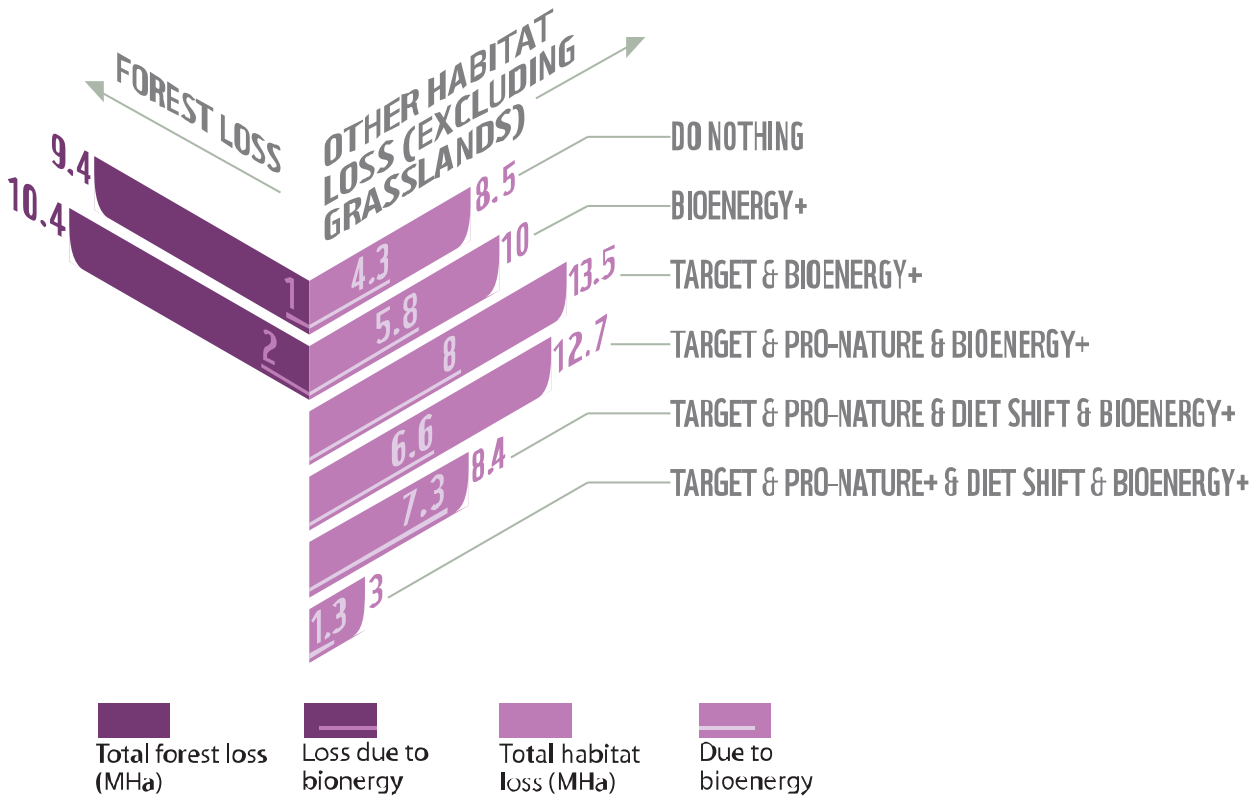
We focus on 2040 to 2050, as this is the period within the Living Forests Vision when the food and energy demands of a rising global population make land competition most acute. Projected loss of non-forest ecosystems[38] such as shrublands is 8.5 million ha per year under Do Nothing, with 4.3 million ha attributed to bioenergy. Under Bioenergy Plus, projected loss is 10 million ha per year, with 5.8 million ha attributed to bioenergy. Impacts on other ecosystems are greater if forests are more strictly protected; so if the Target and Bioenergy Plus Scenarios are combined, projected loss of other natural habitats grows to 13.5 million ha per year, with 8 million ha (60 per cent) due to bioenergy.

Such land-use changes could have major social, cultural and economic impacts, along with impacts on biodiversity and ecosystem services. Adding the Pro-Nature Scenario blocks the expansion of bioenergy production into non-forest ecosystems identified as important for biodiversity conservation. Yet this only has a marginal impact on the projected rate of loss of other natural ecosystems: 12.7 million ha per year, of which 6.6 million ha is due to bioenergy feedstock production. Pro-Nature Plus without any reduction in projected commodity consumption (not shown in the graphic) would further reduce loss of non-forest ecosystems; however, as the findings of chapter 1 of the *Living Forests Report* show, this would result in dramatically higher food prices. The addition of Diet Shift reduces the total loss of other ecosystems to 8.4 million ha per year under Pro-Nature and 3 million ha per year under Pro-Nature Plus without raising food prices significantly.

WHAT THE MODEL SHOWS US

Projected impacts of scenarios on natural forests and other habitats

The rate of change in the area of natural forest and other natural habitats under selected scenarios for the years 2040–2050 (averaged rate of change over this period in millions of hectares per year), including the portion that can be attributed to bioenergy.



WHAT THE MODEL SHOWS US

The Living Forests Model projects that more natural forests will be managed to produce wood and other biomass, and that a significant increase in bioenergy use will require a parallel increase in fast-growing tree plantations.

PROJECTIONS SUGGEST THAT RELATIVELY PRISTINE FORESTS WILL ALSO NEED TO BE MANAGED

The impact of bioenergy expansion on natural forests

Today 1.2 billion hectares of forests, or 30 per cent, have production designated as their primary function[39]. The projected expansion of forest management in the Living Forests Model (see graphic) is driven primarily by demand for bioenergy. Between 2040 and 2050, the area of managed forest will increase by a projected 14.5 million ha per year under Bioenergy Plus; the total area managed for production of timber and biomass will expand by 304 million hectares between 2010 and 2050[40].

Adding the objective of maintaining near zero forest loss (as in the Target Scenario) has only a marginal impact, increasing the rate of expansion of forest management to 15.7 million ha per year. This is because the Bioenergy Plus Scenario assumes the expansion is via sustainable forest management that does not cause forest loss or degradation. Similarly, introducing a broader nature conservation element into the projections through adding the Pro-Nature Scenario has an incremental impact, with the Model projecting 17.1 million additional hectares of forests per year managed for production. A change in diets as assumed under the Diet Shift scenario reduces this rate to 14.2 million ha per year. However, adding the Pro-Nature Plus Scenario "pushes" bioenergy feedstock production into natural forests by excluding the conversion of large areas of other natural habitat and nearly doubles the size of the additional forest area that needs to be allocated to production each year to 27.9 million hectares.

The Model allows more forests to be managed for timber and biomass production in preference to outright loss of forests or other natural ecosystems with high conservation value through conversion to energy plantations. This is based on an assumption that such managed forests will still support much of the original biodiversity and ecosystem services. Some forests brought under management might already be degraded or affected by illegal use; in these cases management can bring positive environmental and social benefits. However, projections suggest that relatively pristine forests will also need to be managed, and great care will be needed to maintain or enhance their social and environmental values.

The biodiversity and carbon implications of extracting more biomass from more forests will depend on factors such as the intensity of management, quality of environmental practices and connectivity with protected areas. From a social perspective, management not under the direct control of indigenous peoples or local communities needs to ensure forests remain accessible for traditional uses. Indeed, bioenergy could provide an additional revenue stream for forest communities that motivates them to manage rather than clear forests.

The impact of bioenergy demand on tree plantations

Tree plantations already have the capacity to supply some two-thirds of industrial roundwood, even though they correspond to only 6.6 per cent of the global forest area[41]. The Bioenergy Plus Scenario in particular suggests that new fast-growing plantations could be an important source of bioenergy feedstocks and fibre. As the graphic on the following page shows, the projected rate of new plantation establishment between 2040 and 2050 ranges from 3.7 to 13 million hectares per year, depending on the scenario. The lowest figure is because Pro-Nature Plus projects much less land available for plantation expansion, pushing feedstock production into a larger area of natural forests.

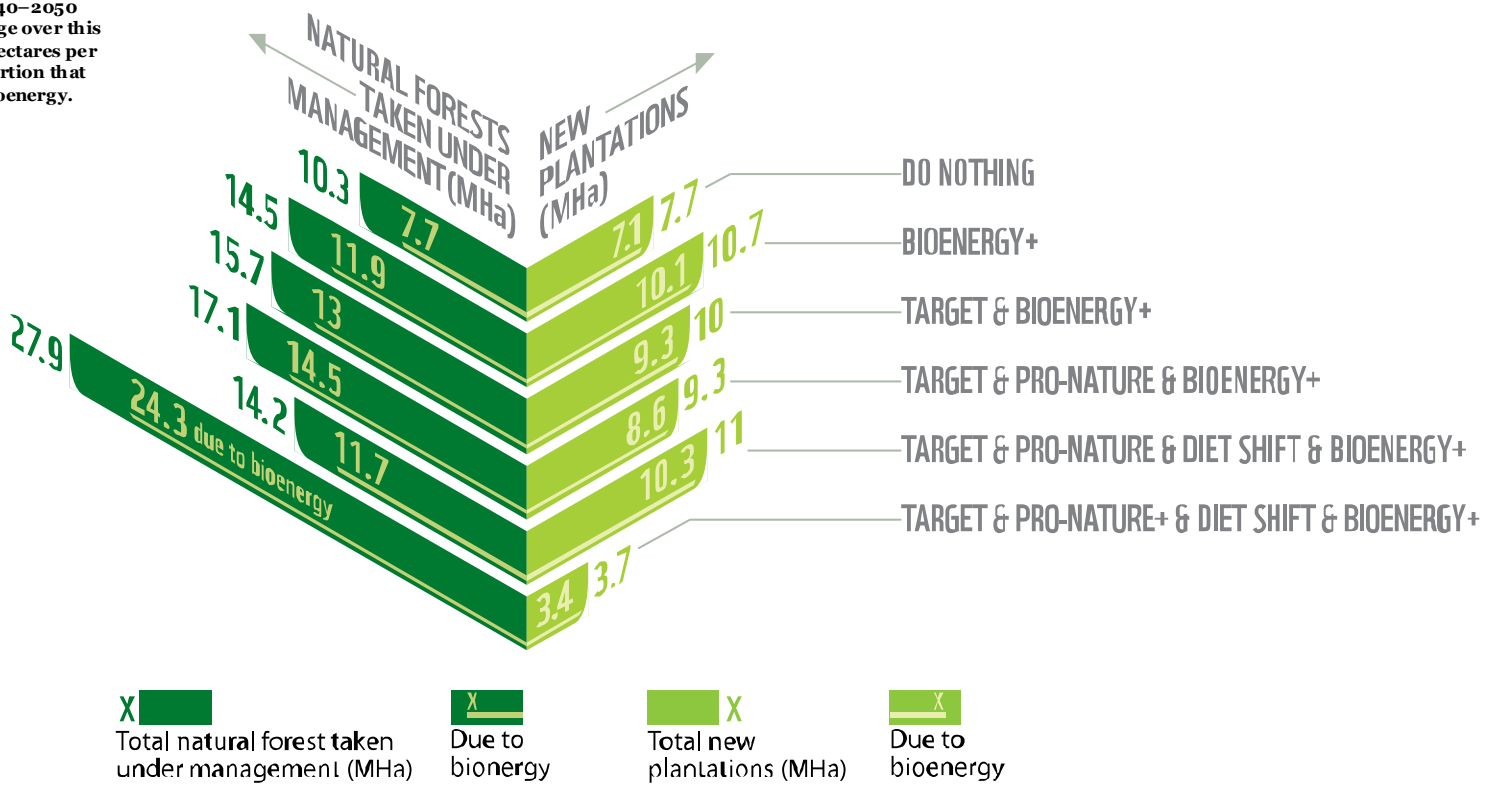
Well-managed plantations in the right places can play a positive role in a future renewable energy strategy. Plantations that do not replace natural or valuable semi-natural habitats can have positive environmental and social impacts. They can help recover degraded or over-grazed land, or be part of a mosaic of monocultures, community-managed agro-forestry and natural ecosystem regeneration. However, in some regions, without significant changes in policies and practices, expansion of intensively managed plantations will continue to have negative impacts – for instance, threatening the rights or livelihoods of forest-dependent peoples or destroying valuable ecosystems and biodiversity.

WELL-MANAGED PLANTATIONS IN THE RIGHT PLACES CAN PLAY A POSITIVE ROLE IN A FUTURE RENEWABLE ENERGY STRATEGY

WHAT THE MODEL SHOWS US

Projected impacts of scenarios on production forests and plantations

Growth in tree plantations and managed area of natural forest for the years 2040–2050 (averaged rate of change over this period in millions of hectares per year), including the portion that can be attributed to bioenergy.



Strict protection of forests could increase the impact of bioenergy expansion on grasslands and other ecosystems with high conservation values.
Reducing overall energy consumption and improving agricultural efficiency are essential to conserving biodiversity. © Martin Harvey / WWF-Canon

WHAT THE MODEL SHOWS US: FOOD CONSUMPTION AND SECURITY

Achieving ZNDD while increasing bioenergy use could affect food security and will require changes in both efficiency of agriculture and consumption patterns.

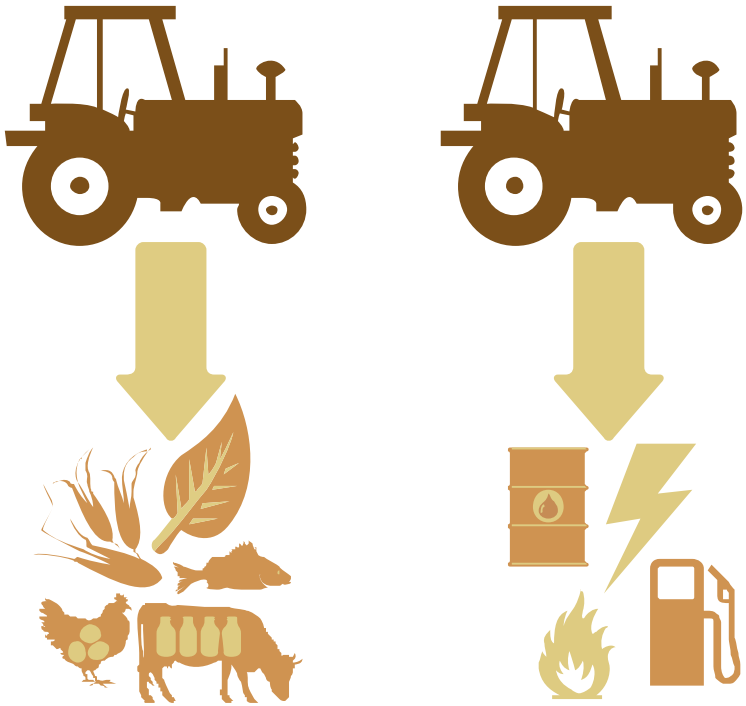
RISING

DEMAND FOR BIOENERGY IS ONE OF SEVERAL FACTORS CITED FOR DRIVING UP COMMODITY AND FOOD PRICES

The Living Forests Model and WWF's *Living Planet Report*[42] show pressures on natural forests and other ecosystems can be substantially reduced by changes in consumption patterns and increased agricultural efficiency. These changes are also needed to avoid negative effects of bioenergy production on food security[43].

Rising demand for bioenergy, and in particular crop-based biofuel, is one of several factors cited for driving up commodity and food prices and taking land out of food production. The FAO warns that biofuel production represents a major risk for long-term food security[44]. There are, however, multiple factors behind commodity and food price increases, including poor harvests linked to extreme weather events; declining food stocks; high oil and energy prices raising the cost of inputs and transport; speculative transactions and export restrictions leading to hoarding and panic buying[45]. Isolating the exact influence of bioenergy on food price and security is difficult in these circumstances.

WWF's Living Forests Vision includes a more equitable distribution of food across the globe; the equity question is addressed in the Diet Shift Scenario (see chapter 1). The Living Forests Model projects that achieving and sustaining ZNDD while meeting global demand for food, fibre and energy is possible if we move toward a more equitable global diet sourced from more efficient agriculture. , for example, which aim to produce food and bioenergy feedstock simultaneously, offer potential for sustainable food and energy in small-scale production systems in some regions. This could dampen food price volatility by increasing flexibility to switch from energy to food production to mitigate food shortages.



SUSTAINABILITY CRITERIA FOR CROP AND WOOD-BASED BIOENERGY

WWF urges governments and industry to link renewable bioenergy with sustainability safeguards.

The Roundtable on Sustainable Biofuels (RSB) is a WWF-supported multi-stakeholder initiative to develop standards for the sustainability of biofuels. The RSB Principles[1], listed below, include the primary safeguards that should inform all bioenergy development. These operate as an overarching standard, incorporating standards for specific commodities as appropriate. Not all principles are applicable in every case, and not all commodity-specific schemes have incorporated the full range of principles yet; addressing obvious gaps is a priority.

Principle 1: Legality. Biofuel operations shall follow all applicable laws and regulations.

Principle 2: Planning, Monitoring and Continuous Improvement. Sustainable biofuel operations shall be planned, implemented and continuously improved through an open, transparent and consultative impact assessment and management process and an economic viability analysis.

Principle 3: Greenhouse Gas Emissions. Biofuels shall contribute to climate change mitigation by significantly reducing lifecycle GHG emissions as compared to fossil fuels.

Principle 4: Human and Labour Rights. Biofuel operations shall not violate human rights or labour rights, and shall promote decent work and the well-being of workers.

Principle 5: Rural and Social Development. In regions of poverty, biofuel operations shall contribute to the social and economic development of local, rural and indigenous people and communities.

Principle 6: Local Food Security. Biofuel operations shall ensure the human right to adequate food and improve food security in food insecure regions.

Principle 7: Conservation. Biofuel operations shall avoid negative impacts on biodiversity, ecosystems and conservation values.

Principle 8: Soil. Biofuel operations shall implement practices that seek to reverse soil degradation and/or maintain soil health.

Principle 9: Water. Biofuel operations shall maintain or enhance the quality and quantity of surface and ground water resources, and respect prior formal or customary water rights.

Principle 10: Air. Air pollution from biofuel operations shall be minimized along the supply chain.

Principle 11: Use of Technology, Inputs and Management of Waste. The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.

SUSTAINABLE CHARCOAL IN THE SPINY FORESTS OF MADAGASCAR

Using fuelwood more efficiently and sustainably is vital to achieving WWF's vision of 100 per cent renewable energy and the Living Forests Vision.

WWF IS WORKING WITH LOCAL PEOPLE TO REDUCE PRESSURE ON THE FOREST AND IMPROVE ENERGY SUSTAINABILITY

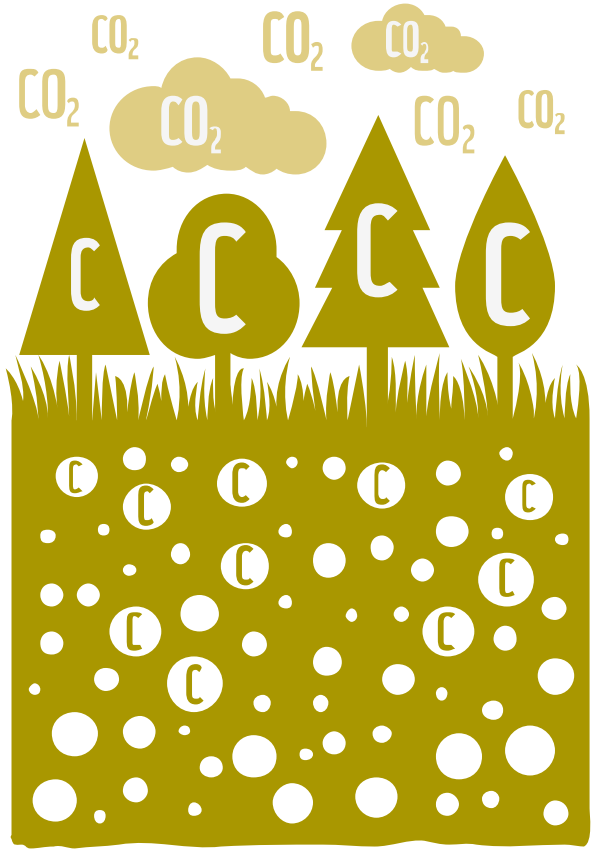
The dry spiny forests of southwestern Madagascar are a unique ecosystem. They exist nowhere else on Earth and include biologically outstanding habitats. The forests have a high level of endemism (unique species), with succulent and spiny plants dominating in a semi-arid environment. They are home to many species, including lemur and tortoise.

The production of fuelwood and charcoal using wood from the spiny forest is becoming increasingly unsustainable. WWF is working with local people to reduce this pressure on the forest and improve energy sustainability. This includes promoting forest plantations for charcoal production, and training communities in new techniques to produce the same amount of fuelwood and charcoal with much less wood. WWF also supports a regulatory system for a chain of custody process, which encourages sustainable management in dedicated areas, transparency in the market, professionalization among charcoal producers and penalties for illegal use. In parallel, a regional energy forest committee is promoting improved cooking stoves, more effective law enforcement in relation to resource use, and implementation of the fuelwood chain of custody.

The forests of Madagascar are home to many species found nowhere else on Earth, including ring-tailed lemurs. © Martin Harvey / WWF-Canon

BIOENERGY AND GREENHOUSE GASES

The potential of forest-based bioenergy to reduce GHG emissions depends to a large extent on how and where the feedstock is produced.



In theory, bioenergy can reduce GHG emissions because the carbon released can be recaptured during plant growth. However, the net balance depends on:

- the GHG emissions associated with bioenergy production (e.g., from direct or indirect land-use change required to cultivate or harvest the feedstock, production of fertilizers, and energy needed to convert feedstock to fuel)
- the accounting time frame (extracting biomass from an intact natural forest system is likely to cause a carbon debt, which will decrease slowly with time[46]; GHG emissions initially exceed those from fossil fuels)
- what fuel type is replaced[47].

17–420

YEARS OF BIOFUEL PRODUCTION TO REPLACE THE CARBON LOST IN CONVERSION OF FORESTS IN SOUTHEAST ASIA, BRAZIL AND THE UNITED STATES

The carbon cycles of forests are far more complex than those in agriculture, increasing the difficulty of understanding the potential carbon benefits from forest-based bioenergy. For example, research from Ontario, Canada, reports a substantial loss in forest carbon due to bioenergy production. Initially GHG emissions exceed fossil fuel-related emissions; the longer-term balance depends on the biomass source and what fuel is replaced. Emissions are larger when logs are used compared to residues. For example, ethanol from logs could increase emissions during a century of continuous production; while ethanol from residues achieves reductions after around a 70 year delay[48].

Land-use change can have dramatic effects, especially if carbon-rich habitats are converted to agricultural production. Another study calculated that it would take 17 to 420 years of biofuel production to replace the carbon lost in conversion of forests in Southeast Asia, Brazil and the United States[49]. Conversely, a new timber plantation on previously degraded land could sequester carbon in the growing trees and stabilized soil, thus creating a positive average carbon balance over repeated biomass harvesting cycles[50].

Based on the modelling and research data available to WWF, forests should and will play an increasing role in the global energy supply. However, more research and greater transparency is needed to work out potential climate benefits.

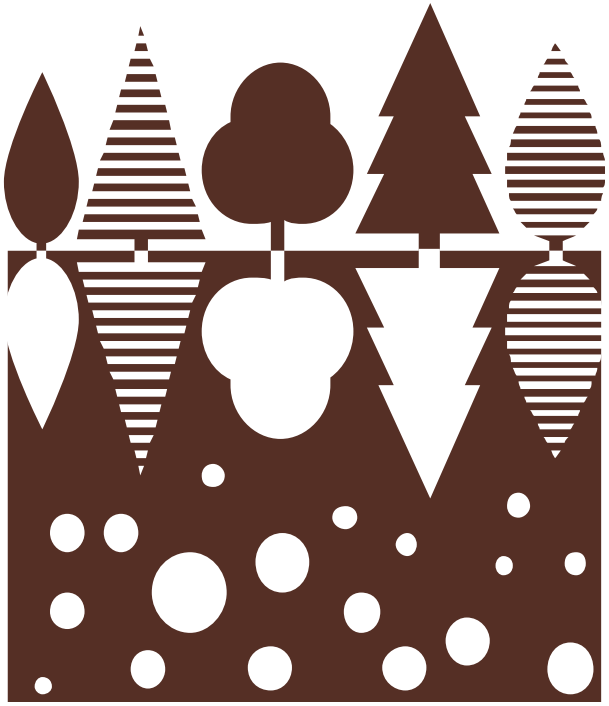
In addition, in most countries energy consumption is still growing; as a result, bioenergy will replace a relatively smaller proportion of fossil fuels, reducing the climate benefits. Simply adding bioenergy to a growing energy mix will not achieve necessary climate targets.

FINNISH FORESTS AND CARBON

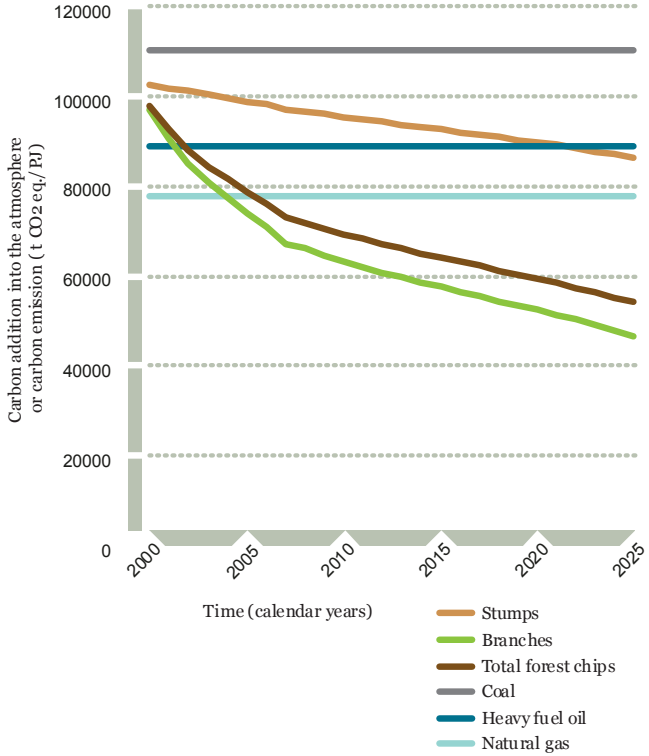
Research from Finland highlights the complexity of estimating climate impacts of bioenergy.

The Finnish Environmental Agency modelled the carbon impact of increased biomass use. They found that using more wood for bioenergy is leading to decreasing carbon stocks in the Finnish forests, because soil carbon levels are lower and burning wood releases more carbon than leaving dead wood to decay slowly. In addition, both transport and chipping of wood cause emissions. Research also showed that different parts of a tree have different GHG benefits[51].

MORE WOOD FOR BIOENERGY IS LEADING TO DECREASING CARBON STOCKS IN THE FINNISH FORESTS



Emissions per PJ of energy generated from forest bioenergy compared to those from fossil fuels in Finland 2000-2025



This compares emissions (in CO2 equivalent) per PJ of energy generated from different forms of forest biomass and fossil fuel. Data for forest residue use was based on actual 2000–2008 figures and projections for 2009–2025, over which time biomass collection is expected to increase from 5 million m3 in 2009 to 13.5 million m3 in 2025. Because the decay process for unused residues left in the forest takes some time to start, net carbon impact of using forest residues for energy production decreases over time, and stumps decay more slowly than branches. Using branches thus delivers immediate savings, while other sources take longer to balance emissions. Total wood chips (stumps and branches) also produce lower emissions because more branches are used than stumps[52].

BIOENERGY IMPACTS ON WATER

Bioenergy expansion has significant implications for water resources and requires strong basin- and catchment-level governance, particularly in water-scarce areas.

2,500 LITRES OF WATER ARE REQUIRED TO PRODUCE ONE LITRE OF LIQUID BIOFUEL

Globally, irrigation water allocated to biofuel production is estimated at 44km^3, or 2 per cent of all irrigation water. Some feedstocks – including sugar cane, oil palm and maize – are highly water intensive[53]. Under current production conditions it takes roughly 2,500 litres of water (about 820 litres of irrigation water) to produce one litre of liquid biofuel – the same amount needed on average to produce food for one person for one day[54].

Current water footprint and **lifecycle assessment** techniques are insufficient to quantify impacts of all types of bioenergy production on water. Implications of water consumption vary greatly depending on what resource base is affected, its previous state, the location and timing of use, and the aggregated effects of all users within a catchment. Methods are being developed within the Water Footprint Network to account for localized water impacts based on consumptive water use (evaporation) and environmental flows needed to maintain a stable ecosystem[55].

The water needs and impacts of bioenergy are often the same as for food production. The water constraints of river basins and the necessity of water for basic human needs and environmental functions make the context critical in any decisions about suitability and sustainability of water use in bioenergy. Water use needs to feature strongly in any guidelines on bioenergy, including the need for governance at basin and catchment scales.

WATER USE NEEDS TO FEATURE STRONGLY IN ANY GUIDELINES ON BIOENERGY, INCLUDING THE NEED FOR GOVERNANCE AT BASIN AND CATCHMENT SCALES

Some feedstocks – including sugar cane, oil palm and maize – are highly water intensive. It takes roughly the same amount of water to produce one litre of liquid biofuel as needed on average to produce food for one person for one day. © Adriano Gambarini / WWF-Brazil

GUIDELINES FOR RESPONSIBLE CROP- AND PLANTATION-BASED BIOENERGY

ACHIEVING THE LIVING FORESTS VISION REQUIRES GOOD GOVERNANCE AND THE INVOLVEMENT OF ALL RELEVANT STAKEHOLDERS

Existing standards and tools provide useful guidance on sustainability in bioenergy production.

Determining the optimal ratio of land and water to be used for food, bioenergy, biomaterials and fibre, carbon storage, biodiversity conservation, and cultural, spiritual and recreational purposes is one of society's greatest challenges. A range of standards and tools provide useful guidance to those wishing to navigate this challenge responsibly. However, comprehensive land-use decision-making needed to achieve the Living Forests Vision requires good governance and the involvement of all relevant stakeholders.

These sources of guidance include:

- the Responsible Cultivation Areas methodology, which draws on a variety of existing approaches (EU Renewable Energy Sources Directive, Renewable Transport Fuel Obligation , Roundtable on Sustainable Biofuels s (see page #), Bonsucro, Round Table on Responsible Soy, Roundtable on Sustainable Palm Oil)
- the Forest Stewardship Council and related efforts to manage forests sustainably
- guidance being developed through the New Generation Plantations framework
- responsible purchasing processes for forest products such as those developed by WWF's Global Forest & Trade Network
- principles such as free prior informed consent.

One emerging conclusion from the *Living Forests Report* is the need to pull these and other complementary approaches together into a single coherent framwork.

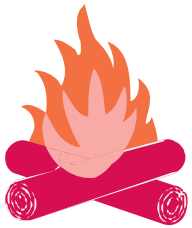
Management: practices should be based on the **Roundtable on Sustainable Biofuels principles** (see page #) or related standards. The **New Generation Plantations framework** was developed for the fibre and timber sectors but can also provide best practice for bioenergy tree plantations. It promotes plantations that maintain ecosystem integrity (i.e., cycles for water, carbon, nutrients and biodiversity); protect and enhance high conservation values; are developed through effective stakeholder processes; and contribute to economic growth and employment.

Planning: the **Responsible Cultivation Area** (RCA) methodology guides land selection for establishing energy crop plantations, which must:

- maintain or increase high conservation values
- not lead to significant reductions in carbon stocks
- respect formal and customary land rights
- not cause unwanted displacement effects (e.g., of food production)
- be in areas agriculturally suitable for the target crop.

This aims to optimize site selection but gives no guidance on management.

CONCLUSIONS: IS BIOENERGY A THREAT OR A SOLUTION?

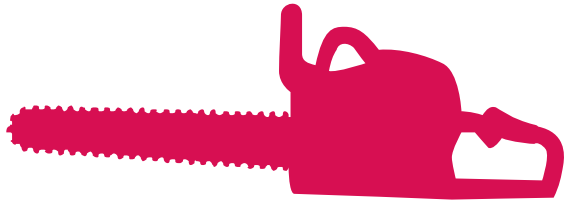


INCREASED DEPENDENCE ON FUELWOOD FOR ENERGY PRODUCTION

Badly managed bioenergy production can destroy valuable ecosystems, undermine food and water security, harm rural communities and prolong wasteful energy consumption.

Wood is the oldest form of fuel. New technologies are revitalizing this traditional energy source and making it, along with crop-based bioenergy, potentially a major contributor to equitable and renewable energy strategies. But there are important questions about how and where more bioenergy feedstock production can take place without negatively affecting biodiversity, food security, water resources or people's rights and livelihoods. Fuelwood collection is already a major cause of forest degradation in many low-income regions with poor governance and rising populations. Additionally, some liquid biofuel feedstocks are driving conversion of valuable habitats and causing concerns about food security.

In this chapter we have used WWF's Living Forests Model to project the implications of an increased dependence on fuelwood for energy production, particularly in relation to WWF's target of 100 per cent renewable energy by 2050.



From this exploration we can conclude:

Without appropriate actions, policies and targets, increased reliance on bioenergy could have many negative impacts:

- The projected expansion in bioenergy consumption will create major additional stresses on the planet's land and water resources.
- Most bioenergy comes from forest biomass and plantation-grown timber. Second-generation technologies could increase reliance on these sources, driving unsustainable expansion of fast-growing tree and crop plantations and extractive forestry in natural forests.
- Crop-based bioenergy competes for increasingly scarce productive land and could drive the conversion of forests and other natural ecosystems into cropland (for bioenergy, or food production displaced by bioenergy elsewhere).
- Bioenergy is not necessarily GHG neutral. The energy needed for cultivation, refining and transport, plus emissions from direct and indirect land-use change caused by increasing feedstock cultivation and biomass harvesting, may result in a negative carbon balance, particularly when intact natural forests are affected.

THE PROJECTED EXPANSION IN BIOENERGY CONSUMPTION WILL CREATE MAJOR ADDITIONAL STRESSES ON THE PLANET'S LAND AND WATER RESOURCES

CONCLUSIONS: IS BIOENERGY A THREAT OR A SOLUTION?

Well-managed bioenergy production can provide energy security, rural development, GHG emission savings and incentives for good forest stewardship.

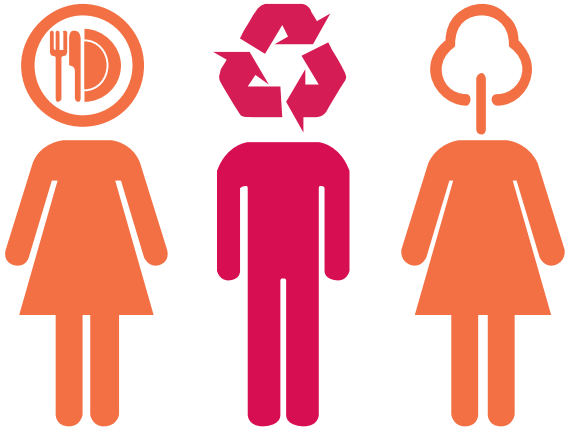
The Living Forests Model presents a range of land-use and consumption options that influence the prospects for bioenergy to deliver social and environmental benefits. From this we can begin to build a picture of the actions, policies and targets we need to develop efficient, equitable and sustainable bioenergy. These include:

- more equitably distributed and more efficiently produced energy
- a reduction in overall energy demand
- changes in consumption patterns, in particular less over-consumption and waste of food, to reduce the footprint of agriculture worldwide
- the further development and promotion of voluntary and regulatory frameworks to ensure bioenergy makes a positive contribution to GHG emission reduction and does not negatively affect biodiversity, food security, water resources or people's rights and livelihoods
- factoring bioenergy development into strategies to achieve ZNDD and conserve biodiversity

Allowing more of the world's forests to be managed to meet the demand for wood for bioenergy can reduce pressure to convert forests and other natural ecosystems to farms and plantations. However, this management must be subject to sustainability standards.

With rising populations and projected consumption levels, our planet does not have enough land to simultaneously conserve nature completely, feed the world and switch to 100 per cent renewable energy. However, we *can* achieve this if those of us with the highest resource use make some reductions in our overall consumption – for example by reducing the animal-based calories in our diets, as outlined in the Diet Shift Scenario in chapter 1[56].

The Living Forests Model projections are based on technologies that we know today. Another potential pathway to alleviating the pressures on the Earth's ecosystems is accelerated research on prospective renewable energy solutions that require less land and water. But we must not rely on technology alone – in the next chapter of the *Living Forests Report* we will consider further the role and management of forests in the timber and paper industries, and in future chapters we will look in more depth at issues relating to climate change and biodiversity conservation. All will raise vitally important issues in this continuing conversation on the future of our forests in the 21st century.



WITH RISING POPULATIONS AND PROJECTED CONSUMPTION LEVELS, OUR PLANET DOES NOT HAVE ENOUGH LAND TO SIMULTANEOUSLY CONSERVE NATURE COMPLETELY, FEED THE WORLD AND SWITCH TO 100 PER CENT RENEWABLE ENERGY

GLOSSARY AND ACRONYMS

FEEDSTOCK

Biodiesel: fuel produced by combining alcohol with vegetable (e.g., plant extracts such as palm oil, corn, soybean, canola/rapeseed, and sunflower) or animal oil/fats, or recycled cooking grease. The fuel can be used in pure form or added to conventional diesel[57].

Bioenergy: Energy derived from biomass. This energy can be used to generate electricity, supply heat and produce liquid biofuels[58].

Bioethanol: the most widespread biofuel, produced by fermentation, in a method similar to beer brewing, of biomass containing carbohydrates (e.g., starches and sugars) such as sugarcane, wheat and corn[59].

Biofuels: fuels (e.g., fuelwood, charcoal, bioethanol, biodiesel, biogas/methane or biohydrogen) extracted through conversion technologies from wood, crops and waste material. There are many kinds of biofuels and their usage and performance in economic, environmental and social terms varies significantly depending upon technology, location and farming practices[60].

FIRST GENERATION BIOFUELS:

Biomass: biological material derived from living or recently living organisms, such as wood and other crops. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes organic material such as fossil fuel which has been transformed by geological processes into substances such as coal or petroleum.

Cellulose: the basic structural component of plant cell walls, cellulose comprises about 33 per cent of all vegetable matter and is the most abundant of all naturally occurring organic compounds. Not digestible by humans, cellulose is a food for herbivorous animals (e.g., cows, horses), is processed to produce papers and fibres, and is chemically modified to yield substances used in the manufacture of such items as plastics, photographic films, etc[61].

Conversion methods: technologies for converting biomass to energy. These differ depending on the feedstock, which can vary greatly in mass, energy density, size, moisture content and reliability of supply.

Ecoregion: a large area of land or water that contains a geographically distinct assemblage of natural communities that (a) share a large majority of their species and ecological dynamics; (b) share similar environmental conditions; and (c) interact ecologically in ways that are critical for their long-term persistence[62].

EJ: exajoule (EJ) = 10^{18} joules.

FAME (Fatty Acid Methyl Esters): the second most common biofuel, often made from rapeseed, oil palm or soya bean. The oils from these plants are converted into a diesel type fuel via a basic process called transesterification[63].

Feedstock: wood, crops or waste products that can be used or converted into biofuels and bioenergy.

First generation biofuels: fuels produced from sugar, starches and oils[64].

Greenhouse gases (GHG): those gaseous constituents of the atmosphere, both natural and artificial, that absorb and re-emit infrared radiation and that are responsible for global warming[65].

GWh: gigawatt hour, unit of electrical energy equivalent to 1000 megawatt hours.

Integrated Food Energy System (IFES): a farming system designed to increase simultaneous production of food and energy through the sustainable use of biomass. They either combine production of food and feedstock on the same land (Type 1 IFES: intercropping, agroforestry or agropastoral systems) or use the by-products/residues of one production system as a base for the other (Type 2 IFES: 'closed loop' or 'zero waste' systems).

Land-based feedstocks: bioenergy feedstocks grown in croplands, plantations or natural forests (i.e., excluding bioenergy feedstocks that are not competing for land, such as municipal solid waste, industrial waste and algae).

Leakage to other ecosystems: in this context, impacts on other ecosystems from activities displaced from forests because of forest protection.

Lignin: the organic substance binding the cells, fibres and vessels that constitute wood and the lignified elements of plants, as in straw. After cellulose, it is the most abundant renewable carbon source on Earth[66].

Living Forests Model: developed for WWF by the International Institute for Applied Systems Analysis (IIASA), the Model draws on G4M and GLOBIOM models[67] to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, GDP and infrastructure. GLOBIOM is an economic model that allocates land and resources optimally based on projected commodity and ecosystem-service demands under future GDP, population and policy scenarios.

Lifecycle assessment: a technique to assess the environmental aspects and potential impacts associated with a product, process or service by: 1) compiling an inventory of relevant energy and material inputs and environmental releases; 2) evaluating the potential environmental impacts associated with identified inputs and releases; and 3) interpreting the results to help make more informed decisions[68].

Natural forest: forest composed of native species (a species that naturally exists at a given location or in a particular ecosystem, i.e. it has not been moved there by humans[69]) with natural ecosystem functions.

PJ: petajoule; PJ = 10^{15} joules.

Perverse incentives: incentives (usually financial incentives such as grants, tax breaks, etc,) that inadvertently cause an unwanted result, such as support for biofuel production to combat climate change that actually results in net carbon emissions.

Renewable energy: energy generated from natural sources: water, wind, solar, biomass or geothermal[70].

Second generation biofuels: liquid biofuels produced from lignocellulosic biomass[71], such as agricultural residues, dedicated energy crops and wood residues.

Sustained yield basis: harvest at a rate of up to 100 per cent mean annual increment of stems, leaving stumps, branches and other organic debris behind to maintain healthy soil structure and to assist soil nutrient levels.

TWh: terawatt hour, unit of electrical energy equivalent to 1000 gigawatt hours.

Zero Net Deforestation and Forest Degradation (ZNDD): no net forest loss through deforestation and no net decline in forest quality through degradation. Zero net deforestation and degradation acknowledges that some forest loss could be offset by forest restoration. Zero net deforestation is thus is not synonymous with a total prohibition on forest clearing. Rather, it leaves room for change in the configuration of the land-use mosaic, provided the net quantity, quality and carbon density of forests is maintained. It recognizes that, in some circumstances, conversion of forests in one site may contribute to the sustainable development and conservation of the wider landscape (e.g. reducing livestock grazing in a protected area may require conversion of forest areas in the buffer zone to provide farmland to communities). Managing forests to avoid degradation is often a key strategy to prevent deforestation[72].

APPENDIX: CHANGING STRATEGIES, DRIVING GROWTH

Bioenergy policies are supporting rapid development in many regions of the world. A few examples are given here.

POLICY FRAMEWORK	MAIN OBJECTIVES	BIOENERGY TARGET	BIOENERGY INCENTIVES	SAFEGUARDS
EU Renewable Energy Directive 2009/28/EC[73]	Climate; energy security; rural income	20% renewable energy by 2020, bioenergy expected to provide around 50% of all renewable energy produced in the EU; binding 10% renewable energy target (more than 90% is likely to be biofuels) in the transport sector.	Tariffs on biofuel imports to protect European production of biofuel. Tax incentives for member states. Feed-in tariff schemes for wood use in electricity and combined heat and power (CHP) production in place in some member states.	**Safeguards relate to biofuels only:** GHG savings: Minimum lifecycle GHG saving thresholds (relative to replaced fossil fuel) for biofuels: 35% by 2013, 50% by 2017; 60% after 2017 for new installations. **Feedstock safeguards:** Incentives only available if feedstocks do not originate from carbon-rich and biodiverse areas[74].
India National Biofuels Policy 2009[75]	Climate; energy security; rural development	10% biofuels in the transport sector by 2012, 20% by 2017.	Minimum price for oilseed crops. Bank loans to farmers for plantations. Biofuels exempt from excise duty. Tax concessions for bio-refinery machinery.	**GHG savings:** None **Feedstock safeguards:** None
USA Energy Independence and Security Act of 2007[76]	Energy security; rural income	30 billion gallons by 2020 (50:50 conventional renewable fuels and advanced biofuels); 36 billion gallons by 2022.	Excise tax exemptions for bioethanol blended gasoline and biodiesel. Subsidies for bioethanol, blending, plant construction, new feedstocks, research and development. 24 states have renewable portfolio standards[77].	**GHG savings:** Minimum lifecycle GHG saving thresholds (relative to replaced fossil fuel) for renewable fuel (20%); advanced biofuel (50%); biomass-based diesel (50%) and cellulosic biofuel (60%). **Feedstock safeguards:** Production must occur on land already cleared for agriculture. No specific legislation for forest biomass.
California, USA Bioenergy Action Plan 2006 (Executive order S-06-06) updated 2011[78]	Climate; energy security; rural income	Biopower (biomass to electricity) produces 17,000–20,000 GWh by 2020. Minimum 40% of biofuels produced in state within California by 2020 and 50% by 2050.	Incentives for bioenergy production and use[79]; e.g. US$20 million for the production of biofuels plus US$13.5 million for infrastructure to support production.	**GHG savings:** Same minimum reduction in GHG as USA at national level. **Feedstock safeguards:** Interagency Forestry Working Group to assess and define sustainability standards for biomass feedstock sourcing.

...continues

APPENDIX: CHANGING STRATEGIES, DRIVING GROWTH

POLICY FRAMEWORK	MAIN OBJECTIVES	BIOENERGY TARGET	BIOENERGY INCENTIVES	SAFEGUARDS
China Medium and Long-Term Development Plan for Renewable Energy and The Renewable Energy Law (2006)[80].	Climate; energy security; rural development	30 million MW per year of total installed capacity of biomass power generation by 2020, plus 50 million tonnes per year of biomass solid fuels, 440 billion m3 per year of biogas, 10 million tonnes per year of bioethanol, 2 million tonnes per year of biodiesel.	Tax incentives and subsidies for bioenergy producing companies, including funds for research, setting standards and establishing demonstration projects. Technology support to encourage rural people to use more bioenergy.	**GHG savings:** Reduce economy's CO_2 emission intensity by 17% by 2015, relative to 2010 levels. **Feedstock safeguards:** Use saline and alkaline, sandy and barren land and barren mountains for bioenergy plantations. Choose suitable species as energy plants and cultivate using scientific methods. Develop new plant species as feedstocks. Limit grain production for biofuel use (quotas not yet set) and develop non-grain crops as biofuels.
Brazil National Climate Change Plan 200881 and Plan for Energy Expansion (2010-2019)[82]	Climate; energy security; rural development	Increase annual consumption of bioethanol by 11% by 2018 (from 2008 baseline). Cogeneration of electricity supply to reach 11.4% of total supply by 2030. Increase biomass electricity production to 8.5 GWh by 2019.	Tax incentives for biodiesel producers to purchase feedstocks from small family farms in poorer regions of the country. Reduction of deforestation. Biodiesel blending target 18% in 2011.	**GHG savings:** Brazilian sugarcane bioethanol designated as advanced biofuel due to 61% reductions relative to fossil fuels on 2005 baseline. Minimum lifecycle GHG saving thresholds. **Feedstock safeguards:** Burning is prohibited in areas suitable for mechanical harvesting. Target of 20% of harvested area to eliminate burning by 2012, 100% by 2017. **Land-use zoning for sugarcane crops:** Sugarcane agro-ecological zoning by federal government provides guidelines on expansion of sugarcane production. **Labour safeguards:** Legislation requires that 1% of net sugar cane price and 2% of net ethanol price must be devoted to medical, dental, pharmaceutical, sanitary and educational services for workers.

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

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Contributors
Editor in Chief: Rod Taylor
Technical Editors: Nigel Dudley, László Máthé, Michael Obersteiner, Sue Stolton
Editorial Team: Rosamunde Almond, Gretchen Lyons, Barney Jeffries

With special thanks for review and contributions from:
Rina Andrianarivony, Dörte Bieler, Jean-Philippe Denruyter, Christina Eghenter, Sarah Hall, Zheng Han, Hanna-Liisa Kangas, Peter Kanowski, Maija Kaukonen, Andrea Kohl, Lifeng Li, Anders Lindhe, Imke Lüebbeke, Heather MacLean, Sally Nicholson, Stuart Orr, Jens Otterstedt, Peter Roberntz, Anke Schulmeister, Luís Neves Silva, Stephan Singer

IIASA's modelling team: Michael Obersteiner, team leader; with Petr Havlik and Kentaro Aoki, Juraj Balkovic, Hannes Boettcher, Stefan Frank, Steffen Fritz, Sabine Fuss, Mykola Gusti, Mario Herrero, Nikolay Khabarov, Georg Kindermann, Florian Kraxner, Sylvain Leduc, Ian McCallum, Aline Mosnier, Erwin Schmid, Uwe Schneider, Rastislav Skalsky, Linda See and Hugo Valin.

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WWF International
Avenue du Mont Blanc
1196 Gland, Switzerland
www.panda.org

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+5000

WWF has over 5,000 staff worldwide

+100

WWF is in over 100 countries, on 5 continents

1961

WWF was founded in 1961

+5M

WWF has over 5 million supporters

WWF

Why we are here
To stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature.

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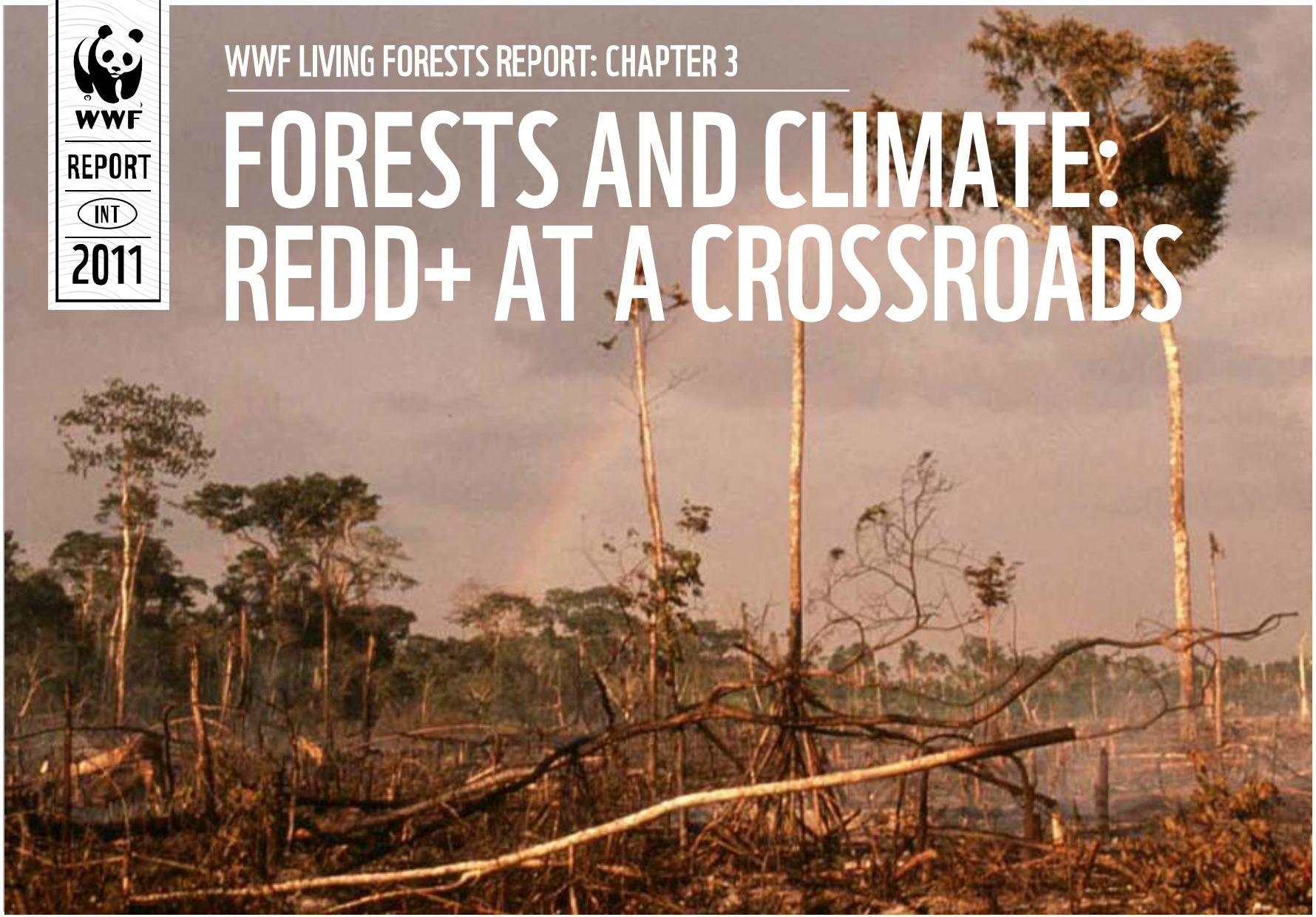
WWF REPORT INT 2011

WWF LIVING FORESTS REPORT: CHAPTER 3

FORESTS AND CLIMATE: REDD+ AT A CROSSROADS



CLIMATE AND LIVING FORESTS

Forests and climate are intrinsically linked: forest loss and degradation is both a **cause** and an **effect** of our changing climate.

Deforestation and forest degradation drive climate change, representing up to 20 per cent of global anthropogenic CO_2 emissions[1]. And **climate change** in turn can damage forests, for instance by drying out tropical rainforests and increasing fire damage in boreal forests. Inside forests, climate change is already harming biodiversity, a threat that is likely to increase[2]. Furthermore, degraded, fragmented forests are less able to withstand rapid shifts in temperature and rainfall patterns[3]. Deforestation and climate change have devastating impacts on many human communities, ranging from food, water and fuelwood insecurity to more frequent and severe weather-related disasters.

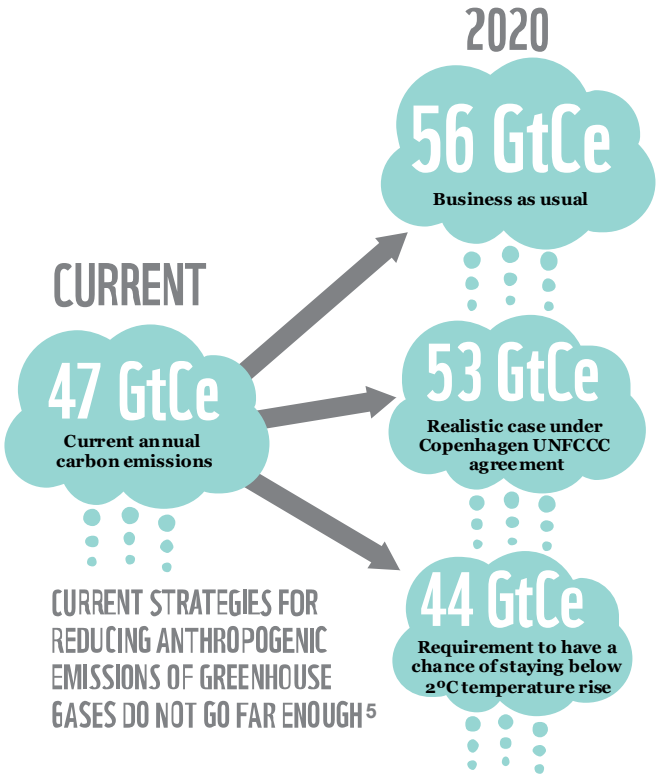
As deforestation and forest degradation have such an important impact on climate change, reducing forest loss can have multiple benefits for ecosystems and people. These include cutting greenhouse gas emissions, sequestering carbon, providing other ecosystems services, and maintaining intact, functioning forests that have the best chance of withstanding climate change.

WWF's envisions a world where humanity lives within the Earth's ecological limits and shares its resources equitably. We advocate **zero net deforestation and degradation (ZNDD)** by 2020 as a critical milestone on the road toward this goal (see chapter 1 of the Living Forests Report). With the International Institute for Applied Systems Analysis (IIASA), we developed the **Living Forests Model**[4], to consider a range of possible forest scenarios over the next half century, and to project the effects of changes in diet, bioenergy, conservation policy, and fuelwood and timber demand. The Living Forests Model shows that with better forest stewardship and more productive use of arable land, the current and projected demand for food, fuel and fibre could be met without further loss of forests. Several of these scenarios are referred to in the text and defined in more detail in the glossary.

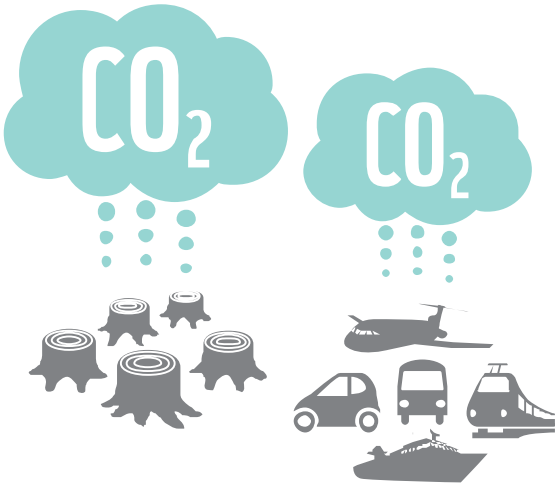
Critically, achieving ZNDD by 2020 depends on preventing **"unnecessary" forest loss**: forests squandered as a result of poor planning and governance, including the absence or weak enforcement of land-use planning laws, inequitable or insecure land tenure and user rights, unregulated or illegal forest clearing, poor forest management, inefficient agriculture, overuse of fuelwood, and other impacts that can be reduced using existing technologies. Creating incentives to keep forests alive, and/or penalizing those who destroy them, is critical if we are to achieve ZNDD and cut carbon emissions.

THE LINK BETWEEN FOREST AND CLIMATE

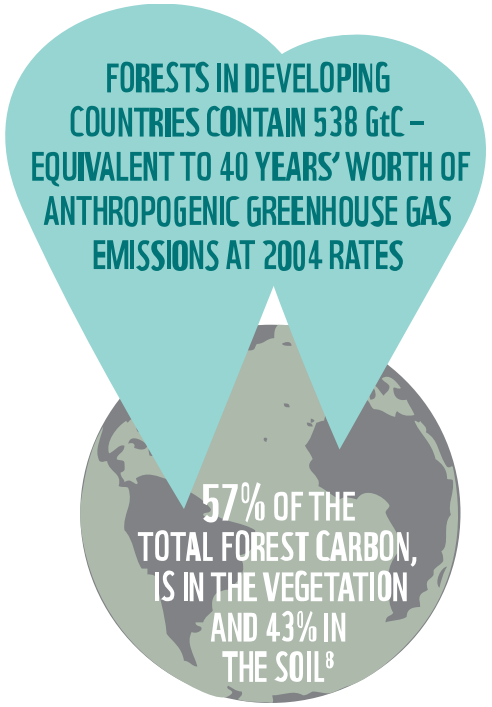
Climate change is one of the greatest threats humankind has known. Forests can be part of the solution.



CURRENT STRATEGIES FOR REDUCING ANTHROPOGENIC EMISSIONS OF GREENHOUSE GASES DO NOT GO FAR ENOUGH[5]



DEFORESTATION AND FOREST DEGRADATION REPRESENT UP TO 20% OF GLOBAL ANTHROPOGENIC CO_2 EMISSIONS[6], MORE THAN THE ENTIRE GLOBAL TRANSPORT SECTOR (WHICH ACCOUNTS FOR 13%)[7]



ANY FUTURE CLIMATE DEAL THAT DOES NOT FULLY INTEGRATE FORESTRY WILL FAIL TO MEET THE NECESSARY TARGETS

LORD NICHOLAS STERN[9]

FOUR WAYS IN WHICH CONSERVING FORESTS HELPS FIGHT CLIMATE CHANGE

Forest conservation can both slow the rate of climate change and help adapt to changes that are already occurring.

Conserving forests is the single largest and relatively cheapest thing we can do to limit the impact of climate change.

Carbon storage

Carbon storage helps to slow climate change, and forests are by far the largest terrestrial carbon stores. Although estimates vary, tropical forests are agreed to have the largest living biomass (170-250 [10]) while many boreal conifer and broadleaved forests in sub-polar regions grow on huge below-ground carbon stores in the form of peat[11]. Temperate forests have been decimated over the centuries[12], but are now expanding in many areas[13], and actively building carbon stores.

Resilience

Ecosystem resilience – the capacity of an ecosystem to continue to function and restore itself during or after disturbance – is critical for security of supply of food, water and many other resources. Evidence suggests that ecosystems with high levels of biodiversity are more resilient[14], and high carbon ecosystems often have high biodiversity[15]. Investment in maintaining resilience is in effect a cheap and effective way of ensuring vital ecosystem services.

Adaptation

Intact forest systems provide a variety of ecosystem functions that could help protect against many stresses that will increase under climate change[16]. These include water purification, flood control, coastal protection, slope stabilization, providing food, energy, materials and medicinal products, and protecting against erosion and desertification[17].

Most forests . In Europe, forests absorb 7-12 per cent of European carbon emissions from the atmosphere[18]. Tropical moist forests continue to sequester carbon in old-growth stage, as shown by research in the Amazon[19] and Africa[20]. Old-growth boreal forests also sequester carbon[21] although increased fire and other human disturbances[22] mean that individual boreal forests may be carbon neutral or even a source of emissions. Natural regeneration, managed restoration and reforestation also sequester carbon.

THE NEED FOR A MECHANISM TO STOP DEFORESTATION

How REDD+ can support the Cancun agreement to slow, halt and reverse the loss of forest cover and carbon[23].

Chapter 1 of the Living Forests Report compared land-use change scenarios in the quest to achieve and sustain ZNDD. This chapter looks at ZNDD from the perspective of carbon emissions, and the resulting impacts on climate. More specifically, it explores how the proposed **REDD+** (Reducing Emissions from Deforestation and Degradation plus) mechanism can help achieve a radical reduction in deforestation. REDD+ aims to make tropical forests more valuable standing than cut down by providing financial incentives to developing countries to maintain their forests. It consists of five integrated activities agreed at the Cancun UNFCCC meeting[24]:

1. Reducing emissions from deforestation
2. Reducing emissions from forest degradation
3. Conservation of forest carbon stocks
4. Sustainable management of forests
5. Enhancement of forest carbon stocks

REDD+ is at a crossroads. It has the potential to mitigate climate change, conserve biodiversity and reduce poverty, but at the international level, discussions on REDD+ are complex and support is fragmented, with a huge funding gap from 2012 to 2020. The challenge is to get REDD+ right by deciding upon methodologies that benefit the climate, people and nature. Issues to be resolved include how to set reference levels, monitoring, reporting, verification, and social and environmental safeguards. There are also challenges at national and local levels around when and how REDD+ should be implemented, which is why WWF advocates a phased approach[25].

This chapter will focus on two higher level priorities: a ***clear vision and target*** and ***adequate funding***. These are two critical enabling conditions that need to be in place at the international level for REDD+ to move forward. The key question is: ***What urgent actions do REDD+ stakeholders need to take now to make REDD+ work for people and nature?*** We return to this in the conclusions.

Achieving ZNDD by 2020 depends on preventing "unnecessary" forest loss: forests squandered because of poor planning and governance, including unregulated or illegal forest clearing, poor forest management and inefficient agriculture. Amazon forest fire, Acre State, Brazil. © Mark Edwards / WWF-Canon

WHY DOES REDD+ MATTER?

REDD+ offers the best prospects of reducing global forest loss and maintaining forest productivity.

International climate change policy now fully recognizes the critical role of forests in achieving the objective of limiting average global temperature rise to 2°C. **UNEP**[26] calculates that reductions in deforestation could cut carbon emissions by at least 2.5 billion tC/year.

REDD+ provides a potentially powerful tool for halting forest loss and achieving low carbon development. It offers the prospect of fresh incentives for managing forests to reduce carbon emissions and to maintain the fullest range of values (such as biodiversity, water supply, soil protection, economic productivity, sustenance and indigenous territories).

REDD+ is, then, a major opportunity to address the drivers of deforestation. It's a chance to transform forest governance, legal frameworks, land use, trade chains and investment patterns to mitigate climate change, curb biodiversity loss and reduce poverty – the very challenges posed by chapter 1 of the Living Forests Report[27].

Reducing forest degradation

Along with reducing forest loss, important additional, cost-effective carbon savings are possible from reducing and reversing forest degradation. Controlling illegal logging, managing forests more sustainably (for example through the reduced impact logging practices promoted by the **FSC**) and introducing measures to limit forest fires can all reduce carbon emissions. Management improvements can also sometimes increase carbon sequestration in managed forests[28]. Research in Sabah, Malaysia, found that improved management increased carbon by 54 tC/ha[29] and multiple studies found average carbon emissions from forestry could be reduced by 30 per cent[30] through management changes. One overview suggests at least 0.16 GtC/year could be saved from tropical forests designated for management as production forests[31], although reduced impact logging can also reduce forestry profits[32].

REDD+ OFFERS FRESH INCENTIVES FOR MANAGING FORESTS TO REDUCE CARBON EMISSIONS AND TO MAINTAIN THE FULLEST RANGE OF VALUES SUCH AS BIODIVERSITY, WATER SUPPLY, SOIL PROTECTION, ECONOMIC PRODUCTIVITY, SUSTENANCE AND INDIGENOUS TERRITORIES

TALKING POINT: THE CBD'S VIEW ON REDD+ AND BIODIVERSITY

WE WILL ONLY ACHIEVE TARGETS WITHIN THE CURRENT UNITED NATIONS DECADE ON BIODIVERSITY IF WE ACHIEVE SYNERGIES BETWEEN THE INTERNATIONAL AGREEMENTS THAT DEAL WITH FORESTS, AND IF WE DEVELOP A WELL-DESIGNED, WELL-FUNDED REDD+ MECHANISM THAT MAINTAINS AND ENHANCES BIODIVERSITY, AND SUPPORTS LOCAL AND INDIGENOUS COMMUNITIES

BIODIVERSITY IS AN ESSENTIAL ENABLING CONDITION FOR REDD+

THE CBD HAS WELCOMED REDD+ AS A POTENTIAL CONTRIBUTION TO THE CONSERVATION AND SUSTAINABLE USE OF BIODIVERSITY

© Y.-J. Rey-Millet / WWF-Canon

The Convention on Biological Diversity (CBD) has welcomed REDD+ as a potential contribution to the conservation and sustainable use of biodiversity. In turn, biodiversity is an essential enabling condition for REDD+.

We support our Parties and sister Rio Convention, the UNFCCC, by developing advice for appropriate biodiversity safeguards for REDD+ and by helping Parties to enhance REDD+ benefits for biodiversity and for indigenous and local communities. The need to harness the full potential of REDD+ for biodiversity, and the need for better coordination at national, regional and international level between biodiversity and climate change agendas are key messages we have heard repeatedly in consultations with over 100 Parties.

The new Strategic Plan for Biodiversity 2011-2020 aims to:

- at least halve deforestation and bring it close to zero where feasible;
- manage all forests sustainably; conserve at least 17 per cent of all land; and
- restore at least 15 per cent of all degraded forests – all by 2020.

We will only achieve these targets within the current United Nations Decade on Biodiversity if we achieve synergies between the international agreements that deal with forests, and if we develop a well-designed, well-funded REDD+ mechanism that maintains and enhances biodiversity, and supports local and indigenous communities.

Dr Ahmed Djoghlaf, Executive Secretary, CBD secretariat

ZERO NET DEFORESTATION AND DEGRADATION

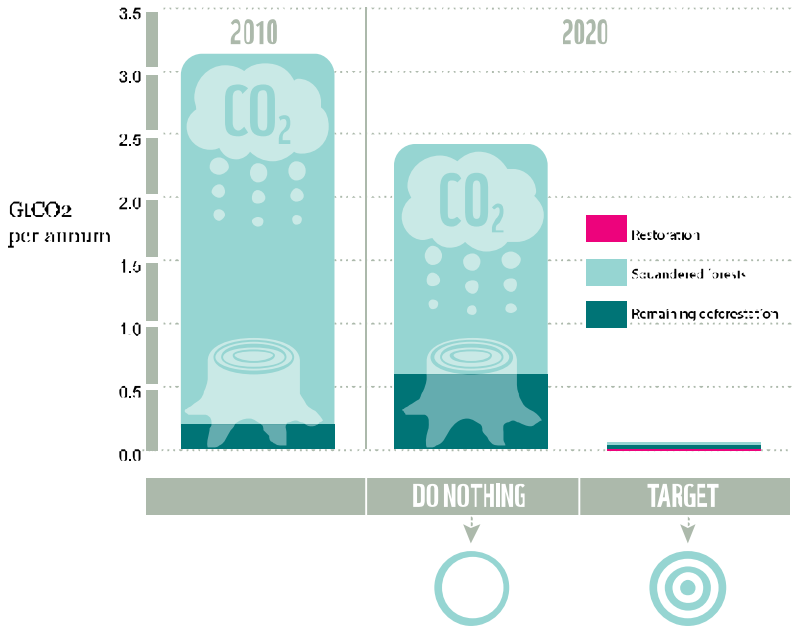
The Living Forests Model shows that ZNDD by 2020 is possible without critical repercussions on food, energy and biodiversity, and is needed to sustain vital ecosystem services. But how can this be achieved?

According to the Living Forests Model, the key challenge in achieving ZNDD by 2020, and thus cutting carbon emissions from forests, is improving governance and planning. Major institutional reforms are needed to remedy perverse incentives, corrupt licensing, disputes over land tenure, land-use decisions driven by poverty and inefficiencies, all of which are leading to the squandering of vital forest resources[33]. Two enablers – a global target and financing – are needed if REDD+ is to be applied at the scale and pace needed to achieve ZNDD by 2020.

An inspiring vision and target: A clear, ambitious and measurable global target for reduced emissions from deforestation and forest degradation is a vital step towards limiting warming to well below 2°C[34], alongside an overarching target for curbing global emissions. WWF has two global targets for 2020 – ZNDD, and no net greenhouse gas emissions from deforestation and degradation – that together provide a framework for countries to formulate ambitious national visions and targets*. These are needed to translate the preamble of the Cancun agreement – "Parties should collectively aim to slow, halt and reverse forest cover and carbon loss, according to national circumstances" – into action and finance on a sufficient scale.

New and additional, predictable and adequate financing, now: One factor that will make or break efforts to reduce forest loss is financing. ZNDD can only be achieved with a major and immediate scaling up of investments in maintaining tropical forests. The proposed REDD+ mechanism is the most feasible vehicle currently available to encourage and channel the necessary public and private finance.

*These targets are set within a context of WWF's overall mission; of particular relevance here is the objective of converting to 100 per cent renewable energy (www.panda.org/**energy**report), discussed in chapter 2 of the *Living Forests Report*.



Emissions ($GtCO_2$ per annum) from deforestation in 2010 and projected in 2020 under the Do Nothing and Target Scenarios.

Emissions from deforestation in the Do Nothing Scenario continue at high levels. The projections show that a major proportion of this deforestation, and resulting CO_2 emissions, are from 'squandered forests': that is, they are driven by poorly planned and governed exploitation of forest resources, rather than by actual global need for those resources. In the Target Scenario (ZNDD), loss of natural forests is reduced to near zero and emissions from any remaining deforestation are compensated for by restoration.

WHAT IS THE RELATIONSHIP BETWEEN CARBON EMISSIONS AND DEFORESTATION?

THE RELATIONSHIP BETWEEN FORESTS AND CARBON BECOMES COMPLICATED WHEN TARGETS ARE PURELY EMISSIONS-BASED AND FALL SHORT OF ZERO NET EMISSIONS

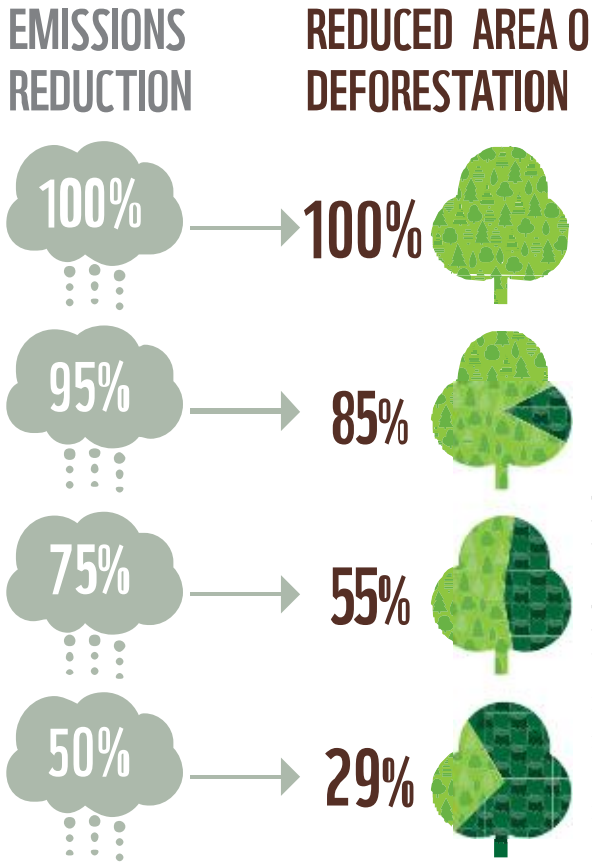
ZNDD will likely change forests from being a net source of carbon to a net sink.

In Cancun in 2010, the parties to the UNFCCC agreed to "slow, halt and reverse forest cover and carbon loss" to reduce climate change. **WWF believes both *area* and *emission*-based targets are needed**. Area-based targets should come first, followed in the longer term by monitoring, reporting and verification (MRV) of emission reductions and the carbon elements of UNFCCC forest targets. The area of forest lost or retained does not always translate to equivalent losses or gains in forest carbon emissions. Emissions can continue for years after deforestation due to decay and soil erosion; there is also a lag due to the slow rate at which carbon accumulates in restoration forests.

ZNDD is likely to cut carbon emissions to zero, albeit with a time lag. ZNDD also allows for an expansion of the area of forests that are managed for production, provided there is no net loss of quality (degradation) in these forests. Achieving zero emissions in newly managed forest areas will depend on the extent to which management practices are carbon neutral or even increase carbon sequestration.

But the relationship between forests and carbon becomes complicated when targets are purely emissions-based and fall short of zero net emissions. A narrow aim to cut carbon emissions will logically focus on high-carbon forests, with the likely result of less intervention to decrease loss and degradation in extensive, low-carbon forests. Some of these low-carbon forests, like Brazilian **cerrado** and African **miombo**, are rich in biodiversity and provide important ecosystem services. As an example of the non-linear relationship between area- and emissions-based accounting, the Living Forests Model projects that a 50 per cent reduction in emissions from forests would only reduce deforestation by 29 per cent (see figure).

This means that, if REDD+ is truly going to support biodiversity conservation and other goals that depend on preventing forest loss, it needs ambitious area-based targets for reducing deforestation. Additional biodiversity safeguards, along the lines of the **Pro-Nature Scenario**, which assumes protection for the highest biodiversity ecosystems outside forests, are also needed.



The relationship between targets to reduce emissions from deforestation and the area deforested.

The figure shows how different targets for reducing emissions from deforestation (expressed as a percentage reduction on projected emissions from gross deforestation in 2030 in a Do Nothing Scenario) impact the area deforested (expressed as a percentage reduction on the projected gross deforestation rate in 2030 in a Do Nothing Scenario).

Boreal forests sequester carbon, although increased fire and other human disturbances mean that individual boreal forests may be carbon neutral or even a source of emissions. Oulanka, Finland. © Wild Wonders of Europe /Staffan Widstrand /WWF

IMPLEMENTING REDD+ IN BRAZIL

Brazil provides a powerful example of how REDD+ might operate to reduce climate change, conserve forests and promote low-carbon economies.

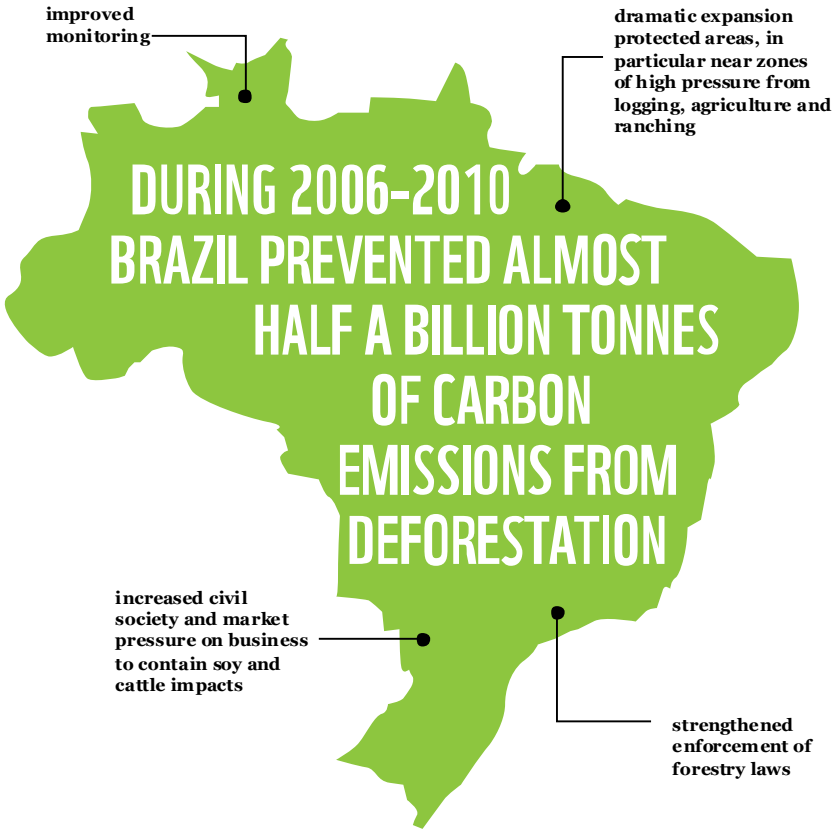
Brazil has had remarkable success in reducing deforestation. During 2006-2010, it more than halved the rate of deforestation in the Amazon region compared to the previous five years, preventing almost half a billion tonnes of carbon emissions. Significantly, this was achieved while increasing agricultural production and reducing poverty. Several actions combined to produce this result:

- a dramatic expansion protected areas, in particular near zones of high pressure from logging, agriculture and ranching
- strengthened enforcement of forestry laws
- increased civil society and market pressure on business to contain soy and cattle impacts
- improved monitoring.

Within this context, the recent emergence of financing for REDD+ based on a payment-for-performance principle is especially timely[35].

Acre state, the home of the murdered rainforest activist and rubber tapper leader Chico Mendes, stands out for its innovative Payment for Ecosystem Services (**PES**)-REDD+ programme[36], designed through extensive consultation involving diverse governmental and civil society organizations, including WWF. Instead of a project-by-project approach as followed in other jurisdictions, the government of Acre first embarked on defining a state-wide, programmatic approach to REDD+. The programme aims to reduce deforestation by 80 per cent by 2020, diminishing CO_2 emissions by up to 133 million tonnes.

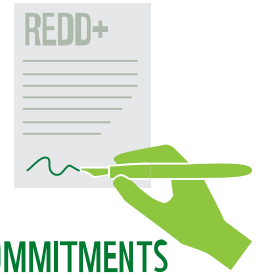
By the end of 2010, over 2,000 families were participating. In exchange for protecting forests, they receive financial incentives, in the form of annual payments based on verified performance, and support to develop sustainable livelihoods, including technical and marketing assistance for agricultural products. A zoning system has identified the most threatened forests, and expanding the programme is a priority in these areas. The PES-REDD+ programme links financial flows and services directly to those providing environmental services in priority areas, and to national goals. It is part of a larger system that aims to value other environmental services such as biodiversity and hydrology. The premise is that REDD+ works best within a wider set of incentives for low carbon sustainable development[37].



CASE STUDY: ELEMENTS OF REDD+ IN BRAZIL

Brazil demonstrates the components of a successful strategy to use forest conservation to meet global climate targets. However, changes to the Forest Code threaten this progress.

Brazil has developed new policy frameworks around PES and low-carbon development which have helped to conserve forests. The approach is based on rewarding performance and outcomes, simplifying administration, managing impacts at scale and focusing on the root causes. Five key components are:



1 **COMMITMENTS**

expressed in policy agreements and measurable, publicly announced national targets

2 **ZONING**

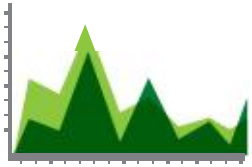
focused on conserving the most threatened forests, and working with those most able to deliver effective forest protection

3 **ENFORCEMENT**

effective monitoring of deforestation, and improved enforcement of laws to prevent further forest loss

4 **INCENTIVES**

rewarding those most directly involved in providing environmental services, based on performance



5 **MARKET PRESSURE**

adjusting business behaviour toward more sustainable production of agricultural commodities

At the heart of these concepts is a significant shift toward: (1) an approach based on rewarding performance and outcomes (2) new policy frameworks around PES/low carbon development designed to increase effectiveness and simplify administrative complexity and (3) managing impacts at scale and at the root causes.

Even with these components in place, the Brazilian achievements remain fragile, and could be reversed if proposed amendments to the Brazilian Forest Code come into force (see Box). This experience shows that improved governance can have a rapid impact in reducing deforestation – but also that governance reforms are vulnerable to political forces and can just as easily be undone.

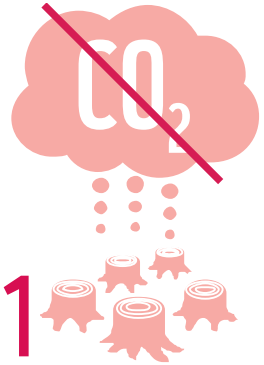
Globally, the challenge remains enormous. During the period that Brazil was achieving impressive reforms, Indonesia and Peru increased their deforestation by almost 50 per cent. REDD+ must walk a fine line – accelerating reform in forest and land management at the pace and scale needed to achieve ZNDD by 2020, while recognizing that rushed processes may not achieve effective and enduring improvements in governance if they do not ensure adequate stakeholder involvement and capacity building.

Brazil's 1965 Forest Code establishes a percentage of rural properties that should be maintained permanently in forest ("Legal Reserves"), and also prohibits clearing of vegetation on steep slopes and along the margins of rivers and streams ("Areas of Permanent Protection"). In 2011, the House of Representatives passed a bill that would drastically reduce the requirement for Legal Reserves and essentially dismantle the concept of Areas of Permanent Protection. Despite opposition by civil society groups including WWF, the House passed the bill with a substantial majority and it is currently under review in the Senate. Studies[38] estimate that, under a worst case scenario, the natural vegetation could be cleared or not restored over an area of 71.0-76.5 million hectares (roughly equivalent to Germany, Italy and Austria combined), resulting in emissions of 26-29 billion tonnes of CO_2e or about four times the goal for global emissions reductions under the Kyoto Protocol during 2008-12.

The burden of climate change is expected to fall disproportionately on the poorest communities; REDD+ should provide benefits to local and indigenous communities, such as payment for their forest stewardship and empowering them to assert their rights to forest resources. Baka family, Cameroon. © Martin Harvey / WWF-Canon

PRINCIPLES FOR SUCCESS IN REDD+

With CARE and Greenpeace, WWF proposes five principles that should be embodied in REDD+ readiness frameworks and projects.



1 CLIMATE TARGETS

REDD+ demonstrably contributes to greenhouse gas emission reductions, with national goals working toward a global objective

Countries like Brazil and Indonesia have set deforestation reduction targets, but there is no time-bound global target under the UNFCCC. In 2008, delegates to the CBD from 67 countries pledged support for WWF's call for zero net deforestation and degradation by 2020. The CBD has since resolved to halve forest loss by 2020 and where feasible bring this to zero: not enough, but the sort of language needed in a REDD+ agreement.

2 BIODIVERSITY

REDD+ maintains and/or enhances forest biodiversity and ecosystem services

REDD+ presents a key opportunity to finance conservation and natural forest restoration, yet current REDD+ efforts do not always identify biodiversity conservation as an explicit goal. REDD+ should: *prioritize forests with high biodiversity, endemism and threatened species* (such as in the Amazon, Congo basin, African miombo woodlands, Sumatra and Borneo, New Guinea and the Mekong Annamite Range)*; focus on areas of greatest forest loss and take action at an ecosystem scale*[39].

3 LIVELIHOODS

REDD+ contributes to sustainable and equitable development by strengthening the livelihoods of forest-dependent communities

Forests support 1.6 billion people and provide a home for 300 million[40]. Developing countries face 75-80 per cent of the potential damage from climate change[41], with a disproportionate burden on the poorest communities. REDD+ should provide benefits to local and indigenous communities, such as remuneration for their forest stewardship and empowering them to assert their rights to forest resources.

4 RIGHTS

REDD+ recognizes and respects the rights of indigenous peoples and local communities

This includes promoting land tenure, self-determination, free, prior and informed consent for any REDD+ projects, and strong social safeguards. Care is needed to manage the tension between the need for speed in scaling up REDD+ and the time required to respect traditional decision-making processes and implement social safeguards.

5 FAIR AND EFFECTIVE FUNDING

REDD+ mobilizes new and additional, predictable and adequate finance for action in priority forest areas in an equitable, transparent, participatory and coordinated manner

Disbursing large sums of money, particularly in countries with a history of weak governance and corruption, presents major institution-building challenges. These challenges should be addressed through a phased approach to REDD+: funding should initially support "readiness" activities at national or sub-national level[42], leading to performance-based payments once projects are put into practice[43]. But the sums required are tiny compared to climate change costs.

TALKING POINT: REDD+ AND FOREST-DEPENDENT COMMUNITIES

TRADITIONAL COMMUNITIES AND INDIGENOUS PEOPLES MUST HAVE THE POWER TO DECIDE WHAT HAPPENS TO THE LAND WITH WHICH THEY ARE LINKED

THE PRESENCE OF INDIGENOUS COMMUNITIES IN THE AMAZON FOREST HAS PREVENTED DEGRADATION AND DEFORESTATION

TRUE SOLUTIONS REQUIRE CHANGING THE OLD "DEVELOPMENT" PARADIGM, WHICH IS IN CONTRADICTION WITH NOT ONLY INDIGENOUS RIGHTS BUT THE PRINCIPLES OF REDD+

Contemporary economics rarely considers the multiple benefits that forest-dependent communities derive from ecosystems, or the institutional principles and organizational processes of indigenous peoples. Gaining respect for, and strengthening, our rights and institutions has been, and will continue to be, the foundation of our struggle, even though they are now recognized in the United Nations Universal Declaration on the Rights of Indigenous Peoples.

The presence of indigenous communities in the Amazon forest has prevented degradation and deforestation[44]. There are many reasons for this: our worldview, our social organization, our sustainable production systems. However, communities are being overwhelmed by the pressures, incentives and "temptations" of industrial agriculture. If no changes in legislation or public policy reverse this trend, indigenous lifestyles will inevitably favour market-oriented behaviour, increasing the risk of deforestation.

It seems only rational and effective for national economies to strengthen the livelihood of forest-dependent peoples. Whatever the structure of REDD+ in terms of actors, rights or distribution of benefits, if local stakeholders do not see a significant improvement in their livelihoods, the risk of deforestation and degradation will remain high.

The fundamental right of indigenous peoples is the right to their territory. In some countries this right, and access to natural resources, is accepted, recognized, established and formalized as law. In the vast majority there are still conflicts between ancestral rights, customary law and "modern" rights granted by governments. Of equal importance, the right to consultation and free, prior, informed and binding consent (ILO Convention 169, UN Declaration on the Rights of Indigenous Peoples) has become law in a few – but not enough – countries. Traditional communities and indigenous peoples must have the power to decide what happens to the land with which they are linked.

REDD+ is based on access to carbon, which is an intrinsic part of the forest. The fact that REDD+ requires new legal processes to make explicit this service should not undermine the rights of indigenous communities to their territories, the forest and its natural resources. If proper discussion does not take place, or problems arise from ambiguous definitions, or indigenous rights are ignored, conflicts will perpetuate.

True solutions require changing the old "development" paradigm, which is in contradiction with not only indigenous rights but the principles of REDD+. Indigenous peoples are in a unique position to help change this paradigm. We are actors with rights. So despite existing differences, indigenous organizations should participate in the discussions, design and development of strategies for REDD+. Our full and effective participation can highlight inconsistencies and help implementation move forward with new, effective and equitable approaches.

Coordinator of the Indigenous Organizations of the Amazon Basin – COICA

WHAT IS NEEDED TO MAKE REDD+ WORK FOR PEOPLE?

REDD+ MUST RECOGNIZE AND RESPECT THE RIGHTS OF INDIGENOUS PEOPLES AND LOCAL COMMUNITIES

SOME INDIGENOUS LEADERS QUESTION WHETHER MARKET MECHANISMS CAN CONTROL DEFORESTATION

REDD+ has major implications for poor, marginalized forest-dependent peoples[45].

Some indigenous peoples and communities living in forest regions are engaging in REDD+ schemes; others oppose the concept. All share some concerns. REDD+ might reduce security of land and resource tenure, encourage land grabs[46] and lead to increased state control and exclusionary forest conservation[47]. Indigenous peoples' organizations have protested against limited participation and influence in negotiations at UNFCCC and for national frameworks[48]. They fear that weak resource rights may prevent them from receiving expected benefits, and "forest destroyers" may gain more than forest stewards. REDD+ could create conflicts within communities. Some indigenous leaders question whether market mechanisms can control deforestation[49] and worry that REDD+ will allow industrialized nations to continue "business as usual" rather than cut emissions.

The International Indigenous Peoples Forum on Climate Change proposed some key conditions (abbreviated)[50], which WWF supports and believes can address these concerns:

KEY CONDITIONS

1

Recognize and respect the rights of indigenous peoples and local communities, while ensuring gender equality, in particular rights to lands, territories and resources. REDD+ should encourage the development of these rights where they do not exist.

2

Ensure the full and effective participation of indigenous peoples and local communities, in accordance with the right to free, prior and informed consent.

3

Recognize the fundamental role and contribution of indigenous peoples' traditional knowledge, innovations and practices.

OTHER USEFUL STEPS

4

Ensure that safeguards are built into all REDD+ readiness frameworks and projects, in accordance with WWF's Statement of Principles on Indigenous Peoples and Conservation

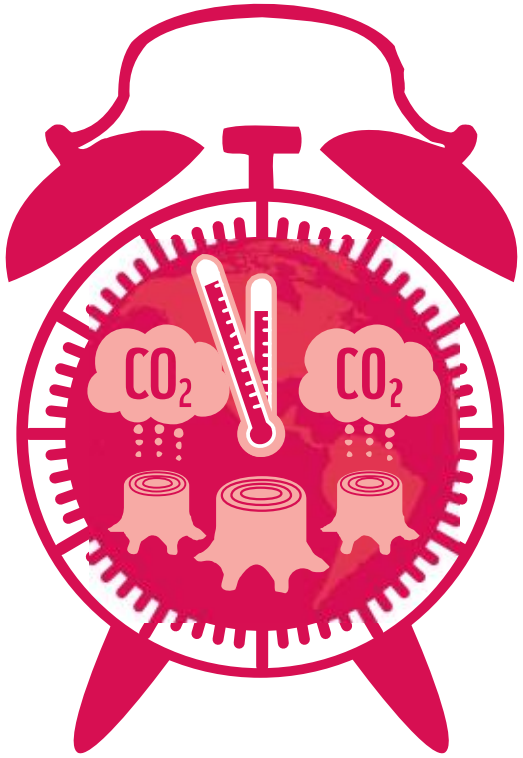
5

Collaborate proactively with indigenous organizations and communities on specific and agreed national processes and/or projects.

WWF is supporting the first community forestry concession test case in Kutai Barat, Indonesia. With 40,000 hectares under community management, the project is helping strengthen land tenure, as well as provide opportunities for increased income for the people of Kutai Barat. Long Tuyo, Indonesia. © WWF-Canon / Simon Rawles

INVESTING IN REDD+ TODAY

Delays are dangerous; if we are serious about keeping average temperature rise below 2°C, we need to start now.



Couldn't we wait a few years and see if other options emerge before deciding to invest big money in REDD+? There are good arguments for investing now.

- **The longer we wait the more forests we lose…**
  The Living Forests Model projects that waiting until 2030 before achieving ZNDD ( ) would sacrifice another 69 million hectares of forest worldwide[51], along with the associated natural, social and cultural capital. Local and indigenous communities' livelihoods would be destroyed. Species would go extinct. Purely economic calculations do not take account of these huge costs.

- **…and the more CO_2 is emitted…**
  Our projections suggest that delaying ZNDD until 2030 would mean emitting at least an additional 24 $GtCO_2$ into the atmosphere, not counting losses from forest degradation or the carbon stored below ground; as the area of deforested land increases, additional carbon is emitted through soil respiration.

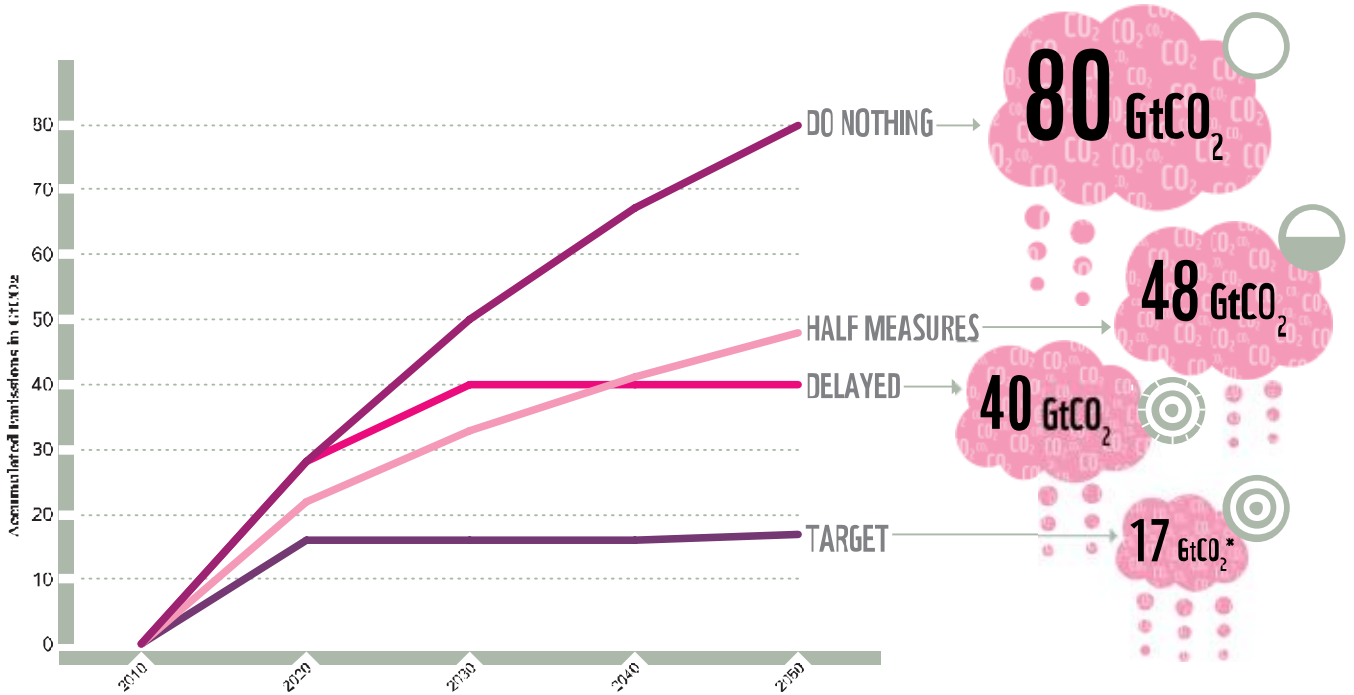
- **…increasing the risk of runaway climate change**
  For instance, a combination of high temperatures and water stress could lead to widespread forest loss in boreal regions, triggering a sudden, massive release of carbon from Arctic peat[52].

- **We cannot plant our way out of the problem**
  The Living Forests Model projects a major expansion of short rotation plantations, but shows that new plantations would not begin to sequester enough carbon to offset emissions from deforestation until more than 30 years from now; in the meantime vast areas of natural forest would be lost and a total of 54 $GtCO_2$ would be released.

- **Acting now will reduce long-term costs**
  Authoritative overviews such as the Stern Report[53], Eliasch Review[54] and McKinsey Report[55] into the consequences of climate change all agree that delaying action will create major increases in the total costs of mitigation and adaptation.

- **The REDD+ moment has arrived**
  Although there has historically been a link between development and deforestation, there is no longer any compelling reason why this should be the case. There are many reasons to promote a development model that retains extensive natural forests. REDD+ has arrived at an ideal time to help "flip" countries from being major forest carbon emitters to being forest carbon savers – the Brazilian state of Acre has shown how this can be achieved.

INVESTING IN REDD+ TODAY

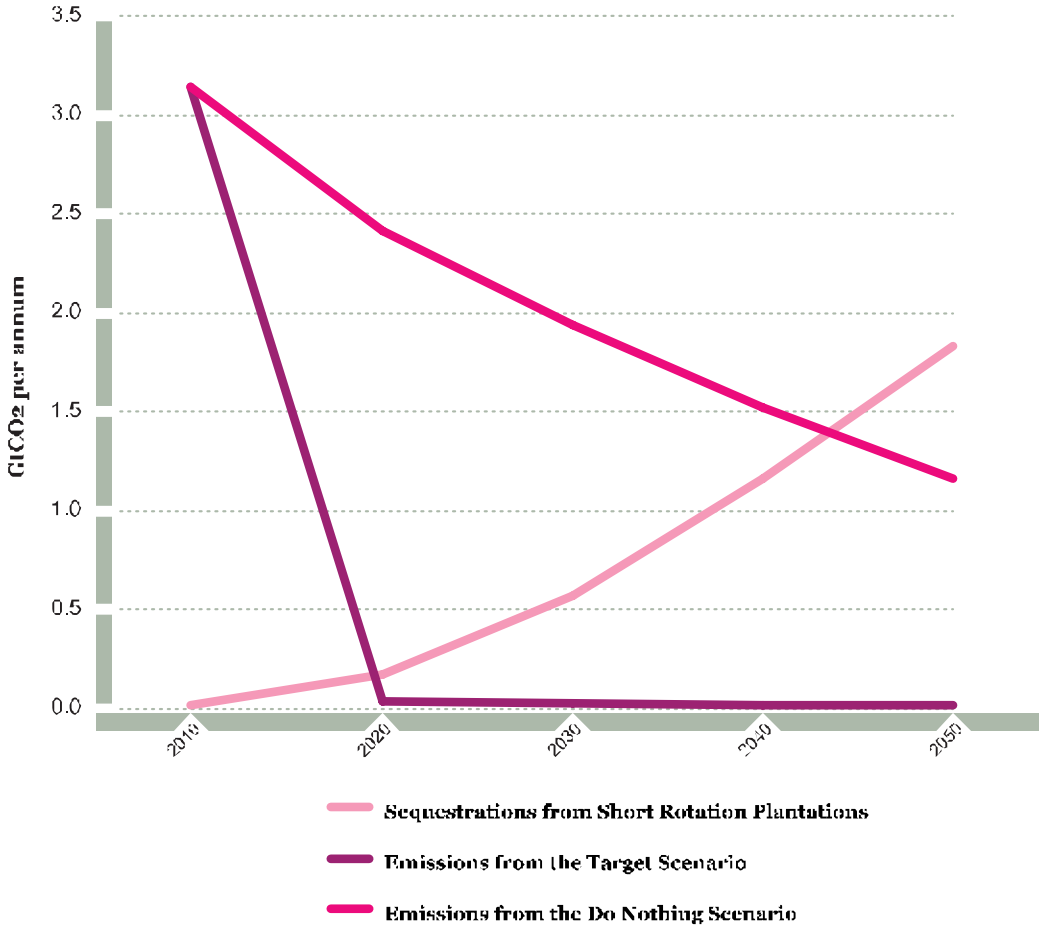


Cumulative emissions of above-ground carbon from deforestation (GtCO2)

Soil emissions are also hugely important, but we lack at present suitable data sources to model their significance accurately over the next 40 years. Including them in the Living Forests Model would increase emissions substantially. It is estimated, for example, that in addition to storing around 160 tC/ha in above-ground biomass, tropical forests store some 40tC/ha below ground and 90-200tC/ha as soil carbon[56]; some 50-80 per cent of the total carbon stock in miombo forests is in the top 1.5 metres of soil[57] and boreal forests store major amounts of carbon in soil and leaf litter.

*This is primarily from emissions between 2010 and 2020 before the target of ZNDD is reached.

INVESTING IN REDD+ TODAY



Projected annual emissions of $GtCO_2$ 2010 to 2050. The figures, for above ground carbon only, show that under the Do Nothing Scenario, the annual rate at which carbon is sequestered in short rotation plantations planted from 2010 onwards will not exceed the rate at which carbon is emitted through deforestation (gross emissions) until 2045; this "break-even" point would most likely be even further delayed if soil carbon were included in the calculation, as soil in areas already deforested continues to lose carbon.

COSTS OF REDD+

Achieving ZNDD and zero forest carbon emissions through REDD+ means a major increase in investment.

REDD+ financing needs to cover a wide range of costs:

- designing and implementing policies
- opportunity costs
- activities to address drivers of deforestation, improve traditional subsistence agriculture and clarify carbon tenure and user rights
- monitoring, reporting and other transactions
- implementing safeguards and strengthening governance.

How much will it cost?

Most available figures on REDD+ implementation are top-down (international) estimates. REDD+ finance should instead be based on actual country financing needs. WWF encourages countries to derive bottom-up estimates, and we support a process under the UNFCCC to develop a common methodology and assumptions to help them do this. Various estimates have been derived, mainly based on opportunity costs alone. WWF supported an NGO estimate of a minimum US$42 billion per year by 2020[58]; the latest UNEP estimates show US$17-33 billion per year is needed to achieve a 50 per cent reduction in deforestation by 2030[59]. These are minimum estimates: they tend not to include additional costs of conserving standing forests and avoiding leakage, which is necessary to comply with REDD+. Transaction costs (which mainly address governance) could be of the same magnitude as opportunity costs, at a minimum doubling current financing estimates.

SOURCES OF REDD+ FUNDING

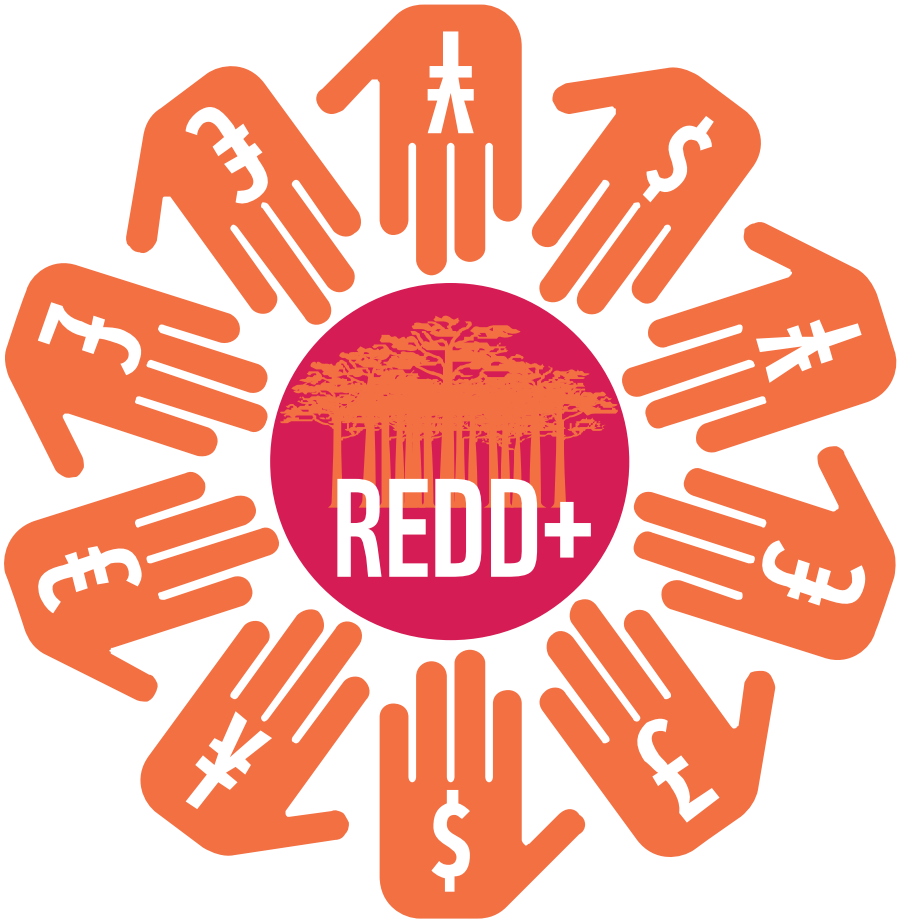
REDD+ will require new and additional, predictable and adequate funding from multiple sources.

Multiple funding sources are crucial to scale up REDD+ finance and to close the funding gap between current financial commitments and the resources required. Governments will not be able to do this on their own, and a proportion of public money needs to be used to help leverage a rapid and substantial increase in private investments. WWF supports REDD+ financing coming from multiple sources, including national budgets (domestic and international development aid), new sources such as financial taxes and mechanisms to generate finance from the international aviation and shipping sectors, and carbon markets. However, we believe REDD+ financing should be additional to international development aid commitments.

Available public funds pledged for REDD+ (though not yet fully disbursed) from donor countries stand at US$7 billion until 2012, but pledges up to 2020 are not yet in place. This gap between long-term needs and pledges should be closed by scaling up public investments to mobilize the additional private sector investments required.

In particular, new and innovative sources of public finance for REDD+ are needed. The reality of national and international politics combined with the stretched state of global public finances will make it difficult to generate sufficient, reliable public financial flows from existing sources. We need to look to new sources, including REDD+ finance from forest bonds[60] and other innovative climate adaptation and mitigation financing opportunities, such as measures to address emissions from international aviation and shipping[61].

How appropriate different sources are will ultimately be determined by how effectively they deliver the core objectives of REDD+: reducing deforestation and forest degradation, avoiding dangerous climate change, and respecting social and environmental safeguards.



TALKING POINT: NORWEGIAN GOVERNMENT'S VIEW ON FINANCING REDD+

FOR REDD+ TO SUCCEED WE MUST CREATE A "PRICE SIGNAL" FOR FOREST CARBON – A VALUE ON STANDING FORESTS AND A COST ON EMISSIONS

THE LION'S SHARE OF REDD+ SUPPORT SHOULD BE PAYMENTS FOR VERIFIED EMISSION REDUCTIONS

ADEQUATE AND PREDICTABLE FINANCE IS CRITICAL BUT IN ITSELF INSUFFICIENT TO REDUCE DEFORESTATION

SUSTAINING FORESTS IS IN DEVELOPING COUNTRIES' INTERESTS, AND SEVERAL KEY COUNTRIES HAVE PLEDGED TO FINANCE A SUBSTANTIAL PORTION OF EMISSION REDUCTIONS THEMSELVES

Adequate and predictable finance is critical but in itself insufficient to reduce deforestation. For REDD+ to succeed we must create a "price signal" for forest carbon – a value on standing forests and a cost on emissions that is internalized in private and public sector decision-making through an incentive structure that provides payments for verified emission reductions. Without this, REDD+ would be nothing new, and would certainly fail to "slow, halt and reverse forest cover and carbon loss". Of course, sustaining forests is also in developing countries' interests, and several key countries have pledged to finance a substantial portion of emission reductions themselves.

Perhaps even more significant, a results-based incentive structure would also redirect a significant chunk of the investment currently driving deforestation into conservation and sustainable use.

While support is needed for upfront REDD+ "readiness" reforms, the lion's share of REDD+ support should be payments for verified emission reductions.

While development aid can finance initial REDD+ preparation, it will offer neither the volume nor predictability needed. The international incentive structure must be financed through global or regional carbon markets and/or credible, predictable international "compliance finance" under the UNFCCC.

REDD+ payments need not necessarily match opportunity costs. Addressing governance challenges, for instance, does not mean compensating for lost illegal revenues. Incentives are needed for governance reforms and to compensate legitimate costs. Direct pricing mechanisms at project level only would risk missing key elements of a national strategy such as land-use planning, regulation and law enforcement. International REDD+ payments must move both political reforms and discrete investment decisions towards sustainability on a systemic scale. National monitoring is needed to avoid leakage and the high transaction costs of project-based mechanisms.

Per Fredrik Ilsaas Pharo, Director, government of Norway's International Climate and Forest Initiative

A RESULTS-BASED INCENTIVE STRUCTURE WOULD REDIRECT INVESTMENT CURRENTLY DRIVING DEFORESTATION INTO CONSERVATION AND SUSTAINABLE USE

TALKING POINT: IS THERE A SILVER BULLET FOR REDD+ FINANCE?

THE ANNUAL COST OF ADDRESSING THE DRIVERS OF DEFORESTATION IS ESTIMATED TO BE US$17-42 BILLION

TOTAL COMMITMENTS TO DATE FROM DONOR GOVERNMENTS AMOUNT TO APPROXIMATELY US$7 BILLION

SUCCESS DEPENDS ON SAFEGUARDS THAT ENSURE THE RIGHTS OF INDIGENOUS AND LOCAL COMMUNITIES, AND STRONG PROVISIONS FOR PROTECTION OF BIODIVERSITY

TODAY, THE MARKET REWARDS TURNING FORESTS INTO FARMS AND PLANTATIONS, AND PUTS LITTLE VALUE ON NATURAL FORESTS

Stopping deforestation worldwide would produce significant emissions savings – equivalent to a doubling of global nuclear energy generation capacity[62] – while at the same time have the potential to deliver conservation and livelihood outcomes at scale. Despite the complexity behind drivers of forest loss, many can be addressed in a manner that is economically efficient, relative to other sectors. Nevertheless, the cost is estimated to be US$17-42 billion annually[63], raising the question of whether public sector funding on its own is sufficient.

Total commitments to date from donor governments amount to approximately US$7 billion. While improvement in governance and reduction of perverse incentives are imperatives for success, asymmetries in political will and capacity limit their effectiveness. Addressing root causes of deforestation can only be effective if the private sector is engaged. From the smallholder in the Amazon to a multinational conglomerate operating in several markets, private actors of all descriptions (legal or illegal) comprise the smallest unit of production.

Today, the market rewards turning forests into farms and plantations, and puts little value on natural forests. The absence of an incentive for conserving forests determines the behaviour of landowners, land users and government ministries. When it comes to finance for REDD+, there is no "silver bullet": an effective mechanism will require policy that is wide-ranging, harnessing the power of capital markets while delivering incentives to communities operating at subsistence level. Its success depends on safeguards that ensure the rights of indigenous and local communities, and strong provisions for protection of biodiversity. Rather than window-dressing or co-benefits, these should be viewed as enabling factors for a mechanism that transforms land use in the tropics.

Christian del Valle, Managing Partner, Althelia Climate Fund

CONCLUSIONS

Unless we act now to halt deforestation, the opportunity to keep global temperature rise below 2°C will be lost forever.

Achieving ZNDD would be a major factor in reducing CO_2 emissions into the atmosphere. The Living Forests Model projects that ZNDD by 2020 is technically *feasible;* having a REDD+ regime widely implemented will help make this target *realistic*. As we illustrated in chapter 1 of the *Living Forests Report*, forest degradation and deforestation in tropical countries is a major environmental, social and economic problem, and will continue to be so unless action is taken[64]. Along with improved management of temperate and boreal forests, a sustainable increase in agricultural productivity, the reduction of wasteful consumption and changes in diet, REDD+ is an effective strategy for ZNDD.

REDD+ is currently high on the political agenda. Governments, the private sector and all stakeholders need to take this opportunity to develop REDD+ *right now* – before we deplete our natural resource base further and release more CO_2 into the atmosphere.

First and foremost, international drivers of deforestation must be addressed as an essential enabling condition for REDD+; otherwise, REDD+ projects could encourage perverse results such as land grabbing for bioenergy, thus undermining their overall effectiveness[65]. Then, REDD+ regimes must follow the principles set out on page 14 and operate under strict environmental and social safeguards, or the full potential benefits will not be realized.

WHAT YOU CAN DO TO HELP REDD+ SUCCEED

GOVERNMENTS CAN

- **Integrate REDD+ into programmes for low-carbon sustainable development**.
- **Use REDD+ as a major opportunity to address the underlying drivers of deforestation** and transform forest governance, legal frameworks, land use, commodity trade chains and investment patterns to address the combined threats from climate change, biodiversity loss and poverty.
- **Use REDD+ to develop clear rights to lands, territory and resources** for indigenous peoples and local communities.
- **Base land-use decisions affecting forests on transparent planning processes** to achieve an optimal distribution of natural forests, plantations, agricultural areas, urban areas and other land uses in a given landscape. Such processes should include well-informed negotiations among a wide range of stakeholders to balance ecological, social and economic dimensions of natural resource use across the landscape.
- **Adopt responsible public procurement policies to help reduce carbon footprint** for all products made from raw materials potentially linked to deforestation. Such policies should recognize credible voluntary certification schemes for wood and paper products, bioenergy, and agricultural commodities such as palm oil, soy and others.

THE PRIVATE SECTOR CAN

Develop ZNDD policies in forestry, agriculture and extractive industry and commodity trade chains. Producers can develop and implement best management practices that are consistent with environmental and social safeguards and certification standards. Further up the supply chain, **manufacturers, traders and end-users** can procure from these responsible suppliers and reject products linked to deforestation and forest degradation. The financial sector can also apply investment screens based on these safeguards and certification standards.

EVERYONE CAN

Live within the planet's sustainable limits. Individuals, businesses and governments need to assess and reduce their ecological footprints. In particular, the way the richest proportion of the global population lives will have to adapt.

Evidence suggests that ecosystems with high levels of biodiversity are more resilient, and high carbon ecosystems often have high biodiversity. Sumatran forest elephant (*Elephas maximus sumatrensis)*, Indonesia. © naturepl.com /Nick Garbutt / WWF

WWF'S DURBAN CALL FOR ACTION

WWF wants governments and leaders meeting at the UN climate convention (COP 17) in Durban to:

1

Close the REDD+ finance gap through a rapid and dramatic increase in investment from multiple sources. Developed countries need to provide leadership in demonstrating that, even under current economic conditions and fiscal pressures, concrete, feasible and cost-effective sources can be mobilized, and reaffirm their commitment to provide *new and additional, predictable and adequate* REDD+ funding. This will require:

- **an agreement to scale up REDD+ finance** based upon estimates of actual country assessments
- **scaled-up funding for REDD+ phase one and two** from bilateral and multilateral sources, urgently needed to assist developing countries to reach the full implementation phase for REDD+ and achieve the pre-conditions necessary for results-based actions
- **commitments for adequate and predictable funding to support results-based actions** from a flexible combination of public and private sources, including market-based sources as well as scaled-up bilateral and multilateral sources
- **a dedicated REDD+ window created under the Green Climate Fund** to secure a flow of scaled-up, new and additional public finance for REDD+.

2

Estimate global REDD+ finance needs from the "bottom up". More realistic national estimates associated with clear actions, targets and timescales are needed. Durban should start a process under the UNFCCC to develop a common methodology and set of assumptions to derive these "bottom-up" estimates.

3

Scale up REDD+ efforts to demonstrably address climate change through agreement on a process to define a measurable, time-bound, global REDD+ target by COP18.

4

Get REDD+ right by deciding upon REDD+ methodologies that benefit the climate, people and nature.

- **Maximize REDD+ co-benefits for people and nature** through agreement on a common framework for national information systems on safeguards, guided by a harmonized international structure that includes measurable indicators, guarantees transparency and full and effective stakeholder participation, and provides for comparisons between national systems.
- **Avoid "hot air" and reward countries equitably** through agreement on modalities for setting reference levels / reference emission levels to be aligned to principles that ensure additionality, avoid displacement, leakage and double-counting, are based on historic data and provide incentives for countries with low deforestation rates to conserve existing forest carbon stocks.
- **Agree on measuring, reporting and verification (MRV) to be an instrument to generate credibility and public trust** that REDD+ works through demonstrably contributing to: a) significant and permanent greenhouse gas emission reductions, b) addressing the underlying causes of deforestation and forest degradation, c) maintaining and/or enhancing biodiversity and ecosystem services, d) sustainable and equitable livelihoods, e) recognizing and respecting the rights of indigenous peoples and local communities and f) full and effective participation of indigenous peoples and local communities.

5

Develop methodologies to effectively reduce and ultimately reverse the drivers of deforestation including the reform of ineffective legal and governance frameworks, harmonization of land-use policies across different sectors (e.g. agricultural, mining, public infrastructure and forests), the negative footprint of national and international markets and trade, perverse subsidies that result in forest clearing, and the absence of clear land use rights and responsibilities, in time for adoption by COP 18.

GLOSSARY AND ACRONYMS

Carbon sequestration: Carbon sequestration is a biochemical process by which atmospheric carbon is absorbed by living organisms, including trees, soil micro-organisms and crops, and involving the storage of carbon in soils, with the potential to reduce atmospheric carbon dioxide levels.

CBD: Convention on Biological Diversity.

Cerrado: The largest savannah region in South America and biologically the richest savannah in the world.

Climate change: The slow variations of climatic characteristics over time at a given place. Usually refers to the change of climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is, in addition to natural climate variability, observed over comparable periods.

CO_2: Carbon dioxide.

Do Nothing Scenario: A Living Forests Model projection of what the world could look like if our behaviour continues in line with historical trends. The Do Nothing Scenario anticipates land-use change due to: (a) demands for land to supply a growing global human population with food, fibre and fuel; and (b) continuation of historical patterns of poorly planned and governed exploitation of forest resources. Key assumptions in this scenario are:

- By 2050, world population reaches 9.1 billion and per-capita GDP almost triples.
- Demand for commodities is driven by changes in affluence (measured by GDP) and human population growth.
- Aggregate historical trends in agricultural productivity gains continue.
- The average human diet in a country changes according to historically observed relationships with per-capita GDP.
- Forestry and agricultural production does not expand into protected areas, but unprotected natural habitats can be managed for production of timber or converted to timber plantations, cropland and pasture.
- Total primary energy use from land-based biomass feedstocks doubles between 2010 and 2050 due to projected energy demand and the competitiveness of bioenergy technologies and supply chains.

FSC: Forest Stewardship Council. WWF considers the FSC to be the most credible certification system to ensure environmentally responsible, socially beneficial and economically viable management of forests.

Greenhouse gases (GHG): Those gaseous constituents of the atmosphere, both natural and artificial, that absorb and re-emit infrared radiation and that are responsible for global warming66.

Living Forests Model: Developed for WWF by the International Institute for Applied Systems Analysis (IIASA) the model draws on G4M and GLOBIOM models[67] to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, GDP and infrastructure. GLOBIOM is an economic model that allocates land and resources optimally based on projected commodity and ecosystem service demands under future GDP, population and policy scenarios.

Miombo: Sparse, dry woodlands of Africa important for their high diversity of large mammals, including populations that make up the well-known East African savannah mammal fauna.

PES: Payments for Environmental Services.

Pro-Nature Scenario: A scenario of the Living Forests Model which projects that the remaining natural ecosystems are conserved (i.e., no further conversion of these ecosystems to cropland, grazing land, plantations or urban settlement) in areas identified as important for biodiversity by at least three separate conservation mapping processes using a UNEP World Conservation Monitoring Centre (UNEP-WCMC) dataset. This scenario assumes that current land uses (e.g., cropland or forestry) in these areas remain constant and continue to produce food or timber[68].

REDD+: A package of actions aimed at (1) reducing emissions from deforestation and forest degradation (REDD) in developing countries; (2) conservation and sustainable management of forests; and (3) enhancement of forest carbon stocks.

Target Delayed Scenario: A projection of the Living Forests Model which projects ZNDD (with near zero gross rate of loss of natural and semi-natural forest) by 2030 and maintained at that level indefinitely.

tC/ha: Tonnes carbon per hectare.

UNEP: United Nations Environment Programme.

UNFCCC: United Nations Framework Convention on Climate Change.

Unnecessary forest loss: Deforestation resulting from poor governance and planning which means we are failing to optimize land use in ways that the Living Forests Model suggests are technically possible (see chapter 1 page 18 for a more detailed discussion of unnecessary forest loss).

Zero Net Deforestation and Forest Degradation (ZNDD): WWF defines ZNDD as no net forest loss through deforestation and no net decline in forest quality through degradation. ZNDD provides some flexibility: it is not quite the same as no forest clearing anywhere, under any circumstances. For instance, it recognizes people's right to clear some forests for agriculture, or the value in occasionally "trading off" degraded forests to free up other land to restore important biological corridors, provided that biodiversity values and net quantity and quality of forests are maintained. In advocating ZNDD by 2020, WWF stresses that: (a) most natural forest should be retained — the annual rate of loss of natural or semi-natural forests should be reduced to near zero; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration. In this accounting, plantations are not equated with natural forests as many values are diminished when a plantation replaces a natural forest.

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Please note: new estimates for variables such as carbon emissions, forest area and consumption levels emerge very regularly. In this report we have taken the latest authoritative statistics available, drawing on analysis and opinions of specialists at WWF and IIASA.

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

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Contributors
Editor in Chief: Rod Taylor
Technical Editors: Bruce Cabarle, Paul Chatterton, Nigel Dudley, Michael Obersteiner, Kirsten Schuyt, Gerald Steindlegger, Sue Stolton

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Editorial Team: Gretchen Lyons, Barney Jeffries

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WWF International
Avenue du Mont Blanc
1196 Gland, Switzerland
www.panda.org

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2012

WWF LIVING FORESTS REPORT: CHAPTER 4

FORESTS AND WOOD PRODUCTS

FORESTS AND WOOD PRODUCTS

"WE ARE LIVING AS IF WE HAVE AN EXTRA PLANET AT OUR DISPOSAL. WE ARE USING 50 PER CENT MORE RESOURCES THAN THE EARTH CAN PROVIDE, AND UNLESS WE CHANGE COURSE THAT NUMBER WILL GROW VERY FAST – BY 2030, EVEN TWO PLANETS WILL NOT BE ENOUGH[3]"

Jim Leape, Director-General, WWF International

This chapter of the Living Forests Report explores how we can meet future demand for **wood products** within the finite resources of one planet.

The *Living Forests Report* aims to catalyse debate on the future role and value of forests in a world where humanity is living within the Earth's ecological limits and sharing its resources equitably. The report presents **Zero Net Deforestation and Degradation** (ZNDD) by 2020 as a target that reflects the scale and urgency with which threats to the world's forest biodiversity and climate need to be tackled. We use the **Living Forests Model**[1], developed by WWF in collaboration with the International Institute for Applied Systems Analysis (IIASA), to look at the land-use implications of ZNDD under a range of scenarios that consider different conservation, dietary and energy-use options.

The first three chapters of the report were published in 2011:

- Chapter 1 – ***Forests for a Living Planet*** examines the drivers of deforestation and the need to shift to a new model of sustainable forestry, farming and consumption with ZNDD.
- Chapter 2 – ***Forests and Energy*** examines the safeguards needed to ensure expanding use of **bioenergy** helps to provide energy security, rural development and greenhouse gas (**GHG**) reductions without destroying valuable ecosystems or undermining food and water security.
- Chapter 3 – ***Forests and Climate – REDD+ at a Crossroads*** highlights REDD+ as a unique opportunity to cut GHG emissions from forests in time to prevent runaway climate change, but only if investments are made now.

This 4th chapter examines current and future demand for wood products and how this can best be met. We explore the many values and uses of **wood** and its footprint relative to alternative materials (**pages 2-7**); the current and future demand for wood products (**pages 8-17**); the relationship between wood production and the conservation of other forest values (**pages 19-21**) and various options for producing wood (**pages 22-31**). The chapter concludes with broad solutions that will enable humanity to optimize the use and benefits of wood without diminishing the natural capital in the world's forests.

While this chapter focuses on wood as the major commodity extracted from forests, it is important to note that forests also produce **non-timber forest products** (NTFPs). The global value NTFPs is hard to assess but was estimated at US$18.5 billion in 2005[2]. The economic, cultural and ecological value of NTFPs makes them an important component of sustainable forest management and the conservation of biological and cultural diversity.

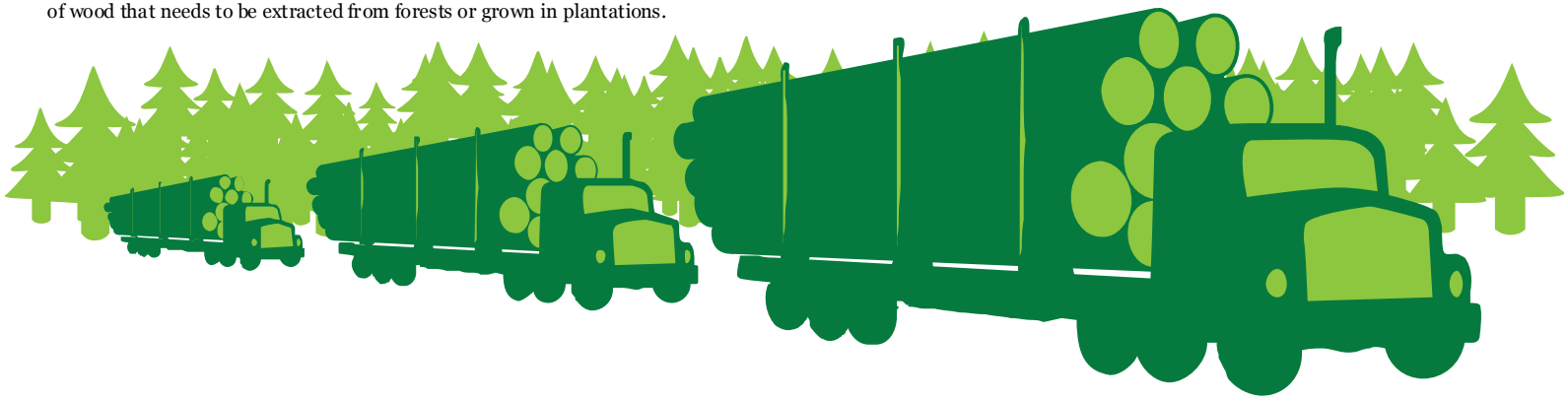
WOOD PRODUCTS: TODAY AND TOMORROW

Humanity will likely use more wood in more ways as the future unfolds. If **production forests** are managed sustainably and wood products are used efficiently or replace others with a heavier footprint, this should be good for the planet.

WWF advocates reducing wasteful consumption of wood and **paper**. But even with more frugal use and greater efficiencies, net demand is likely to grow with rising population and incomes in developing countries. So how can we produce more wood without destroying or degrading forests, in a world where competition for land and water is increasing? This challenge spans the whole supply chain, from where and how wood is grown and harvested to how wisely and efficiently it is processed, used and reused. It also involves changes to consumption patterns – such as eliminating excessive and wasteful use of paper in rich societies, while improving access for the poor to paper products that can improve education, hygiene and food safety.

EVEN WITH MORE FRUGAL USE AND GREATER EFFICIENCIES, NET DEMAND IS LIKELY TO GROW

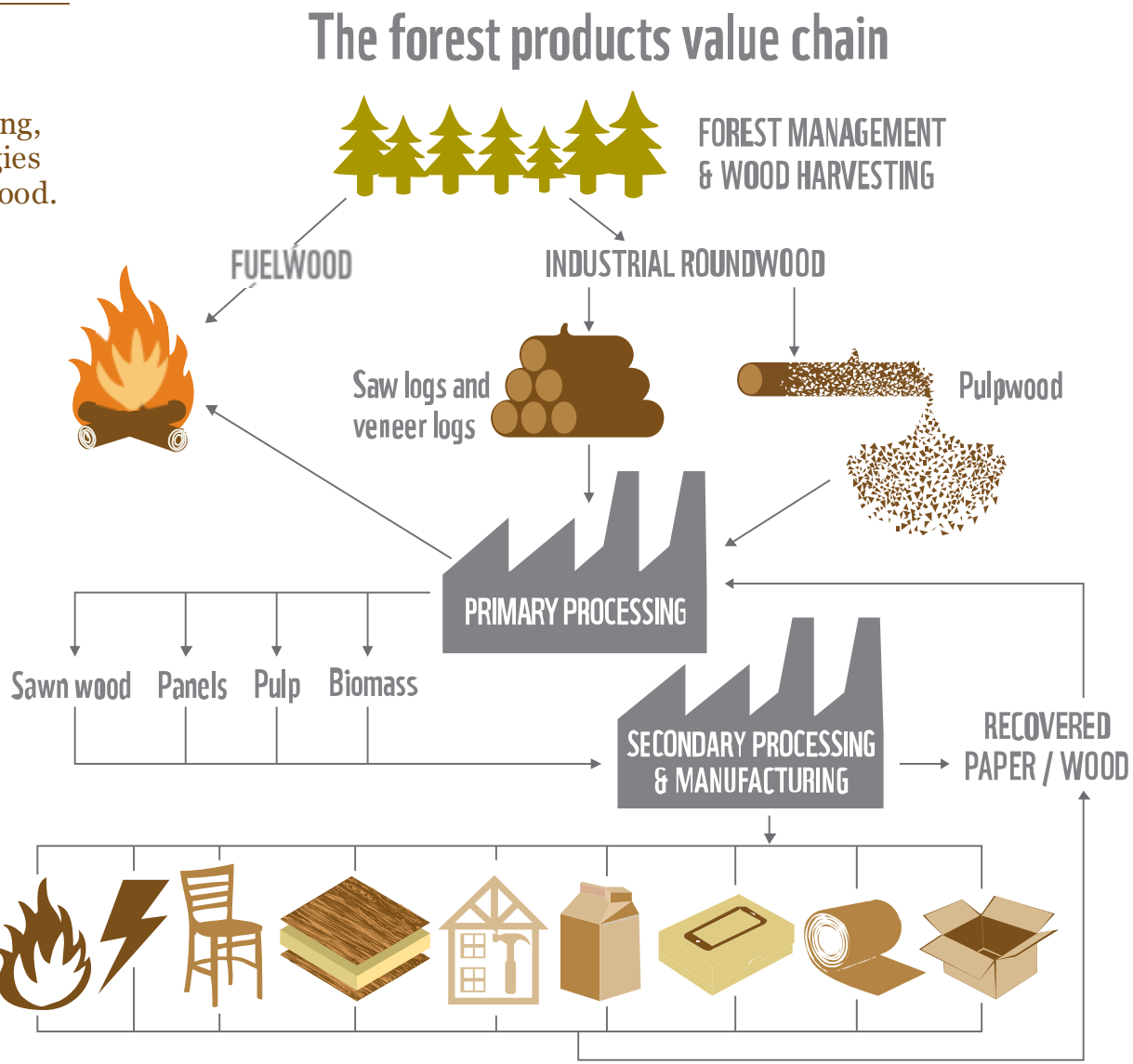
Advancing technology is enabling new uses of wood and its core chemical components in composites, films and chemically processed speciality **cellulose**. In the future such uses could add significantly to the volume of wood that needs to be extracted from forests or grown in plantations.



THE MANY USES OF WOOD

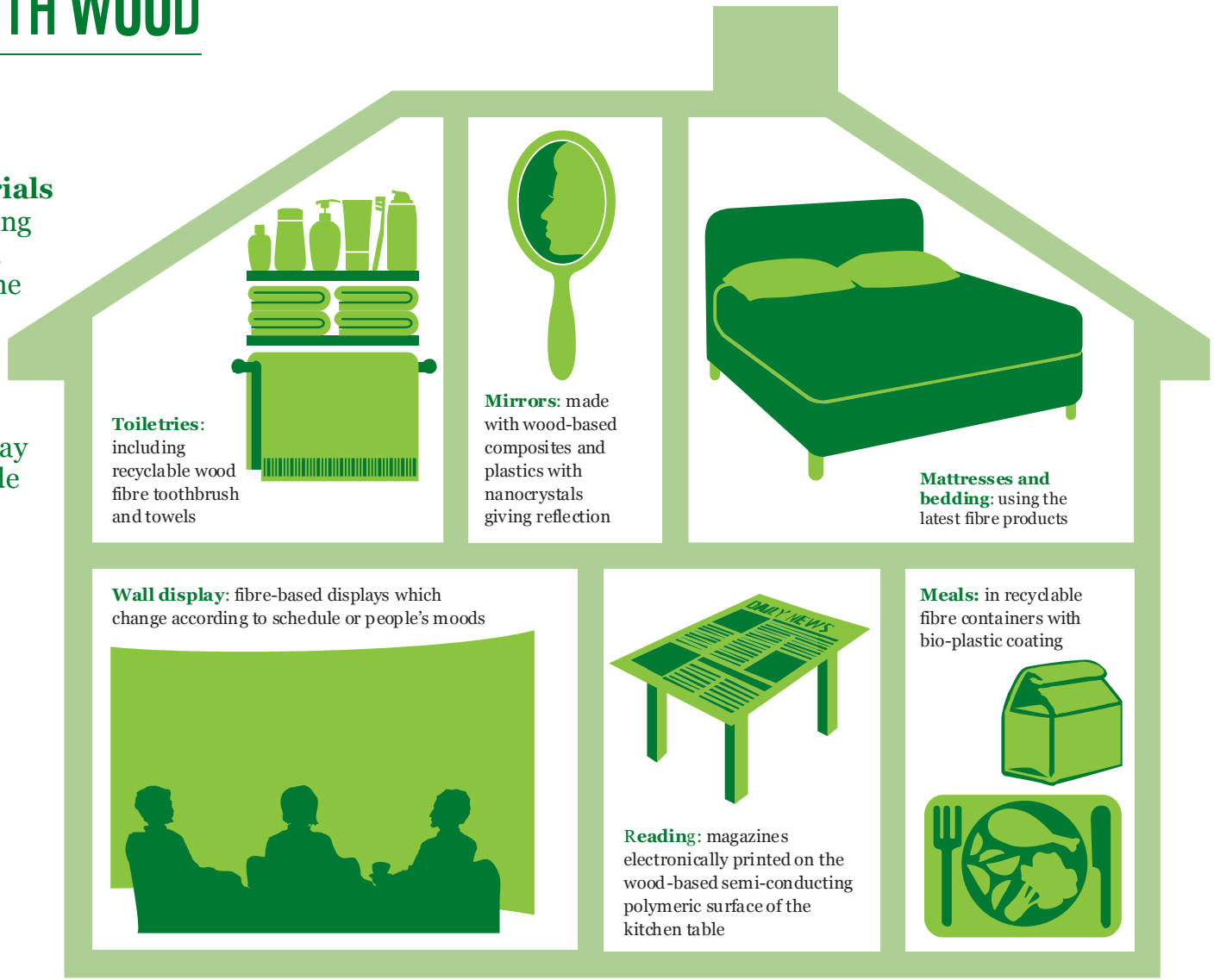
Wood is used to construct and furnish buildings, to make paper products for hygiene, writing, printing and packaging, and to produce energy. New technologies are creating many more ways to use wood.

Many terms used to describe wood materials mean different things in different regions and contexts. For the purposes of this chapter we use the terminology set out in the graphic of the forest products value chain, which is defined more fully in the glossary.



THE FUTURE WITH WOOD

Wood-based biomaterials will be used in an increasing range of pharmaceuticals, plastics, cosmetics, hygiene products, consumer electronics, chemicals, textiles and construction materials[4]. By the middle of the 21st century everyday uses of wood might include those shown here.



WOOD'S NATURAL ADVANTAGE

Wood is engineered and synthesized by nature, biodegradable and, if forests are managed well, renewable.

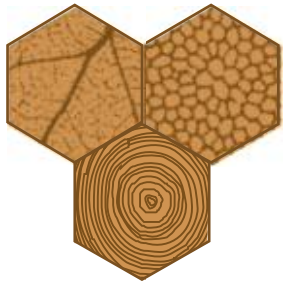
Wood is a strong, pliable and aesthetically appealing raw material that can be produced with less energy and pollution than artificial materials such as steel and plastic. But many things can undermine this natural advantage – unsustainable forestry practices harm forests and deplete carbon stores; huge logs can be lost or wasted; indiscriminate plantation expansion can displace communities and take away their livelihoods; dirty pulp mills pollute air and water; and paper fit for recycling is dumped in landfills or burned.

Solid wood items, such as furniture or wood used in construction, can have extremely long working lives. With suitable design, care and maintenance wooden furniture can last 100 years or more, and wooden structural components in buildings can endure for centuries. Even in extreme environments, such as in the sea, wooden pilings can last much longer than other materials such as steel or concrete.

Technological advances are enabling many innovative uses of wood: composites for construction, bio-foam for car interiors, bio-plastic coating for food packaging, bio-based polymer paints in consumer electronics, and pharmaceutical uses such as pills bound with **wood pulp** derivatives for slow release in the body. Wood-based chemicals and new wood-based biomaterials currently use a small portion of total wood supply. They tend to be by-products (e.g., of pulp mills) and not viable if produced in standalone plants[5]. However, longer term, new technologies, prices and energy policies could mean that these products absorb a much greater portion of the wood supply.

Key benefits of wood-based materials over other materials

Nature does much of the engineering and synthesis



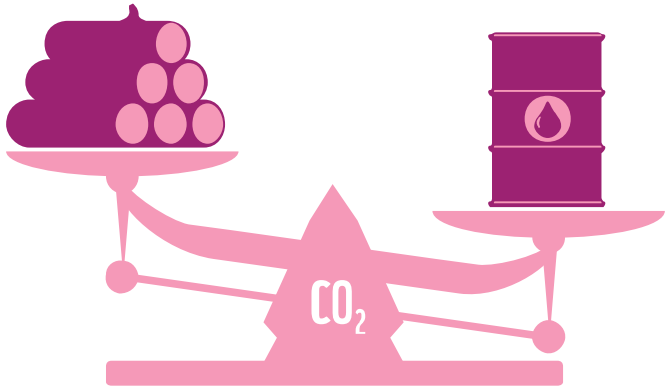
Wood is renewable, recyclable and biodegradable

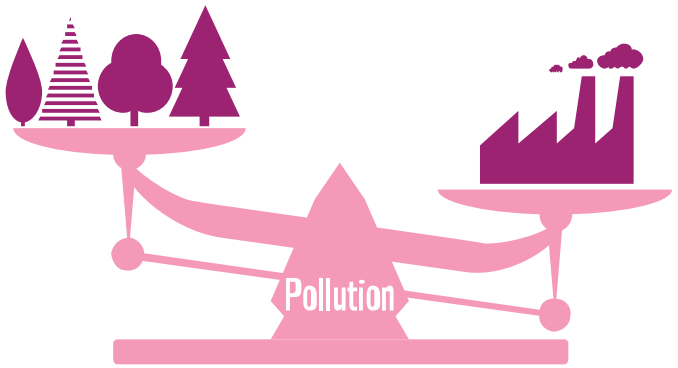
THE FOOTPRINT OF WOOD COMPARED TO OTHER MATERIALS

More demand for renewable materials, whether driven by legislation, policy or personal choice, could lead to more use of wood-based products.

The potential for more innovative uses of wood heightens the need for accurate life-cycle comparisons of wood products with alternatives derived from fossil fuels, mines or quarries. Results could have major implications on policies and consumer preferences.

The complexity of evaluating the overall footprint of different products has prompted a plethora of life-cycle assessment (LCA) methodologies and much subjectivity in their application. This means LCA studies are difficult to compare and often reach opposing conclusions. Causes of inconsistency include varied approaches to quantifying impacts, especially on biodiversity, of raw-material extraction across sectors and contexts, and uncertainties due to the lack of representative and up-to-date inventory data on inputs. The ISO guidelines on LCA (ISO 14040:2006 and revisions) stress the need for transparency in LCA reporting and provide guidance tailored to specific product categories.





We need to understand how the environmental costs and benefits of wood-based products compare with similar products made from other materials. More robust studies on product footprints could help us make important everyday choices:

- **Wood, concrete or steel in buildings?**
  Wood-frame houses create space in the walls for easy insulation, while innovative engineered wood beams can bear the loads needed to structure a multi-storey building with less mass than steel and concrete alternatives. A recent study[6] of energy "embodied" in building materials found that wood outperformed cement and steel by more than a factor of 10 on energy and GHG savings in the supply chain per cubic metre constructed. But comparing the full environmental impact of materials is not simple: design variables, for example, affect the efficiency of heating, ventilation and air conditioning over the life of the building.
- **Wood, oil or cane to make plastic packaging?**
  The use of fossil-based plastic packaging has a range of well-documented environmental problems[7]. Polylactic acid, a compostable bio-polymer substitute for fossil-based plastic packaging, can be made from sugars extracted from the cellulose (C6 sugars) and hemicellulose (C5 sugars) of wood[8]. But how does this compare with another substitute – high-density polyethylene made from sugarcane?
- **Paper, fossil-based plastic or glass for beverage containers?**
  A meta-analysis of LCA studies on the environmental impact of beverage packaging found most studies ranked the environmental performance of wood-based cartons ahead of other forms[9].
- **Plastic, aluminium or cork[10] for wine bottle stoppers?**
  One study found that the cork stopper out-performs aluminium and oil-based plastic alternatives in reducing GHG emissions, atmospheric acidification, ozone depletion, eutrophication of surface water and solid waste[11]. Using cork supports biodiversity-rich forests in the Mediterranean and elsewhere. Producers also claim new treatments have dramatically reduced the risk of wine being wasted after becoming tainted by chemical compounds sometimes found in cork[12].

THE MANY LIVES OF WOOD

A single piece of wood or wood fibre can be recycled through a succession of different products.

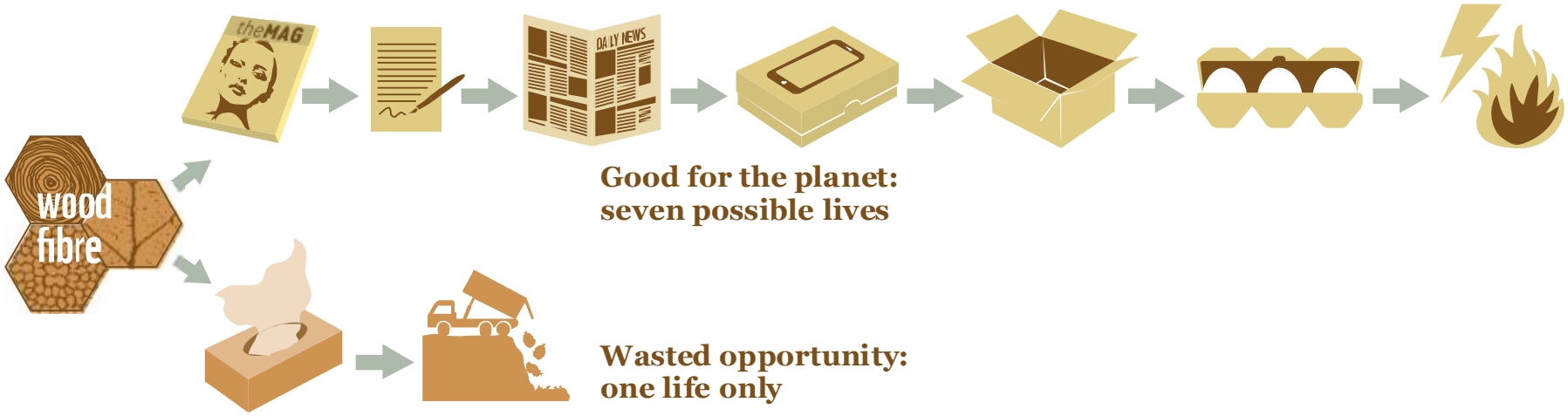
Nearly all types of solid wood can be reused if recovered and separated from other waste. Wood can be salvaged from old buildings, bridges and wharfs and used again in modern décor, from furniture to flooring. Smaller, less valuable wood scraps can be collected and used to make particle board and other modern composite products. In the UK, more than half of the wood previously sent to landfill is now recycled[13].

Paper can be recycled and reused many times, thus reducing the volume of **virgin wood fibre** needed to produce paper products.

This recycling flow can be shortened if paper is prematurely burned or dumped in landfills. In 2010, 28.5 per cent of the 227 million tonnes of municipal waste generated in the US was paper and **paperboard**[14].

The proportion of virgin wood fibre that needs to be added at each recycling stage depends on the product quality requirements, for example, virgin wood fibres tend to be stronger, longer and produce whiter paper than those that have been recycled several times. Technologies are under development for a very short wood fibre that can be used even beyond the seven uses shown below.

The many lives of a wood fibre



THE DEMAND FOR WOOD PRODUCTS

The Living Forests Model projects significant growth in wood removals to meet rising demand for wood products.

In 2010, global reported wood removals[15] amounted to 3.4 billion m³. Total removals were undoubtedly higher due to illegal or unreported wood harvesting, especially fuelwood. Of the reported harvest, 1.5 billion m³ was used as industrial roundwood and the rest for fuelwood[16].

The Living Forests Model (see figure) projects annual wood removals in 2050 will be three times the volume reported for 2010. The projection includes steadily growing demand for solid wood and paper products between now and 2050 in emerging markets. However, a projected massive escalation in use of wood as a feedstock for bioenergy is the main driver of rising demand. The Living Forests Model projects that by 2050, annual demand for **energy wood** (woody biomass that is not used for household fuelwood or the production of wood-based products) alone will exceed 6 billion m³ under the **Do Nothing scenario** and 8 billion m³ under the **Bioenergy Plus scenario** (the latter projection is more than double the total reported wood removals in 2010)[17].

The Living Forests Model projections are based on certain assumptions, and should not be read as an attempt to forecast the future, given the many uncertainties that will affect future demand and supply. For example, the model does not attempt to factor in potential, but currently unknown, uses of wood spurred by future technological innovation, nor does it assume dramatic shifts in consumption patterns or recycling rates. However, the model does highlight the likelihood of steady growth in overall volume of virgin wood for products and the potential for dramatic growth in the volume of wood harvested for use as energy "and to reach ambitious carbon mitigation targets under the Bioenergy Plus scenario[18].

	FAO 2010	LIVING FORESTS MODEL 2030		2050	
		Do Nothing	Bioenergy Plus	Do Nothing	Bioenergy Plus
Saw logs & veneer logs	853	1,444	1,444	1,763	1,773
Pulpwood*	527	754	754	905	893
Other industrial roundwood[19]	153	153	153	153	153
Energy wood	1,868	2,753	3,138	6,317	8,209
Household fuelwood		2,064	2,064	2,218	2,054
Total wood supply	**3,401**	**7,168**	**7,553**	**11,356**	**13,082**

Units: millions of cubic metres (roundwood equivalent)

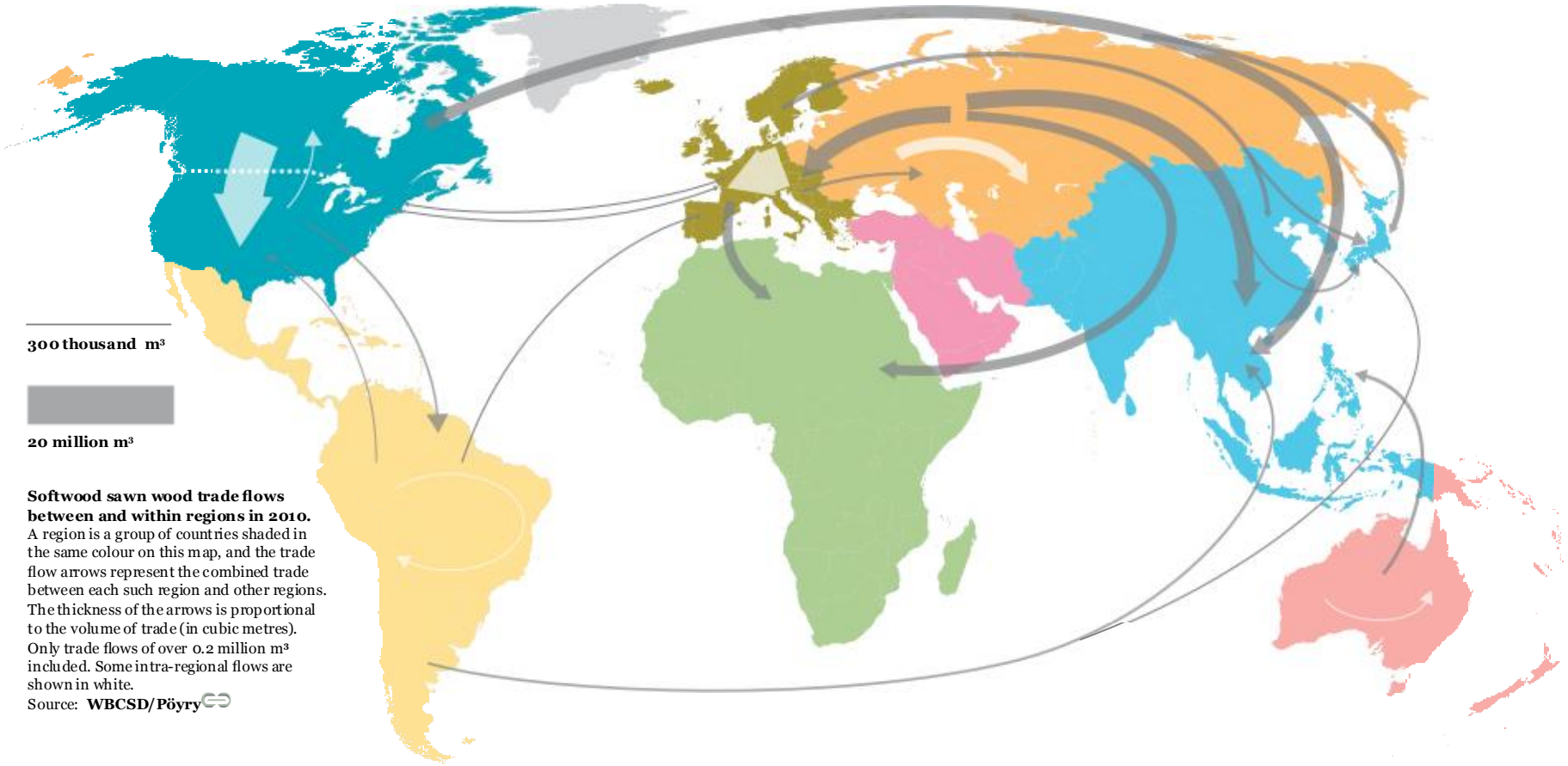
Projected annual rate of wood removals in 2030 and 2050 under the Living Forests Model's Do Nothing and Bioenergy Plus scenarios compared to FAO statistics on reported wood removals in 2010. Source: FAO (2010 figures20) and IIASA (2030 and 2050 projections)

* Pulpwood does not include offcuts and sawdust from saw logs that are used in significant amounts in pulp production.

TRADE IN SAWN WOOD AND PANEL PRODUCTS

The major regions importing sawn wood and panels are Asia, North America and Western Europe, although Africa and the Middle East are fast emerging as major destinations.

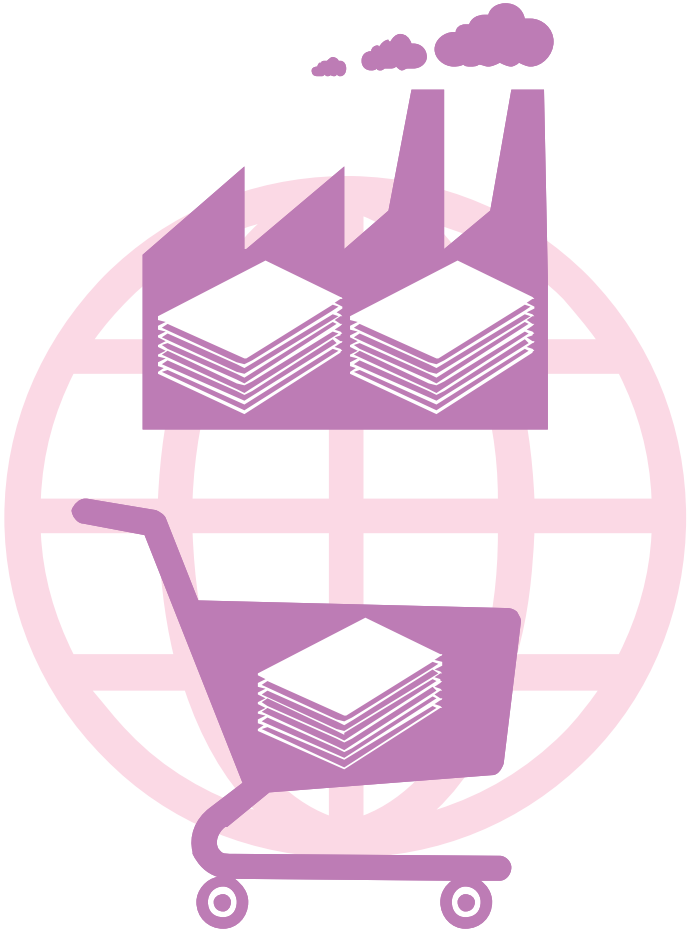
The increased demand for sawn wood and panels could compound the pressure on forests in WWF priority places such as the Amazon and Guianas, Chocó-Darién, Sumatra, Atlantic Forests, Altai-Sayan Montane Forests, Borneo, Mekong Complex, Southwest Australia, Congo Basin, Amur-Heilong, Yangtze Basin, Southern Chile, Coastal East Africa and the Mediterranean.



Softwood sawn wood trade flows between and within regions in 2010.
A region is a group of countries shaded in the same colour on this map, and the trade flow arrows represent the combined trade between each such region and other regions. The thickness of the arrows is proportional to the volume of trade (in cubic metres). Only trade flows of over 0.2 million m³ included. Some intra-regional flows are shown in white.
Source: **WBCSD/Pöyry**

WHERE IS PAPER MADE AND CONSUMED?

Around 40 per cent of the annual industrial wood harvest is processed to make paper and paperboard.



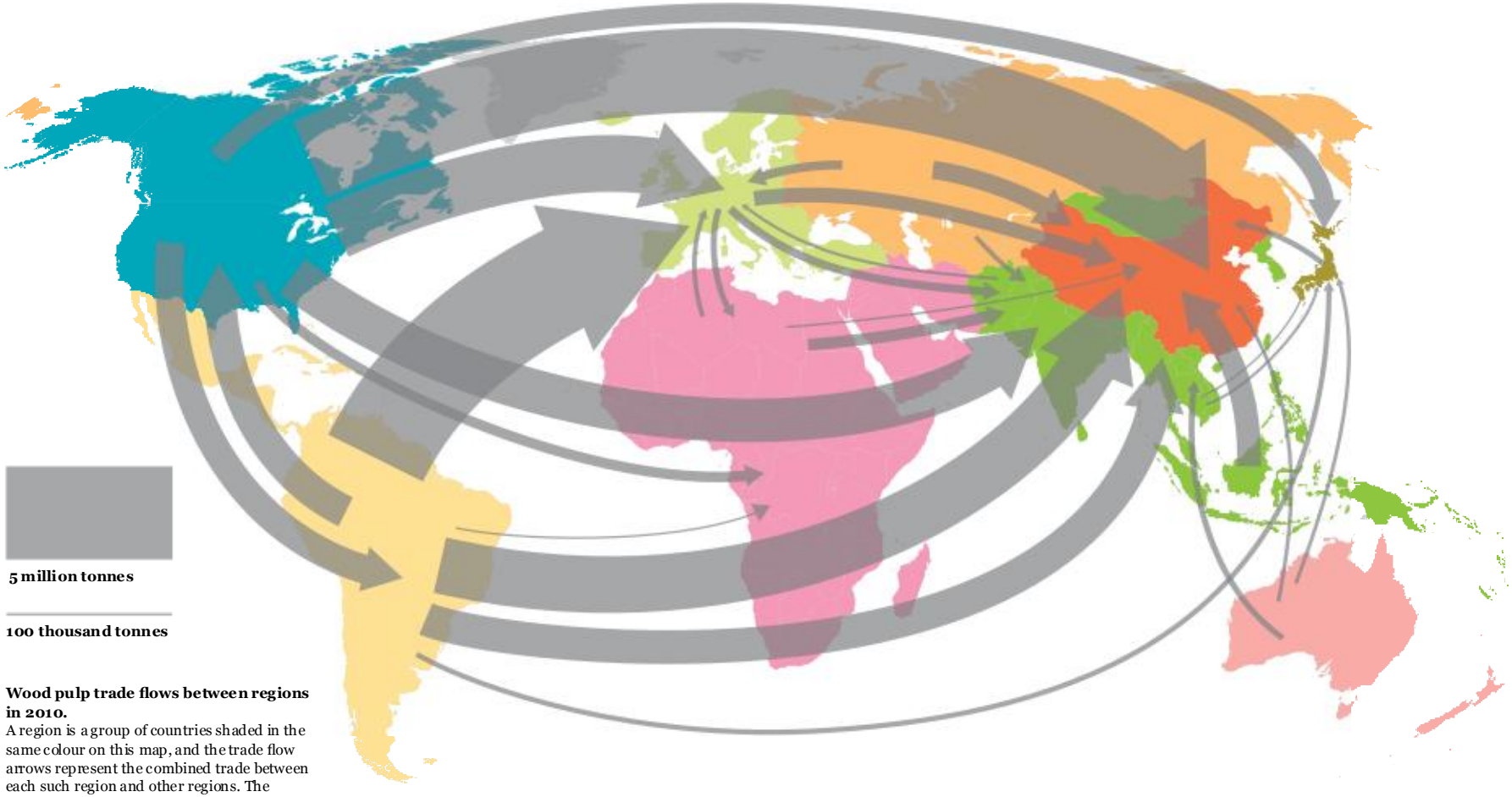
The volume of wood used in this production has doubled since the 1960s. Paper and paperboard production has increased fourfold in the same period, through increased wood harvest and use of **recovered paper**[21].

As shown in Figure A, Page 12, the main paper consuming countries/regions are China, the US, Japan and Europe (mainly Germany, Italy, UK, France)[22]. While China appears to be consuming most of its paper production, this statistic masks that as much as a quarter is exported as packaging for manufactured goods and in finished products that use paper (e.g., in instruction manuals)[23]. Most analysts anticipate a continuing shift in trade patterns due to faster-growing demand in emerging markets. The highest long-term demand growth for paper is expected in packaging (wrapping paper, containers and cartons) and tissue[24]. Demand for printing and writing papers has lower expected growth – even declining in some regions, leading to a lower net demand for wood pulp in North America, Japan and Western Europe.

Trade in **market pulp** is growing steadily as more paper products are produced away from the wood supply. This is associated with a trend to locate paper mills closer to the end customer (for example, to supply specialized products tailored to the buyer's needs) or in countries with comparative advantage in manufacturing (e.g., China).

The increased demand for virgin wood fibre for pulp and paper and the related wood pulp trade (see map on next page) could compound the pressure on forests in WWF priority places such as Sumatra, New Guinea, Southern Chile, Amur-Heilong, Altai-Sayan, Chocó-Darién, Atlantic Forests and Borneo.

GLOBAL WOOD PULP TRADE FLOW



Wood pulp trade flows between regions in 2010.
A region is a group of countries shaded in the same colour on this map, and the trade flow arrows represent the combined trade between each such region and other regions. The thickness of the arrows is proportional to the volume of trade (in tonnes). Intra-regional flows and flows below 100,000 tonnes are excluded.
Source: **WBCSD/Pöyry**

PAPER CONSUMPTION AND PRODUCTION

In 2009, China (24 per cent) and the US (19 per cent) were the world's biggest paper and paperboard producers[25]. North America and the Nordic countries have built very few new production lines in the past 15-20 years and will decrease production in the future, while Asia's production is expected to increase (see figure A). According to WBCSD/Pöyry estimates[26], the main paper-producing region in 2025 (see figure B) will be Asia ahead of North America and Western Europe. Increased demand for wood pulp and recovered paper is projected in China, the rest of Asia, Eastern Europe and Latin America.

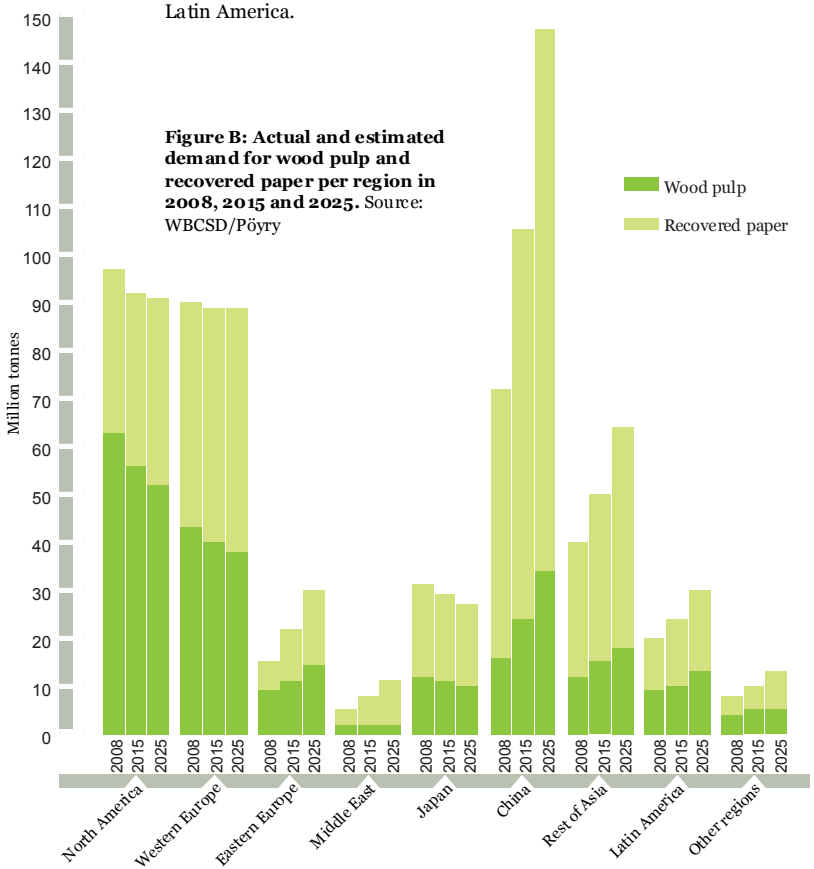


Figure B: Actual and estimated demand for wood pulp and recovered paper per region in 2008, 2015 and 2025. Source: WBCSD/Pöyry

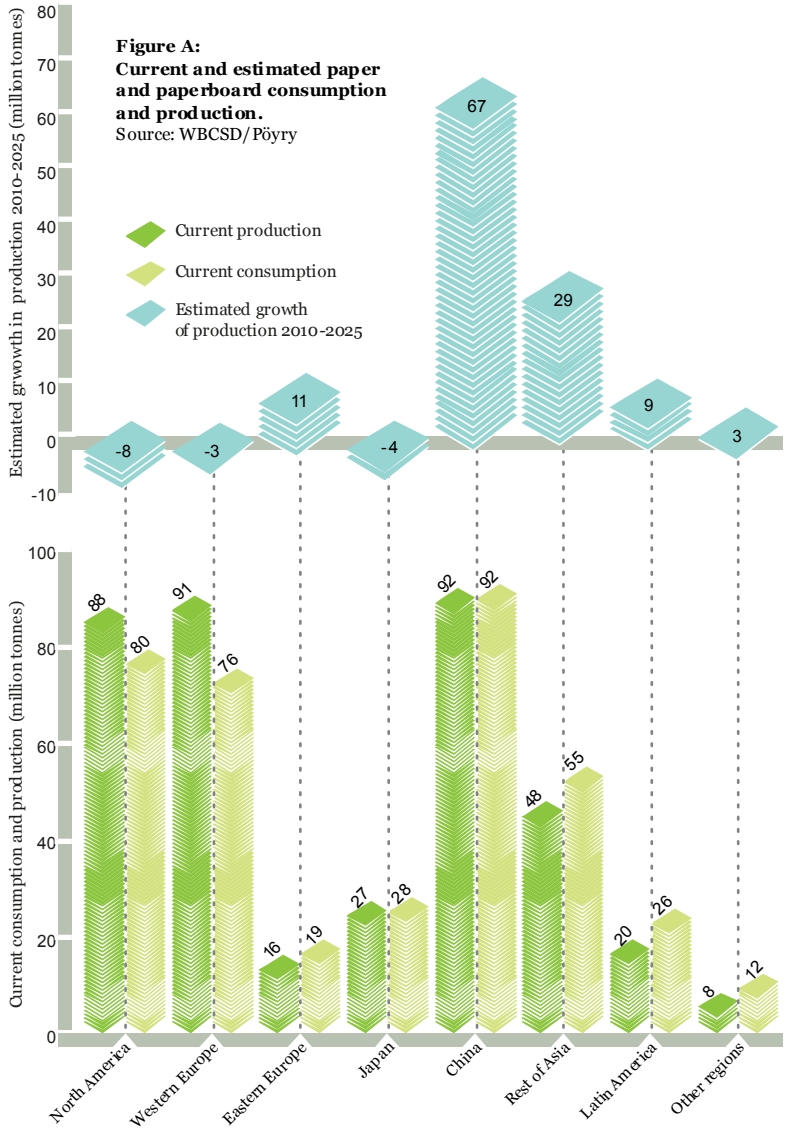


Figure A: Current and estimated paper and paperboard consumption and production. Source: WBCSD/Pöyry

TALKING POINT: AN INDUSTRY VIEW

Paper produced from a certified forest in Sweden.

The forest industry has a long history of change and expansion, from papyrus to Gutenberg and modern paper machines and bio-refineries. It now stands before another period of change and transition. There are three main foundations for the success of this change: sustainable management of a renewable raw material in natural forests and plantations; new processes and technologies; and, finally, new types of bio-based products for the consumer.

In sustainable forest management, consistent work in developing methods, equipment and certification for forests in all corners of the world is bearing fruit. The integration of new harvesting technology, new models for plantation forestry, new programmes to extend the use of environmental best practices, new ways of addressing social issues and the assurance, education and technology transfer benefits of independent certification are bringing results with accelerating speed – in conserving biodiversity, for instance.
New technologies are being developed by the industry and equipment manufacturers, including more material- and energy-efficient processes and advances such as nanotech coating, new pulping methods, and engineered wood building systems. This increasingly happens in cooperation with the end product part of the chain. The new high-tech wood-based solutions will leave a significantly lower ecological footprint than alternative materials.

In new products, the industry enters even deeper into the consumer's day-to-day with bio-based materials, biofuels and bio-based chemicals, leading to new alliances. Among others, the automotive, pharmaceutical, cosmetics, textiles, electronics and food sectors are becoming a closer part of the forest industry's network.

The forest-based industry is central to a new low-carbon economy. Wood-based products can substitute for many less sustainable, non-renewable alternatives. Forests represent the best investment option for large-scale carbon storage.

Sustainable forest management is the key strategy for producing more fibre. Innovation, including through biotechnology, will also be essential for expanding the sustainable supply of biomass in a resource-limited world. Using this fibre wisely as a foundation of a bio-based economy is a significant sustainable development opportunity.

All in all, the forest industry is embracing this change as an opportunity. In an age of resource scarcity, its sustainable, renewable, material-efficient products are ideally placed to satisfy the needs at the heart of the consumer's daily life.

Jose Luciano Penido, Chairman, Fibria and Riikka Joukio, Senior Vice President, Metsa Group; Co-chairs, WBCSD Forest Solutions Group

IMPACT OF RECYCLING ON OVERALL DEMAND FOR WOOD

Increasing the proportion of recycled material in wood products can reduce demand for virgin wood fibre and increase the net value of wood.

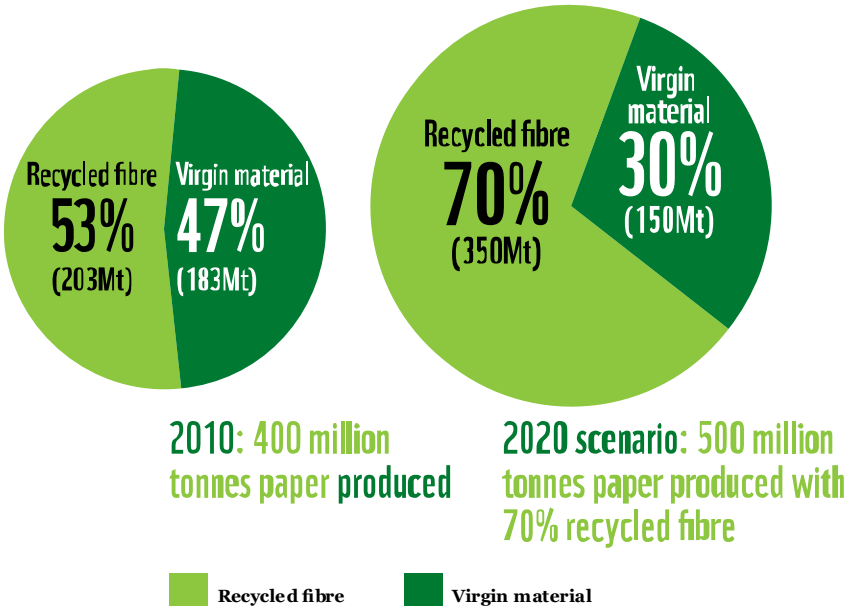
Use of material other than virgin wood fibre for the production of sawn wood, panels and paper increased from 21 per cent of total fibre use in 1990 to 37 per cent in 2010 and is projected to reach almost 45 per cent in 2030[27]. Recovered paper is the largest source, then **non-wood fibre**, but collection of waste wood products (demolition waste, used furniture, etc.) is increasing rapidly, as is use of recycled wood in board production.

In 2010, recovered paper comprised 53 per cent of the fibre used in global paper production, increasing from 43 per cent in 2000[28]. Virgin fibres make up the other 47 per cent, including 4.7 per cent from non-wood sources (e.g., bamboo, agricultural residues, etc.)[29]. Non-wood fibres are used extensively in India, for example, and if sourced from sustainably managed areas could help reduce the footprint on forests.

Paper recovery and use vary greatly between countries. China alone imported 50 per cent of the recovered paper that was internationally traded in 2009[30]. Recovered paper use will further grow in the future. A scenario developed by Voith[31] (see figure) indicates that even with higher global paper consumption, demand for virgin material (both wood and non-wood) would drop if global use of recovered paper increased. In theory, this would reduce the share of the world's forests and land that needs to be allocated to fibre production for the paper industry.

Increased recycling involves sorting and separating paper products from other waste. A **recovery rate** of 90 per cent was reached by South Korea in 2009. Efforts to increase recycling are likely to have the greatest impact on the overall footprint of the paper industry if targeted at countries with low recovery rates and increasing consumption; reducing the distance that recovered paper is transported for recycling would also have a significant effect.

Producing more paper with less virgin material



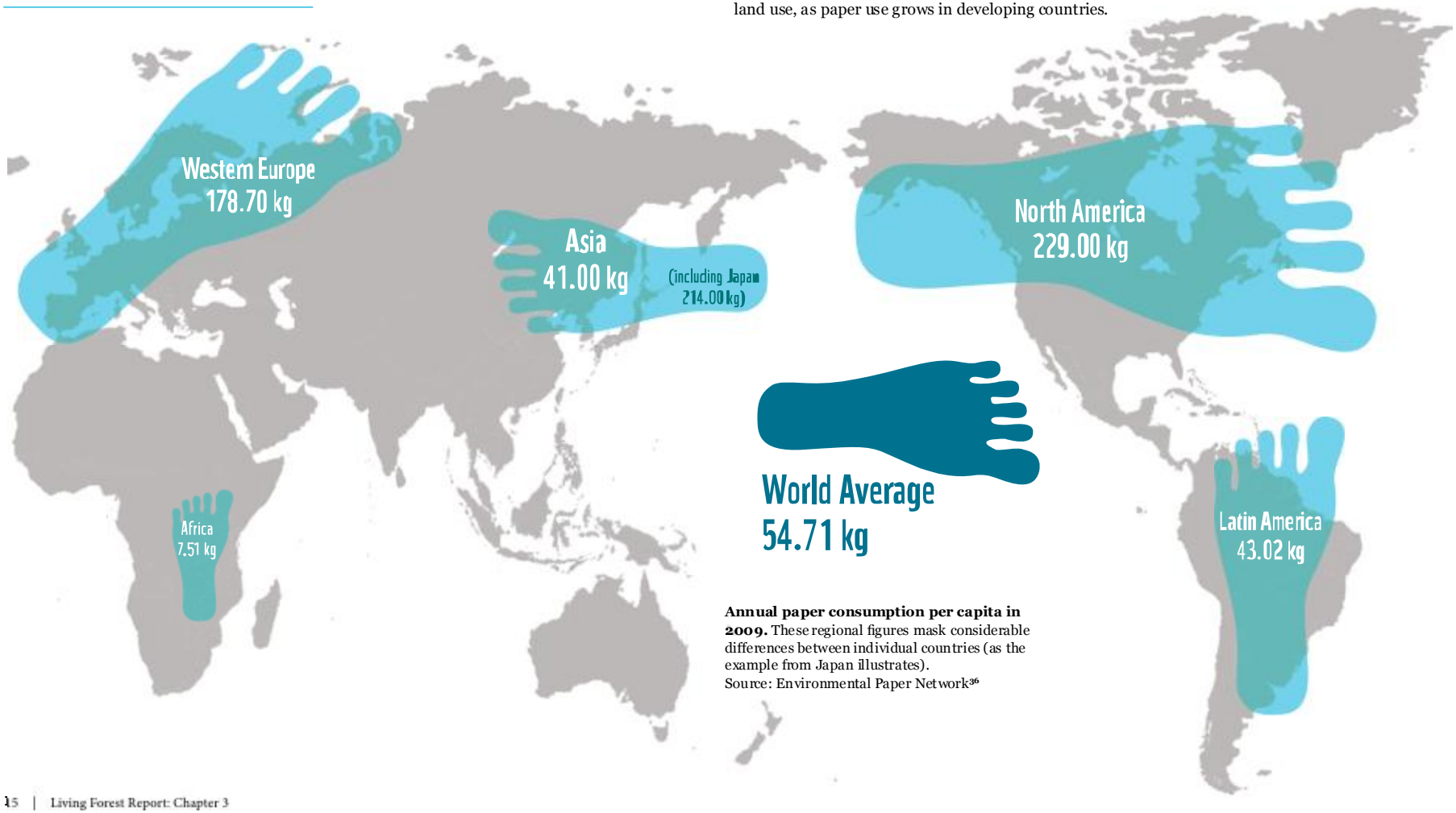
Increased paper recycling and improved paper-making technologies could reduce the demand for virgin material by 2020. The ratio of different fibre sources (in % and volume) for worldwide production in 2010 (source: FAO[33]) and under a scenario for the year 2020 (source: Voith[34]).

Trends in the mix of paper products consumed will affect the prospects for increased recycling. **Recycled fibres** make up almost 80 per cent of fibre in **container boards**, but barely 10 per cent of fine printing paper, for instance. Consumer preferences are another key factor. For example, increased consumer demand for recycled content could erode the market for pure-white tissues, motivating the makers of these throwaway products to use more recycled fibre – today's global average for recycled fibre in tissue products is 50 per cent[32].

PAPER CONSUMPTION PATTERNS

Rich societies can reduce wasteful paper use, while the poor need more paper for education, hygiene and food safety.

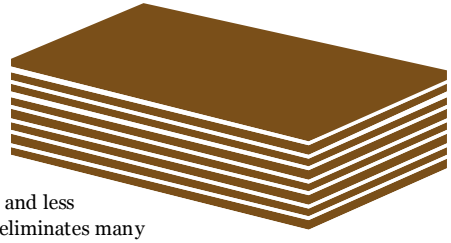
Today, 10 per cent of the world's population consumes over 50 per cent of the paper[35]. This is hardly fair – paper is an important means to share knowledge and express ideas, improve sanitation and keep food safe. A 10 per cent reduction in paper and paperboard consumption in North America and Europe would match one year's consumption in Africa and South America combined. Reducing wasteful consumption, like over-printing or over-packaging, would also ease the pressure on forests and land use, as paper use grows in developing countries.



Annual paper consumption per capita in 2009. These regional figures mask considerable differences between individual countries (as the example from Japan illustrates).
Source: Environmental Paper Network[36]

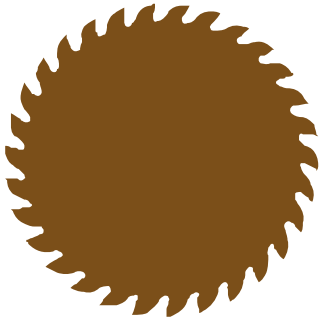
MORE PRODUCTS FROM LESS WOOD

In addition to increased recycling, more efficient processing and manufacturing can help reduce pressure to extract more wood from forests.



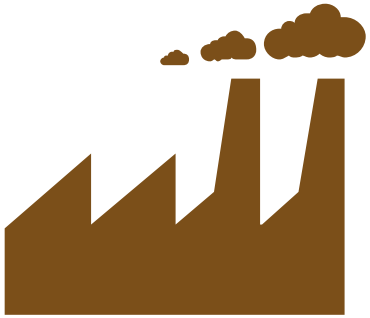
Changing technologies

Engineered wood products make very efficient use of a given volume of wood and can be manufactured from fast-growing, underutilized and less expensive wood species. Engineered wood also eliminates many defects found naturally in wood, improving the material's inherent structural advantages. By-products from other production processes – small chips or unusable pieces of wood – can increasingly be used in composites and pulp. In the paper industry, new product designs and advances in engineering offer the prospect of near limitless reuse of short, recycled fibres.



Sawmills

On average sawmills operate at around 50 per cent efficiency[37]: in other words, only half the saw log is converted to sawn wood. In Europe and North America some mills reach above 70 per cent efficiency. Many mills are able to send their sawdust and off-cuts for further processing, such as the manufacture of panel products, but this is not always the case. While challenges vary regionally (tropical sawmills, for example, deal with a larger variety of log sizes and species), greater efficiency is possible through better logging and log grading systems, infrastructure and sawing technology. A 10 per cent increase in milling efficiency for tropical sawn wood could reduce global demand for saw logs by 100-200 million m^3 per year[38]. Increased efficiencies in small sawmills will increase profitability, benefiting local communities.



Pulp and paper mills

Ongoing innovation is enabling more efficiency in pulp and paper mills. New processing technologies mean more cellulose fibres can be extracted from a given volume of wood and less left to be burned. Smart use of mineral additives in paper, and better-engineered packaging (thinner but stronger), allow more units to be produced from the same volume of pulp. Increasingly mills can be seen as "bio-refineries" with by-products used to substitute oil from fossil fuels in materials such as polylactic acid.

Use of non-wood fibre

Other plant-based materials can supplement the use of wood fibre in many product lines: these include paper made from bamboo fibre or residues from food crops and furniture made from rattan. The relative efficiency and environmental impact of these other plant fibres will vary with the circumstances in which they are grown, sourced and processed and the fibre properties they bring to the end product.

OPTIONS FOR INCREASING WOOD PRODUCTION

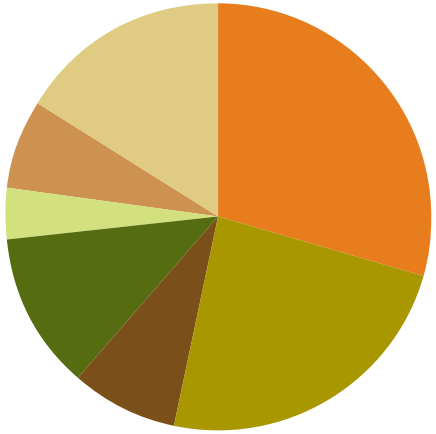
Higher demand for wood could be supplied from new plantations and by extracting more from natural forests.

The Living Forests Model projects a significant increase in wood demand (including as a feedstock for bioenergy) over the coming decades, even with increased recycling, reuse and efficiency. According to the model, this demand can be met by a combination of enlarging the portion of the world's natural forests that is managed for production, and establishing new tree plantations.

According to statistics collected by the FAO, almost 1.2 billion hectares of forest (or 30 per cent of the total forested area) are currently designated primarily for the production of wood and NTFPs with an additional 949 million hectares (24 per cent) designated for multiple uses – usually including some extraction of wood and NTFPs (see pie chart). Worldwide over 60 per cent of the growing stock in the production forest area consists of commercial species (ranging from over 90 per cent in Europe to just 20 per cent in Africa), though not all are of harvestable size or in areas available for wood supply[39].

In 2010, the world's estimated **growing stock** of wood totalled 527 billion m^3 in all forests and plantations and 15 billion m^3 in other wooded land[40]. This has decreased slightly in the last 20 years due to net forest loss, but growing stock per hectare has increased[41]. Over 165 billion m^3 of growing stock (nearly one third of the global total) is in areas zoned for production (natural forests and plantations) or multiple use[42].

Reported global wood removals in 2010 amounted to 3.4 billion m^3, of which about half were industrial roundwood (1.533 billion m^3) and half fuelwood[43]. That means total wood removals were less than 1 per cent of the world's growing stock, and industrial roundwood removals comprised about 1 per cent of the growing stock in production and multiple-use forests. This suggests there is no shortage of wood in the world's forests; however, the sustainability of extracting more depends on many local variables in community aspirations, ecology and forest management practices. Already, high-value species (such as mahogany, merbau, Chinese oak and ramin) and large saw logs are in short supply in some regions[44].



Global forest functions in 2010.
Source: FAO

Figures do not add to 100% due to rounding

Production	30%
Multiple use	24%
Protection of soil and water	8%
Conservation of biodiversity	12%
Social services	4%
Other	7%
Unknown	16%

SHOULD MORE NATURAL FOREST BE OPENED UP TO COMMERCIAL HARVESTING?

To supply more wood, natural forests can either be logged more heavily or logged lightly over a larger area.

Depending on the scenario, the Living Forests Model projects that between 242 million and 304 million additional hectares of natural forest outside protected areas would need to be managed for commercial harvesting by 2050[46]. The scenarios assume that demand for wood beyond the volumes sourced from plantations will come from well-managed natural forests, and project an expansion of up to 25 per cent above the current area of natural forest used for commercial wood production.

The environmental and social impact of any new logging concession or tree plantation will vary according to local context, management practices, safeguards applied and how revenues are distributed. This makes it difficult to draw blanket conclusions about the respective merits of expanding production in natural forests or more plantations as a means of increasing the global supply of wood.

Similarly, there is no simple verdict on whether it is better to log natural forests more heavily in a smaller area or conduct a lighter form of logging over a larger area. The options will be defined by restrictions under local laws or voluntary sustainability standards, and by what is economically viable. The optimal balance between protection and exploitation of forests is hotly contested from ideological and scientific standpoints. Debates rage over the impacts of logging on forest carbon[47] and studies have reached sharply differing conclusions on the biodiversity impacts of logging in tropical forests[48,49]. One recent study concluded that the economic forces behind industrial logging regimes are several hundred years out of synchronization with the natural cycles of forests[50]. In addition, increased harvesting, particularly of previously undisturbed boreal forests, would likely lead to a major release of carbon, largely from peat deposits[51].

Not all the natural forests currently designated for production are commercially viable, while others are being "mined" by over-harvesting or destructive logging. Optimizing yield from the total area designated as production forest will require some changes in the location and configuration of this area and assumes robust land-use planning. For example, heavily degraded production forests that are no longer commercially viable could be rezoned for other uses that would enable their restoration and regeneration.

SUSTAINABLE WOOD EXTRACTION AS A FOREST CONSERVATION STRATEGY

Forest stewardship, motivated by a commercial interest in maintaining wood supply, can help protect vulnerable forests from illegal logging, encroachment or conversion to farmland.

The market for wood can motivate good forest stewardship that safeguards a critical resource and protects forest values; or it can destroy the very places where wood grows.

Production forests play a crucial role in maintaining global climate, economic development and biodiversity conservation. They provide vital buffers for, and links between, protected areas. However, the capacity of production forests to provide ecosystem services and sustain timber yields varies greatly depending on how well they are managed and the values protected in the surrounding land-use mosaic. For example, poorly planned selective logging results in waste of harvested wood, unnecessary damage to residual trees and soil, and large canopy gaps that disrupt forest ecology and increase the risk of fire. The Tropical Forest Foundation suggests that 50 per cent less damage to remaining trees during logging operations would increase productivity on a given land base by 20 per cent[52].

The pursuit of conservation objectives in a forest managed for timber production may mean less wood is removed in each harvesting cycle, reducing revenues in the short term. Yet less intensive forms of logging and the creation of "set-asides" can also help maintain the longer-term productivity of the forest by sustaining ecological, carbon, nutrient and water cycles and decreasing vulnerability of tree species to disease and fire.

However, a forest manager may need to achieve a certain threshold of wood extraction per hectare to make the implementation of environmental and social safeguards viable or to compete with a possible alternative land-use that would require the forest to be cleared. For this reason, conservationists are often supportive of efforts to develop new markets for lesser-known tropical timber species. Cameroon, for instance, has an estimated 630 tree species of actual or potential commercial value, of which over 500 are scarcely used at all[53]. In such circumstances, improved markets for lesser-known species might help make responsible forest management viable. This is a double-edged strategy though, as more commercial species may make illegal logging more alluring in regions where governance is weak or encourage the expansion of logging into pristine forest areas.

Another way of making sound forest stewardship more viable is the creation of new market mechanisms (e.g., REDD+) to pay forest managers for environmental services provided. This may motivate management practices that are more sustainable than an operation seeking to maximize timber yields as its only revenue stream. Some stakeholders, however, oppose use of such funds for commercial forestry[27].

Management plans with environmental safeguards – an essential stepping stone?

The area of tropical natural forest currently used for wood production that is covered by management plans increased by about 35 million hectares between 2005 and 2010, to an estimated 131 million hectares[55]. The gap between forests with no management plan and those under responsible management is huge. While the growth in areas with a plan is a promising sign, the areas without management plans (roughly two-thirds of the 400 million or so hectares of production forest in the tropics) remain vulnerable to degradation or deforestation.

TALKING POINT: A RIGHTS AND RESOURCES VIEW

Forest communities, indigenous peoples and smallholders manage a growing share of the world's forests, and an important share of forest products, services and employment. New rigorous research by the Rights and Resources Initiative analysing the world's most-forested developing countries makes clear that recognizing the rights of these stakeholders has strong social, economic and environmental benefits. It also shows that, globally, the area of forest recognized as owned or controlled by indigenous peoples and communities has increased from 10 per cent in 2002 to 15 per cent today; in the forests of developing countries it has increased from 21 per cent to 31 per cent (around 680 million hectares of forest lands). The 27 countries studied are home to 2.2 billion rural people and include 75 per cent of the developing world's forests. Secure local land rights are key to sustainable development – a global target set at the 1992 Earth Summit[56]. Legislation recognizing or strengthening land rights has also increased dramatically – with, for example, over 50 laws enacted since 1992. Adoption of the UN Declaration on the Rights of Indigenous Peoples (UNDRIP) in 2007 provided a new impetus, but major progress is still needed: 97 per cent of forest lands in Africa and 60 per cent in Latin America are still being contested.

Given secure tenure rights, many communities and smallholders become highly effective managers, reforesters and producers for high-quality export tropical timber, wood products for fast-growing domestic markets, NTFPs, and key environmental services including water and biodiversity conservation. Chhatre and Agarwal,[57] for example, link participation in community-owned forests to significantly lower carbon emissions in a sample of 80 forests in East Africa, South Asia and Latin America.

The developed world dynamics between private ownership and wood supply are also changing with demographics, reducing wood supply from some, and increasing it in others. Private forests in the USA contribute much more per hectare to GDP then public forests, and private forest owners in Europe have associated (e.g., through the International Family Forest Alliance (IFFA)) to supply changing wood markets, promote a next generation of owners and diversify the range of products and services their forests could provide.

Augusta Molnar, Rights and Resources Initiative

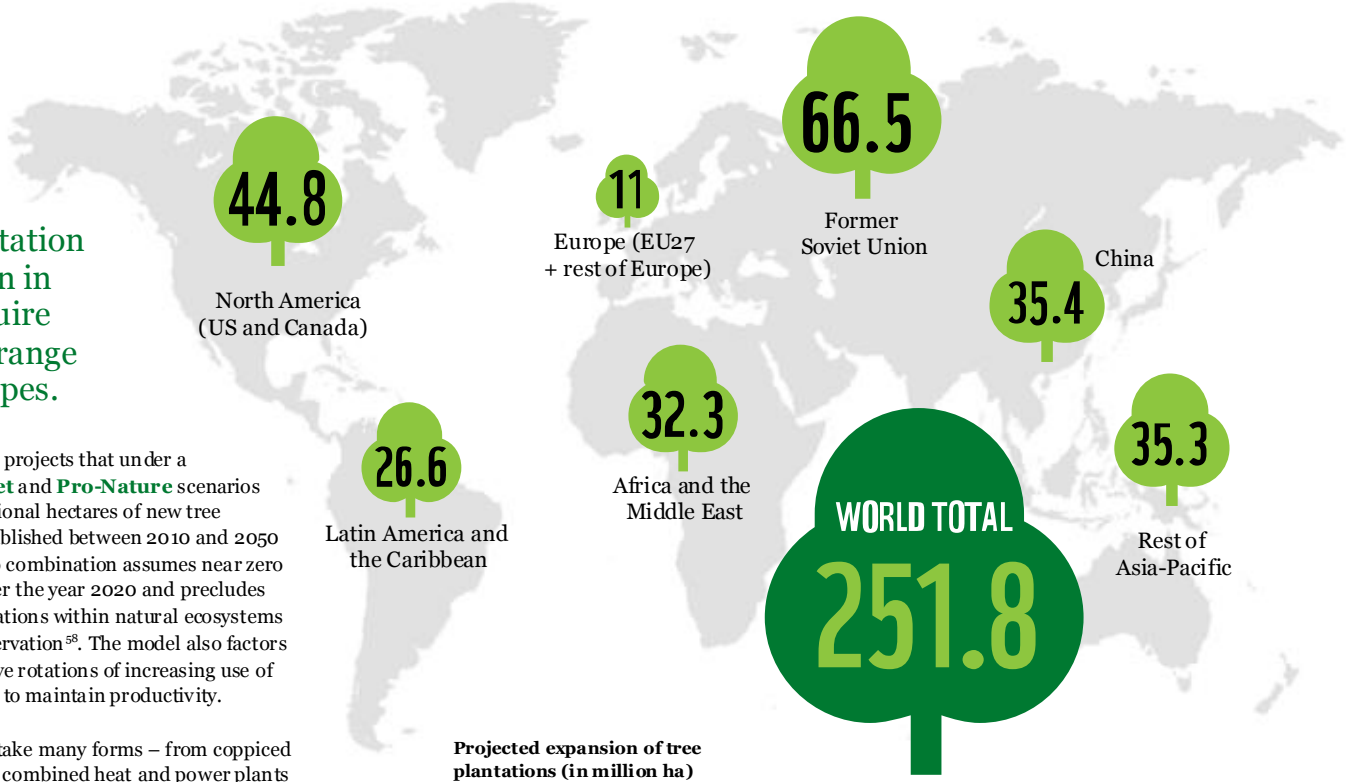
A child sitting in front of a recently felled tree on the edge of Virunga National Park, near the provincial capital of Goma in the Democratic Republic of Congo. Communities that depend on forest resources can be important allies in sustainable forest management.

THE ROLE OF TREE PLANTATIONS: 1

Ending deforestation and degradation in forests will require expansion of a range of plantation types.

The Living Forests Model projects that under a combination of the **Target** and **Pro-Nature** scenarios around 250 million additional hectares of new tree plantations would be established between 2010 and 2050 (see figure). This scenario combination assumes near zero loss of natural forests after the year 2020 and precludes the creation of new plantations within natural ecosystems in priority areas for conservation[58]. The model also factors in the costs over successive rotations of increasing use of fertilizer and pest control to maintain productivity.

These plantations would take many forms – from coppiced willow and poplar to feed combined heat and power plants in cooler northern regions, mixed plantations of native species for high quality timber products, or "fastwood" acacia and eucalyptus plantations nearer to the equator.



Projected expansion of tree plantations (in million ha) under the Living Forests Model's Target and Pro-Nature scenarios combined, by region between 2010 and 2050. Source: IIASA

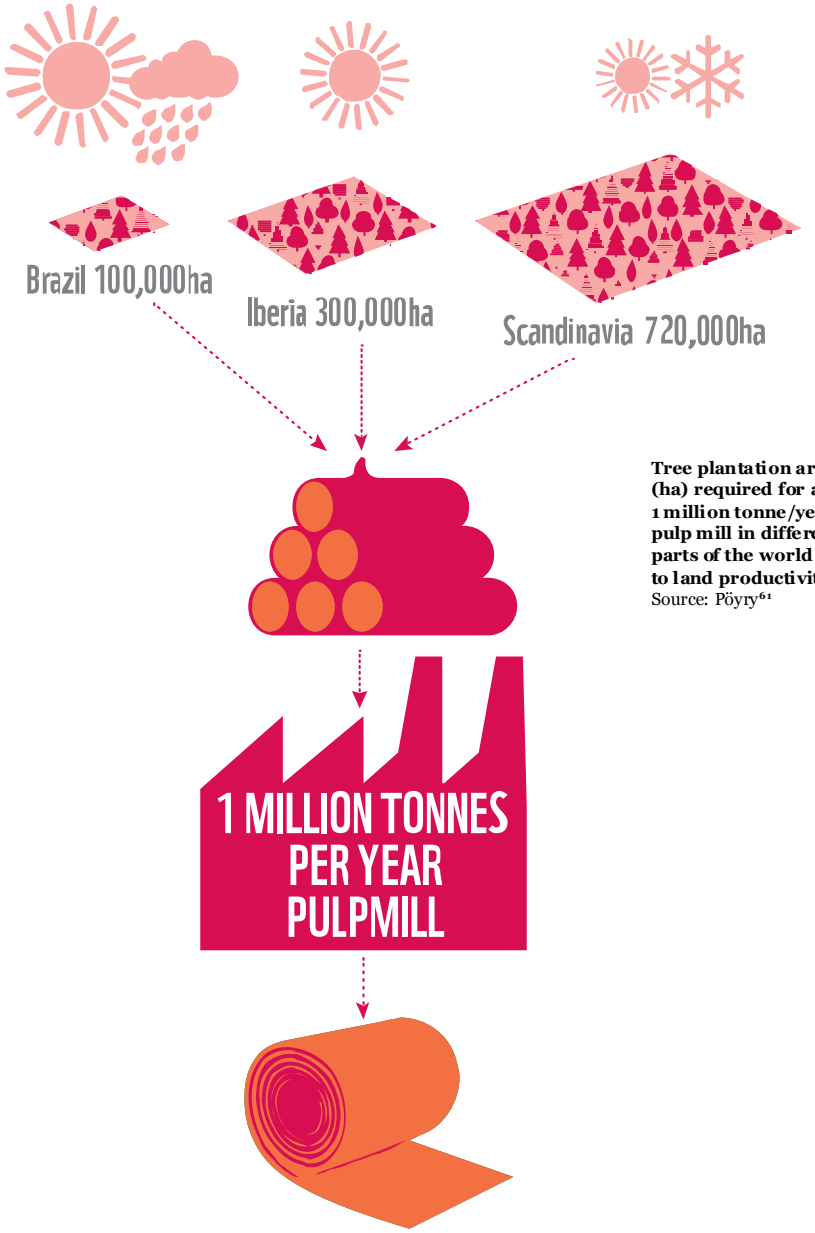
THE ROLE OF TREE PLANTATIONS: 2

In the right place and managed sustainably, tree plantations can reduce the pressure to bring natural forest areas into production.

Tree plantations made up only 7 per cent of total forest cover in 2006, but provided 50 per cent of industrial roundwood[59]. A growing proportion can be described as **intensively managed plantations**, with a rotation of 5 to 25 years. These supply around 40 per cent of plantation wood and their area has increased by 2 per cent per year since 2000, mostly in Asia, Oceania and South America[60]. They yield far more wood per hectare than natural forests, with the highest yields achieved close to the equator (see figure). Improvements in landscape planning and planting techniques could boost productivity even more.

Uncertainties remain, however, about the long-term impacts of tree plantations. Most intensively managed plantations are in their first or second rotation and are so new that long-term environmental impact studies are unavailable.

To realize the productivity benefits of plantations with positive rather than negative social and environmental impacts, further expansion of tree plantations should be focused on degraded land, while maintaining or restoring natural ecosystems in the surrounding landscape, safeguarding the rights and livelihoods of indigenous peoples and local communities, and promoting greater benefit-sharing.



Tree plantation area (ha) required for a 1 million tonne/year pulp mill in different parts of the world due to land productivity.
Source: Pöyry[61]

THE ROLE OF TREE PLANTATIONS: 3

Along with improved practices, advances in biotechnology could further boost plantation yields. But the precautionary principle[62] must be applied in deciding if and how they are deployed and such advances must first gain social acceptance.

The Living Forests Model assumes that future tree plantation yields will match the best yields achieved today for a given combination of climate variables and soil type[63]. However, in theory biotechnology, whether through conventional plant breeding or genetic modification, could improve plantation yields and reduce globally the portion of land that needs to be dedicated to wood production.

So far there has been very limited commercial deployment of genetically modified (GM) trees and no international consensus exists on the potential risks, benefits and ethics of GM technology (see box). Wherever GM organisms are proposed to be released into the environment, WWF advocates a strong precautionary approach with respect to environmental and social impacts and transparent monitoring for such impacts. National regulatory frameworks for environmental use and release of GM organisms (including field trials and commercialization) should support and implement the Cartagena Protocol on Biosafety.

GM trees

An extract from The Forests Dialogue Scoping Paper on GM Trees[67]

Gamborg and Sandøe[64] note "that if modern biotechnology is to stand a chance, three main conditions for public acceptance must be met: utility, low risk, and an assurance that the biotechnology is used in a decent way". But they also note that surveys suggest these are necessary but not sufficient conditions, and that "moral acceptability is a better predictor ... than risk or usefulness". Thus, a fundamental challenge for proponents of GM trees is to build public trust[65], in part by finding ways of demonstrating to members of civil society that GM trees satisfy these conditions and tests. Societies will continue to rely on technological advances, such as those offered by genetic modification[66]; conversely, as aspects of the agbiotech debate (amongst many others) illustrate, scientific advances do not necessarily or inherently confer legitimacy or gain social acceptance. More profound social processes are necessary to engender legitimacy and acceptance of scientific innovation for which the balance of potential benefits and risks is uncertain, and this applies to GM trees as to other such technologies.

WHERE IS NON-FOREST LAND POTENTIALLY AVAILABLE FOR NEW TREE PLANTATIONS OR RESTORATION OF NATURAL FORESTS?

In many regions there is potential to regain lost forest cover through mosaics of new plantations, natural forest restoration and responsible farming.

Map A (see next page) represents the maximum forest area the Earth could naturally support. Areas of existing tree cover are in dark green and currently non-forested areas, with the biophysical characteristics needed to make restoration of tree cover a possibility, are in light green. These are mainly areas where forests have been cleared since the last ice age, and currently comprise croplands, grasslands and degraded lands. Within these areas restoration of tree cover could take many forms – from ecological restoration for biodiversity objectives to **agroforestry** or intensively managed plantations.

Map B (see page 26) excludes current tree cover and shows the potential forest and tree plantation productivity in terms of expected mean annual increment of above-ground carbon in the potential areas for restoration of tree cover (light green areas in Map A) . The darker green areas are where restoration of tree cover would have greatest productivity. Depending on the purpose of the restoration, this would determine the speed at which carbon is sequestered, commercial timber is grown or habitat is restored.

WWF does not advocate the restoration of tree cover in all or most of the areas in Map B, which simply identifies areas with biophysical characteristics capable of supporting forests. A decision to restore tree cover in a specific place, for whatever purpose, must involve local stakeholders, respect the aspirations of local communities and recognize the right of indigenous peoples to give or withhold their free, prior and informed consent to activities that will affect their rights to their lands, territories and other resources[68]. The type of restoration is critical – restored natural forests, for example, will have higher biodiversity conservation value than single-species tree plantations.

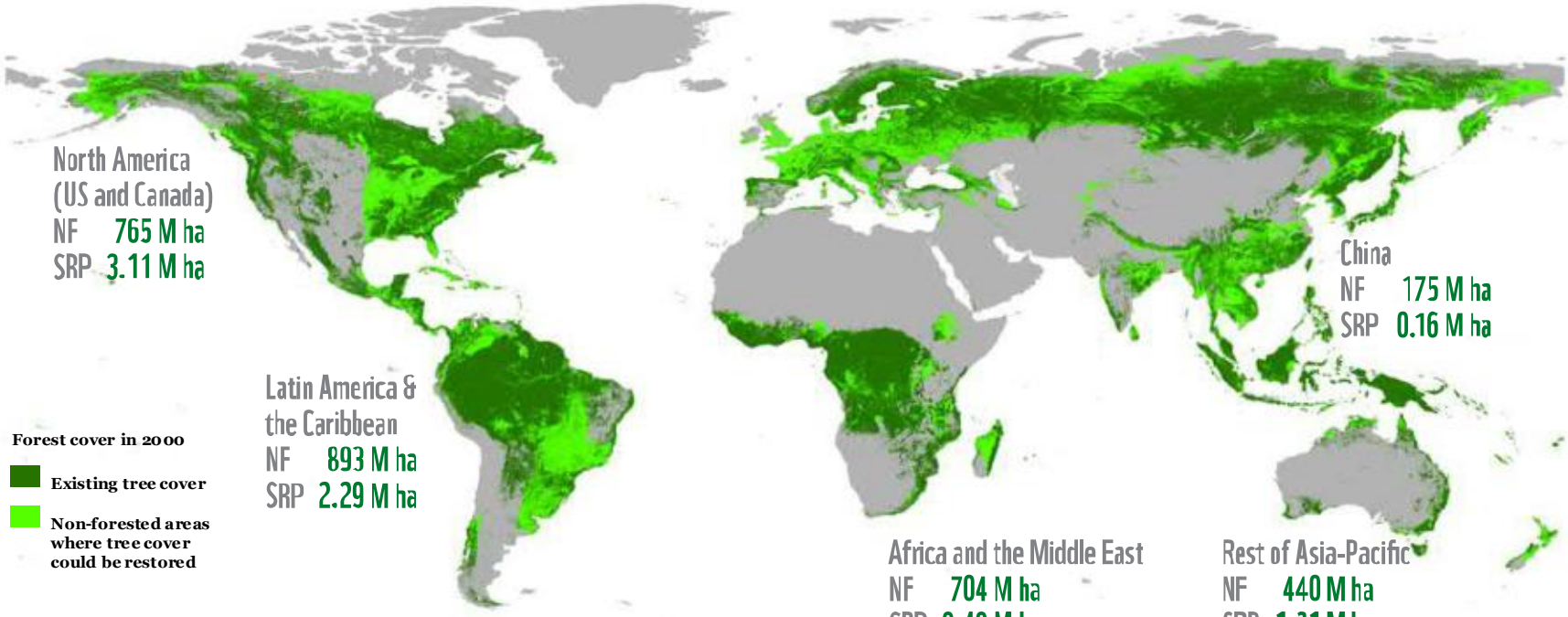
Depending on the circumstances, restoration of tree cover could enhance or conflict with food production. Allocation of land and water between crops, pastures, forests or tree plantations will ultimately depend on global consumption patterns and public sector policies around food, water and energy security. Changes in food consumption patterns (such as those outlined in the **Diet Shift scenario**[69]) will determine how much land with potential for restoration of tree cover could be taken out of food production without creating food shortages.

Many of the potential restoration areas overlap WWF's Global 200 ecoregions, a representative sample of biomes and habitat types where conservation would achieve the goal of saving most life on Earth. Sustainable land-use mosaics and restoration of forest cover are critical components of strategies to enhance ecological integrity and conserve biodiversity in many of these ecoregions.

GLOBAL POTENTIAL TREE COVER

World Totals

Natural Forest (NF) 4,347 M ha (million hectares)
Short rotation plantations (SRP) 7.29 M ha



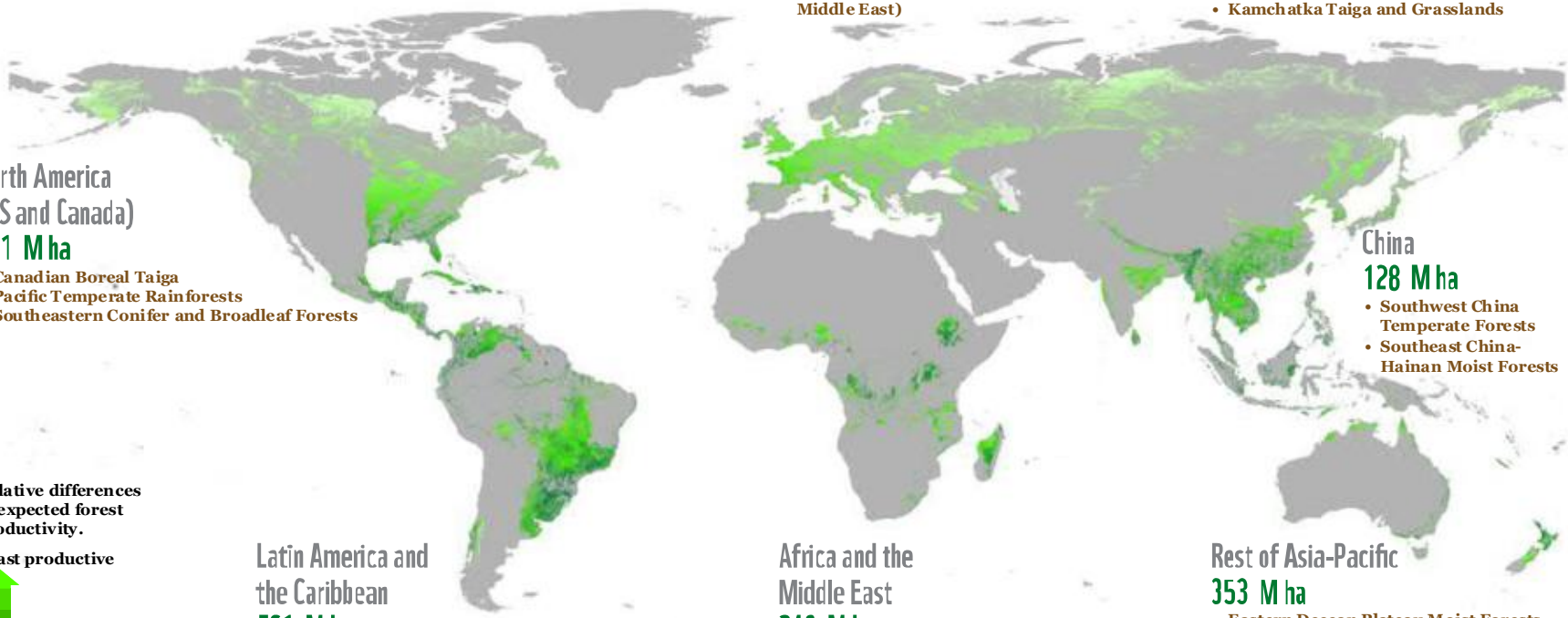
Map A: Global potential tree cover map. The Global Land Cover 2000 map was used to identify existing tree cover (dark green). The IIASA G4M biophysical model was used to identify areas where forests could occur (light green). The latter are non-forested areas with the biophysical characteristics needed to make restoration of tree cover a possibility)[70]. This is based on climate variables (temperature and precipitation) and soil characteristics from the Harmonized World Soil database.

COVER 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 Glossary/Acronyms References & Endnotes Acknowledgements Back Cover

POTENTIAL AREAS FOR RESTORATION OF TREE COVER

Map B: Potential areas for restoration of tree cover. This builds from Map A by excluding existing tree cover. Within the potential areas for restoration of forest tree cover, the map shows potential forest productivity, in terms of expected mean annual increment (MAI) of above-ground carbon. The green shading indicates relative differences in expected productivity. Areas named in brown are examples of WWF Global 200 ecoregions with strong potential for restoration of tree cover.

World 2,155 Million Hectares (M ha)



North America (US and Canada)
281 M ha
- Canadian Boreal Taiga
- Pacific Temperate Rainforests
- Southeastern Conifer and Broadleaf Forests

Europe (EU 27 + rest of Europe)
183 M ha
- European-Mediterranean Montane Forests
- Mediterranean Forests, Woodlands and Scrub (extends into Africa and the Middle East)

Former Soviet Union
401 M ha
- Altai-Sayan Montane Forests (extends into China and Mongolia)
- Central and Eastern Siberian Taiga
- Kamchatka Taiga and Grasslands

China
128 M ha
- Southwest China Temperate Forests
- Southeast China-Hainan Moist Forests

Relative differences in expected forest productivity.

Least productive

Most productive

Latin America and the Caribbean
561 M ha
- Atlantic Forests
- Cerrado Woodlands and Savannas
- Northern Andean Montane Forests

Africa and the Middle East
248 M ha
- Ethiopian Highlands
- Madagascar Dry Forests
- Madagascar Forests and Shrublands

Rest of Asia-Pacific
353 M ha
- Eastern Deccan Plateau Moist Forests
- Indochina Dry Forests
- Naga-Manapuri-Chin Hills Moist Forests
- Northern Indochina Subtropical Moist Forests (extends into China)

TALKING POINT: THE FAO'S VIEW ON PLANTED FORESTS

This pine nursery is part of a timber cooperative in Oaxaca, Mexico.

Planted forests can be environmentally sound sources of renewable energy and industrial raw material. Covering 264 million hectares worldwide they can support rural livelihoods, help communities raise their standard of living, and advance sustainable development. Planted forests contribute to maintaining ecological processes, to mitigating climate change, and to restoring degraded lands. In many countries they have emerged as a substantial component of natural resource use and will continue to become an increasingly important part of the landscape, given their critical significance for local economies, forest industry and products, energy and the environment.

FAO will continue to support developing countries in their efforts towards sustainable management of planted forests as documented in the Voluntary Guidelines for Responsible Management of Planted Forests. FAO further adopts an important role in facilitating an informed public debate about the controversy of planted forests and in supporting major stakeholder groups, including the public, to better understand the role of planted forests in integrated ecosystem management and sustainable development.

Dr Walter Kollert, FAO Forestry Department

HALTING ILLEGAL LOGGING

Although the illegal trade remains on a massive scale, solutions to this problem are emerging.

Improved enforcement of forest laws and increasing regulation of trade in wood products is helping reduce illegal logging. Research carried out by Chatham House estimates that illegal logging has fallen 50 per cent in Cameroon, 50-75 per cent in the Brazilian Amazon and 75 per cent in Indonesia since 2000[71].

New trade regulations targeting illegal logging

Governments in consumer countries are introducing prohibitions on trade in products containing illegally sourced wood and other policy measures linked to the Forest Law Enforcement, Governance and Trade (FLEGT) initiatives[72]. The 2008 amendment of the US Lacey Act makes it an offence to import, handle or sell illegally sourced wood products[73]. The EU Timber Regulation[74] will enter into force in 2013, requiring those placing wood products on the EU market to exercise due diligence to ensure the wood was legally sourced. The Australian government is also developing an Illegal Logging Prohibition Bill, which, if passed, will regulate due diligence requirements for importers and processors. However, other growing markets for wood products have yet to take firm action. China, for example, has commissioned a study into the country's role as an importer of illegally sourced wood, but has no official plans to develop legislation to tackle the issue[75].

Traceability

One critical step in reducing illegal logging and associated trade is accurate tracing of wood along the supply chain. Without traceability a business cannot be sure that the wood or fibre in products it sells, uses or manufactures originates from a legal source. Technology is making full traceability more feasible. Better labelling devices (such as bar-coded tags or radio-frequency identification chips that can be scanned electronically) on logs or processed material enable efficient and accurate data capture at critical points along the supply chain. Internet-related data management systems are harder to forge or falsify than paper-based manual-entry systems. DNA and isotopic[76] testing as well as fibre analysis can be used to check suspicious claims about the source or species of wood in a product. However, in regions where the trade in logs or processed wood is fragmented (involving numerous intermediaries) and opaque (e.g., characterized by cash transactions and poor official record keeping), full traceability may only be feasible if governance and government-led tracking is strengthened and if buyers simplify their supply chains and use the emerging tracking and tracing systems.

However, legality is only a step towards sustainability. Elements of sustainability, such as good governance, inclusiveness and maintaining forest ecosystems, usually require actions that go beyond mere legal compliance.

WHAT QUALIFIES AS SOUND MANAGEMENT OF PRODUCTION FORESTS?

"Sustainable forest management" is a much-contested term and no simple consensus definition exists. However, the Forest Stewardship Council (FSC) principles provide a useful benchmark to assess the sustainability of production forestry.

There have been many attempts to define sustainable forest management, by bodies such as Forests Europe[77] and the International Tropical Timber Organization[78]. All have their merits, but no global definition has been agreed. WWF believes that the FSC principles serve as a useful checklist of critical aspects of forest management that is environmentally sound, socially just and economically viable.

FSC's 10 Principles of Forest Stewardship

1. Compliance with laws and FSC principles
The Organization shall comply with all applicable laws, regulations and nationally ratified international treaties, conventions and agreements.

2. Workers' rights and employment conditions
The Organization shall maintain or enhance the social and economic wellbeing of workers.

3. Indigenous peoples' rights
The Organization shall identify and uphold indigenous peoples' legal and customary rights of ownership, use and management of land, territories and resources affected by management activities.

4. Community relations
The Organization shall contribute to maintaining or enhancing the social and economic wellbeing of local communities.

5. Benefits from the forest
The Organization shall efficiently manage the range of multiple products and services of the Management Unit to maintain or enhance long-term economic viability and the range of environmental and social benefits.

6. Environmental values and impacts
The Organization shall maintain, conserve and/or restore ecosystem services and environmental values of the Management Unit, and shall avoid, repair or mitigate negative environmental impacts.

7. Management planning
The Organization shall have a management plan consistent with its policies and objectives and proportionate to scale, intensity and risks of its management activities. The management plan shall be implemented and kept up to date based on monitoring information in order to promote adaptive management. The associated planning and procedural documentation shall be sufficient to guide staff, inform affected stakeholders and interested stakeholders and to justify management decisions.

8. Monitoring and assessment
The Organization shall demonstrate that progress towards achieving the management objectives, the impacts of management activities and the condition of the Management Unit are monitored and evaluated proportionate to the scale, intensity and risk of management activities, in order to implement adaptive management.

9. Maintenance of High Conservation Value Forests
The Organization shall maintain and/or enhance the High Conservation Values in the Management Unit through applying the precautionary approach.

10. Implementation of management activities
Management activities conducted by or for The Organization for the Management Unit shall be selected and implemented consistent with The Organization's economic, environmental and social policies and objectives and in compliance with the Principles and Criteria collectively.

FOREST CERTIFICATION TO IMPROVE FOREST MANAGEMENT

Forest certification enables the buyers of wood products to seek assurances that the wood was legally harvested and came from a well-managed forest.

Forest certification is a voluntary process, usually market driven, where an accredited body verifies the legality and social and environmental qualities of forest management against an agreed standard[79]. Increasingly, such standards are set at a national level with equitable participation of all relevant stakeholders. The link from the forest floor to final point of sale as a certified forest product is achieved through an audited chain of custody.

Perhaps 30 per cent of the world's production forest is certified, and around 13 per cent of this under FSC[80]. To have the greatest impact, certification will need to expand significantly in those regions, particularly the tropics, where forests suffer most from destructive forestry, and do so while maintaining quality standards and systems. Longer term, voluntary certification has the ability to generally raise standards of forest management, certified or not, by for instance highlighting outmoded forestry practices[81].

What does WWF regard as credible forest certification?

Certification of good forest management by a third party under a system requiring:

- Alignment with globally applicable principles that balance economic, ecological and equity interests;
- Participation of all major stakeholders in the governance of the system and in the development of broadly accepted standards for responsible forest management;
- Respect for legal and traditional rights and maintenance of High Conservation Values;
- Independent, robust mechanisms for verifying and communicating the performance of certified forest managers.

WWF considers that FSC is currently the only credible forest certification system, while other major schemes have significant shortcomings[82].

Certification facts

As of 28th October 2012:

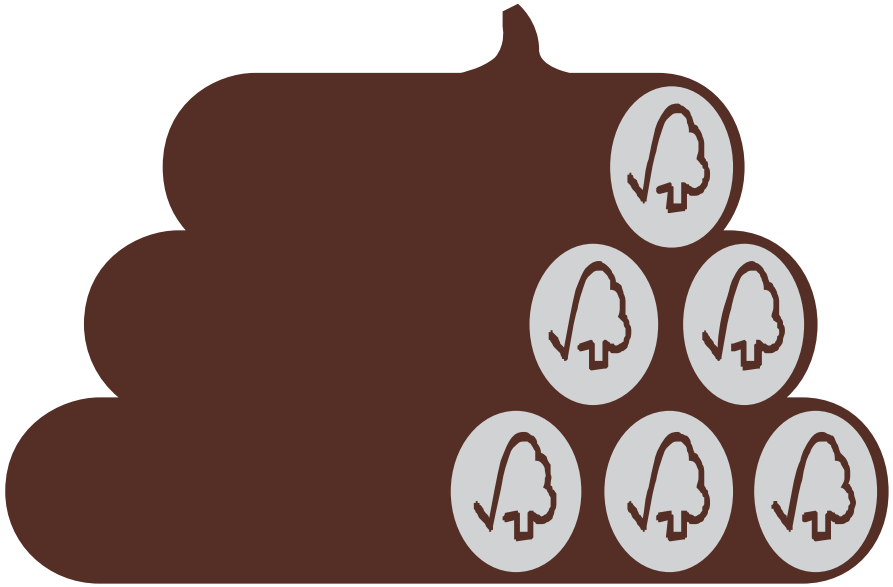
- 405 million hectares of forest and plantations were certified under the two major international schemes (FSC and **PEFC**), this figure includes some forests certified under both schemes[83];
- 164 million hectares were FSC certified (about 106 million hectares of natural forest, 13 million hectares of plantations and 45 million hectares of semi-natural and mixed plantation and natural forest)[84];
- 241 million hectares were PEFC certified[85];
- Only 4 per cent of tropical production forests have been certified under any scheme[86].

The potential supply of industrial roundwood from all certified forests and plantations (under all schemes) was estimated as 447 million m3 roundwood equivalent in mid-2011, about 25 per cent of global production[87].

DOES FOREST CERTIFICATION MAKE A DIFFERENCE?

Studies indicate that FSC certification has a positive impact on economic, ecological and social aspects of forest management, but more research is needed.

While many studies describe benefits of forest certification (see box for some examples), measuring the impacts of forest certification presents many challenges. The majority of the studies are based on indirect approaches – not field-based assessments – and the few with primary data have faced challenges in attributing observed impacts to the certification intervention[88]. More well-structured studies are needed to fully evaluate the impact of FSC and other forest certification schemes.



Tropical forests in general
An extensive study of Corrective Action Requests (CARs)[89] looking at FSC-certified operations in natural tropical forests concludes that FSC certification has a positive impact particularly in the fields of: health and safety of employees and their families; management plans; monitoring; use of reduced-impact logging; and protection of rare, threatened species. The study found that the number of CARs given in certification assessments was decreasing over time, suggesting that companies have incorporated management activities that are in line with FSC requirements as standard best practice.

Borneo
The Deramakot Forest Reserve (DFR) in Sabah, Borneo covers 55,000 hectares and was originally licensed for logging in 1956. In 1989, it was designated as a model site to develop sustainable forest management and all logging activities were suspended. A new management system with reduced-impact logging was implemented in 1995 and DFR was FSC certified in 1997. Studies comparing DFR with similar conventionally logged forests have shown DFR to be more effective in sustaining biodiversity[90]; it is one of the few areas in Sabah containing all five Bornean wild cat species, including the bay cat (Pardofelis badia) – one of the world's rarest wild cats[91]. DFR is also estimated to have 54 tonnes more carbon per hectare stocked in the above-ground vegetation than the Tangkulap Forest Reserve (a conventional logging site)[92].

Gabon
A study from Gabon[93] looking at the quality of wildlife management of forest concessionaires concluded that FSC-certified operations comply significantly better with national legislation and IUCN recommended best practices compared to non-certified companies.

Brazil
In plantation forestry in Brazil, FSC-certified operations performed substantially better on social and environmental aspects than non-certified companies[94].

BIG CHALLENGES, POTENTIAL SOLUTIONS

WWF has three key platforms for engaging the forest products industry in the uptake of responsible practices.

Global Forest & Trade Network (GFTN)

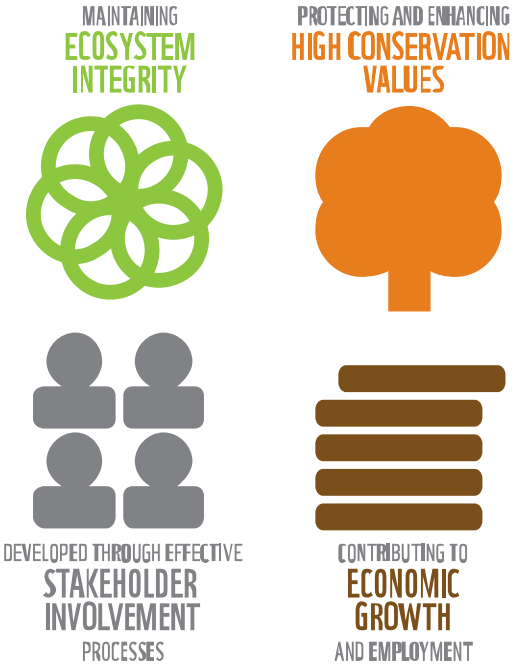
GFTN is the world's longest-running and largest forest and trade programme, involving nearly 300 companies, ranging from small operations supplying local markets to large, fully integrated multinational companies, in over 30 producing and consuming countries. Companies participating in GFTN commit to responsible purchasing of forest products or to achieving credible forest certification in the forests they manage. Participation is based upon annual performance towards long-term targets. Participants have been a key force in generating market demand for legal and certified products and achieving certification in some of the world's most valuable and threatened forests.

WWF | GLOBAL FOREST & TRADE NETWORK

New Generation Plantations project (NGP)

The NGP project is a platform bringing companies and governments together with WWF to develop and promote better plantation management. The NGP concept describes an ideal form of plantation that:

- maintains ecosystem integrity – including biological, carbon, nutrient and water cycles;
- protects and enhances High Conservation Values – biodiversity, ecosystem services and social and cultural values;
- is developed through effective stakeholder involvement – local communities, governments and NGOs;
- contributes to economic development – creating jobs and helping businesses and economies.



Paper Sector Transparency Tools

WWF has created a range of tools to reduce the ecological footprint of paper:

- Best measures for a paper efficient office;
- A guide explaining the potential environmental costs of paper and how to minimize these, including practical tips for buyers and producers;
- Check Your Paper, an online database of brands transparent about their environmental footprint, to assist responsible buyers; it scores how well a paper performs on responsible fibre sourcing, clean production and climate impacts.
- An Environmental Paper Company Index, showcasing paper producers' global environmental footprint in different product categories. In 2012, these were fine paper, tissue and packaging.

RISING TO THE CHALLENGE – WOOD PRODUCTS AND FORESTS IN PERPETUITY

The key challenge for the wood products industry in a future with zero net deforestation and forest degradation is how to supply more wood products with less impact on forests.

"WE ALL FACE UNCOMFORTABLE CHOICES AND TRADE-OFFS, BUT ONLY BY TAKING BRAVE, INFORMED DECISIONS CAN HEALTHY, SUSTAINABLE AND EQUITABLE HUMAN SOCIETIES BE ENSURED, NOW AND INTO THE FUTURE."[68].

The future looks bright for responsible producers of wood products. Demand should continue to grow as emerging and developing nations use more paper for hygiene, education and packaging and more wood to construct and furnish better houses and buildings. Wood should increasingly substitute for many alternative materials that are less sustainable, more energy intensive and bring a heavier pollution load. New technologies are likely to enable greater use of wood to make biofuels, pharmaceuticals, plastics, cosmetics and textiles. This growing demand should be tempered by less profligate consumption in richer societies, new efficiencies and more recycling.

Critical enablers of a forest products sector that contributes positively to the health of the planet include:

- **Better forestry:** e.g., ensuring legality and sustainable forest management; more sustainable plantations; rationalized and inclusive landscape-scale forest zoning; responsible procurement practices.
- **Better technologies:** e.g., increased mill and recycling efficiencies; new low-footprint wood products.
- **Better governance:** e.g., stronger social safeguards; effective enforcement of regulations.
- **Better policies:** e.g., incentives to reduce the rate of forest conversion and destructive logging, such as public policy measures to reward forest stewardship that delivers carbon storage, biodiversity conservation or water regulation services.
- **Better information:** e.g., long-term ecological impacts of various forms of natural forest management and intensive plantations.
- **Wise consumption:** e.g., more repeat use of individual wood fibres; new consumption patterns that meet the needs of the poor while eliminating waste and over-consumption by the affluent. This includes wood products as well as food and energy, as all commodities are competing for land and water.

There is no fundamental reason why ZNDD cannot be achieved while sustaining a vibrant wood products industry and meeting people's needs. However, this assumes that the forest industry adopts sympathetic approaches to ecosystems, local communities and small forest owners. The forest products industry has the potential to be either a friend or an enemy of a living planet.

In this chapter, we have assumed that wood production can be managed to address social and environmental concerns. The next chapter of the report will focus on projected areas of future loss ("deforestation fronts") and the implications for biodiversity conservation.

GLOSSARY, NOTES AND ACRONYMS

Agroforestry: ecologically-based natural resources management system that, through the integration of trees on farms and in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits for land users at all levels .

Bioenergy: energy derived from biomass, which can be used to generate electricity, supply heat and as a liquid biofuel.

Bioenergy Plus scenario: a scenario of the Living Forests Model where bioenergy feedstock demand is based on the "global 2°C scenario" derived from the POLES (Prospective Outlook for the Long-term Energy System) model .

Biomass: biological material derived from living or recently living organisms, such as wood and other crops. Biomass may also include biodegradable wastes that can be burnt as fuel. It excludes fossilized organic material which has been transformed by geological processes into substances such as coal or petroleum.

Cellulose: the basic structural component of plant cell walls, cellulose comprises about 33 per cent of all vegetable matter and is the most abundant of all naturally occurring organic compounds. Not digestible by humans, cellulose is a food for herbivorous animals (e.g., cows, horses), is processed to produce papers and fibres, and is chemically modified to yield substances used in the manufacture of such items as plastics, photographic films, etc.

Container board: container board is a type of light-weight paperboard specially manufactured for the production of corrugated board (formed by gluing one or more fluted sheets of paperboard to one or more flat sheet). It is typically used in the packaging of large materials.

Diet Shift scenario: a scenario of the Living Forests Model where the total global consumption of animal calories is maintained at the 2010 global average with convergence in per capita consumption across regions (i.e., those now below the global average consume more in the future, while those now above the global average consume less).

Do Nothing Scenario: A Living Forests Model projection of what the world could look like if our behaviour continues in line with historical trends. The Do Nothing Scenario anticipates land-use change due to: (a) demands for land to supply a growing global human population with food, fibre and fuel; and (b) continuation of historical patterns of poorly planned and governed exploitation of forest resources. Key assumptions in this scenario are:

- By 2050, world population reaches 9.1 billion and per-capita GDP almost triples.
- Demand for commodities is driven by changes in affluence (measured by GDP) and human population growth.
- Aggregate historical trends in agricultural productivity gains continue.
- The average human diet in a country changes according to historically observed relationships with per-capita GDP.
- Forestry and agricultural production does not expand into protected areas, but unprotected natural habitats can be managed for production of timber or converted to timber plantations, cropland and pasture.
- Total primary energy use from land-based biomass feedstocks doubles between 2010 and 2050 due to projected energy demand and the competitiveness of bioenergy technologies and supply chains.

Energy wood: woody biomass that is not used for household fuelwood or the production of wood-based products.

FAO: Food and Agriculture Organization of the United Nations

Fibre: cellulose-filled cells that are extracted from biological material (e.g., wood, bamboo, agricultural residues) and used to manufacture a variety of products, including paper.

Fuelwood: roundwood that will be used as fuel for purposes such as cooking, heating or power production. It includes wood harvested for fuel from main stems, branches and other parts of trees and wood that will be used for charcoal production (e.g., in pit kilns and portable ovens). It also includes wood chips to be used for fuel that are made directly (i.e. in the forest) from roundwood.

GHG: greenhouse gas

Growing stock: volume of wood in all living trees in a given area that have more than a specified diameter at breast height (or above buttress if these are higher). Includes the stem from ground level or stump height up to a specified top diameter, and may also include branches above a specified minimum diameter .

High Conservation Value (HCV): an exceptional or critical ecological attribute, ecosystem service or social function of forests and other biomes, defined by the FSC as follows:
HCV1 – Species diversity: Concentrations of biological diversity including endemic species, and rare, threatened or endangered species, that are significant at global, regional or national levels.

GLOSSARY, NOTES AND ACRONYMS

HCV 2 – Landscape-level ecosystems and mosaics: Large landscape-level ecosystems and ecosystem mosaics that are significant at global, regional or national levels, and that contain viable populations of the great majority of the naturally occurring species in natural patterns of distribution and abundance.

HCV 3 – Ecosystems and habitats: Rare, threatened or endangered ecosystems, habitats or refugia.

HCV 4 – Critical ecosystem services: Basic ecosystem services in critical situations, including protection of water catchments and control of erosion of vulnerable soils and slopes.

HCV 5 – Community needs: Sites and resources fundamental for satisfying the basic necessities of local communities or indigenous peoples (for example for livelihoods, health, nutrition, water), identified through engagement with these communities or indigenous peoples.

HCV 6 - Cultural values: Sites, resources, habitats and landscapes of global or national cultural, archaeological or historical significance, and/or of critical cultural, ecological, economic or religious/sacred importance for the traditional cultures of local communities or indigenous peoples, identified through engagement with these local communities or indigenous peoples .

Industrial roundwood: all harvested wood (saw logs, veneer logs and pulpwood) suitable for processing into wood products, and excluding wood used directly as fuelwood.

Intensively managed plantations: plantations of introduced and/or native tree species established through planting or seeding for rapid production of biomass (5 to 25 years).

Living Forests Model: developed for WWF by the International Institute for Applied Systems Analysis (IIASA) the model draws on G4M and GLOBIOM models to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, GDP and infrastructure. GLOBIOM is an economic model that allocates land and resources optimally based on projected commodity and ecosystem service demands under future GDP, population and policy scenarios.

Market pulp: pulp that is produced in one location, from virgin or recycled fibre, dried and shipped to another location for further processing to make paper and paperboard.

Non-timber forest product (NTFP): a product of biological origin other than wood derived from forests, other wooded land and trees outside forests . NTFP refers to all the resources/products (other than industrial roundwood and derived sawn timber, wood chips, wood-based panels and pulp) that may be extracted from forest ecosystems and are used within the household or are marketed or have social, cultural or religious significance. These include plants and plant materials used for food, fuel, storage and fodder, medicine, wrapping materials and bio-chemicals, as well as animals .

Non-wood fibre: cellulose-filled cells that are extracted from biological material other than wood (e.g., bamboo, agricultural residues) and used to manufacture a variety of products including paper.

Panels and panel product: a range of materials (e.g., plywood, particleboard or fibreboard) typically formed into sheets from particles, fibres or veneers, made from industrial roundwood or recovered fibre/ wood.

Paper: material mainly used for writing or printing upon or for packaging, as well as for tissue products, that is produced by pressing together moist fibres, typically derived from pulpwood, fibre crops or recovered paper, and drying them into flexible sheets.

Paperboard: a relatively stiff, heavy material, thicker than paper, that is produced by pressing together moist fibres, typically derived from pulpwood, fibre crops or recovered paper, and drying them into thick sheets.

PEFC: Programme for the Endorsement of Forest Certification, a major certification organization.

Production forest: forest area designated primarily for production of wood, fibre, bioenergy and/or non-timber forest products .

Pro-Nature scenarios: scenarios (Pro-Nature and Pro-Nature Plus) of the Living Forests Model which project that the remaining natural ecosystems are conserved (i.e., no further conversion of these ecosystems to cropland, grazing land, plantations or urban settlement) in areas identified as important for biodiversity by three separate conservation mapping processes using a UNEP World Conservation Monitoring Centre (UNEP-WCMC) dataset. These scenarios assume that current land uses (e.g., cropland or forestry) in these areas remain constant and continue to produce food or wood .

GLOSSARY, NOTES AND ACRONYMS

Protected area: a clearly defined geographical space that is recognized, dedicated and managed through legal or other effective means in order to achieve the long-term conservation of nature with associated ecosystem services and cultural values .

Pulp: a material prepared by chemically or mechanically extracting cellulose fibres from pulpwood, fibre crops or recovered paper.

Pulpwood: industrial roundwood that will be used for the production of pulp, particleboard or fibreboard. It includes roundwood (with or without bark) that will be used for these purposes in its round form or as split wood or wood chips made directly (i.e. in the forest) from roundwood. It does not include by-products from the sawmill.

Recovered paper/wood: fibre, paper and wood from unused material, collected waste and manufacturing waste. It can be divided into pre-consumer and post-consumer recovered paper/wood.

Recovery rate: percentage of usable recycled materials that have been removed from waste generated in a specific area or by a specific industry.

Recycled fibre: fibre made from processing recovered paper or wood.

REDD+: A package of actions aimed at (1) reducing emissions from deforestation and forest degradation (REDD) in developing countries; (2) conservation and sustainable management of forests; and (3) enhancement of forest carbon stocks.

Roundwood: All wood felled or otherwise harvested and removed.

Saw logs: Roundwood that will be sawn (or chipped) lengthways for the manufacture of sawn wood.

Sawn wood: planks or boards mechanically sawn from saw logs.

Target scenario: a scenario of the Living Forests Model where ZNDD (with near zero gross rate of loss of natural and semi-natural forest) is achieved by 2020 and maintained at that level indefinitely .

Veneer logs: roundwood that will be used for the production of veneer (a thin facing layer of wood) mainly by peeling or slicing.

Virgin wood fibres: wood fibre used for the first time in the manufacture of paper or other products.

WBCSD: the World Business Council for Sustainable Development .

Well-managed natural forests: natural and semi-natural forests managed in an economically viable, socially equitable and environmentally sustainable way that maintains biodiversity and ecosystem services. The FSC elaborates this further with 10 principles .

Wood: the hard fibrous material that forms the main substance of the trunk or branches of a tree or shrub.

Wood-based biomaterials: materials synthesized from wood fibre.

Wood fibre: cellulose-filled cells that are extracted from wood and used to manufacture a variety of products including paper. It covers both virgin wood fibre and fibre from recovered paper or wood.

Wood pulp: pulp made from virgin wood fibres.

Wood products: the wide range of products that are manufactured from industrial roundwood.

Zero Net Deforestation and Forest Degradation (ZNDD): WWF defines ZNDD as no net forest loss through deforestation and no net decline in forest quality through degradation. ZNDD provides some flexibility: it is not quite the same as no forest clearing anywhere, under any circumstances. For instance, it recognizes people's right to clear some forests for agriculture, or the value in occasionally "trading off" degraded forests to free up other land to restore important biological corridors, provided that biodiversity values and net quantity and quality of forests are maintained. In advocating ZNDD by 2020, WWF stresses that: (a) most natural forest should be retained — the annual rate of loss of natural or semi-natural forests should be reduced to near zero; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration. In this accounting, plantations are not equated with natural forests as many values are diminished when a plantation replaces a natural forest.

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Contributors
Editor in Chief: Rod Taylor
Technical Editors: Nigel Dudley, Emmanuelle Neyroumande, Michael Obersteiner, Sue Stolton and George White

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Editorial Team: Gretchen Lyons, Barney Jeffries

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IIASA's modelling team:
Michael Obersteiner, team leader; with Petr Havlik and Kentaro Aoki, Juraj Balkovic, Hannes Boettcher, Stefan Frank, Steffen Fritz, Sabine Fuss, Mykola Gusti, Mario Herrero, Nikolay Khabarov, Georg Kindermann, Florian Kraxner, Sylvain Leduc, Ian McCallum, Aline Mosnier, Erwin Schmid, Uwe Schneider, Rastislav Skalsky, Linda See and Hugo Valin.

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www.panda.org

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WWF LIVING FORESTS REPORT: CHAPTER 5

SAVING FORESTS AT RISK

CONTENTS

SAVING FORESTS AT RISK

The *Living Forests Report* series has explained the reasons for and implications of an ambitious forest conservation target: Zero Net Deforestation and Forest Degradation (ZNDD) by 2020.

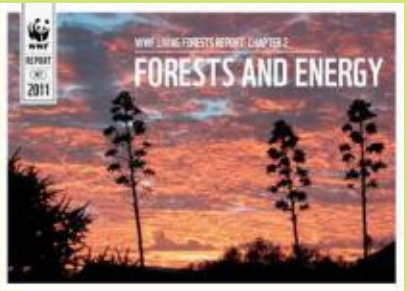
Achieving ZNDD will not happen by accident. It will require a huge, collective advocacy effort, along with policy changes by governments and industry. Achieving ZNDD will require a mosaic of protected and sustainably managed forests, integrated with other land uses such as farms, settlements and infrastructure. Strategies to get there include: preventing the squandering of forests through achieving good governance and control of outside pressures that lead to loss and degradation; protecting and restoring the most ecologically valuable forests; introducing incentives for sound stewardship of production forests; increasing efficiency of wood use; reducing waste; and optimizing other land uses to mitigate the pressure to access more land by clearing forests.

The prospect of success in preventing large-scale deforestation will be improved by focusing efforts on those places where threats of deforestation and degradation are greatest. So, which forests are in the firing line and what is driving deforestation? What could help to slow and stop the rate of loss? This chapter identifies where most deforestation is likely between 2010 and 2030: these are the ***deforestation fronts*** where efforts to halt deforestation must be concentrated. The chapter also provides compelling examples of *solutions* for reversing the projected trends in these deforestation fronts.

UP TO 170 MILLION HA OF FOREST COULD BE DESTROYED BY 2030

THE LIVING FORESTS REPORT

Chapter 1 – **Forests for a Living Planet** examines the causes of deforestation and the need to shift to a new model of sustainable forestry, farming and consumption with ZNDD.



Chapter 2 – **Forests and Energay** examines the safeguards needed to ensure expanding use of bioenergy helps to provide energy security, rural development and greenhouse gas (GHG) reductions without destroying valuable ecosystems or undermining food and water security.

Chapter 3 – **Forests and Climate** highlights REDD+ as a unique opportunity to cut GHG emissions from forests in time to prevent runaway climate change, but only if investments are made now.

Chapter 4 – **Forests and Wood Products** examines current and future demand for wood products and how this can best be met.

DEFORESTATION FRONTS

WWF describes places at imminent risk of large-scale deforestation as *deforestation fronts*, and defines them for the purposes of this report as follows:

Deforestation fronts are the places where the largest concentrations of forest loss or severe degradation are projected between 2010 and 2030. Collectively, these places will account for over 80 per cent of the forest loss projected globally by 2030, i.e. up to 170 million ha.

Forest loss/deforestation and degradation are defined by WWF as:

Forest loss/deforestation: Conversion of forest to another land use or significant long-term reduction of tree canopy cover. This includes conversion of natural forest to tree plantations, agriculture, pasture, water reservoirs and urban areas; but excludes logging areas where the forest is managed to regenerate naturally or with the aid of silvicultural measures.

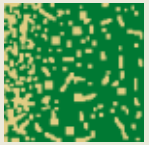
Forest degradation: Changes within forests that negatively affect the structure or function of the stand or site over many decades, and thereby lower the capacity to supply products and/or ecosystem services.

Severe forest degradation: Changes within forests that cause serious and permanent negative changes to the structure or function of the stand or site, and thereby lower the capacity to supply products and/or ecosystem services.

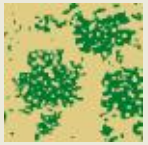
Typology of deforestation fronts

Deforestation does not progress the same way everywhere. Although inevitably a simplification, we distinguish three types of deforestation fronts:

Hard front: Gradual encroachment into an intact forest block from outside, forming a distinct edge.



Dispersed front: Numerous dispersed patches of deforestation over a large area that collectively add up to a significant area of forest loss.



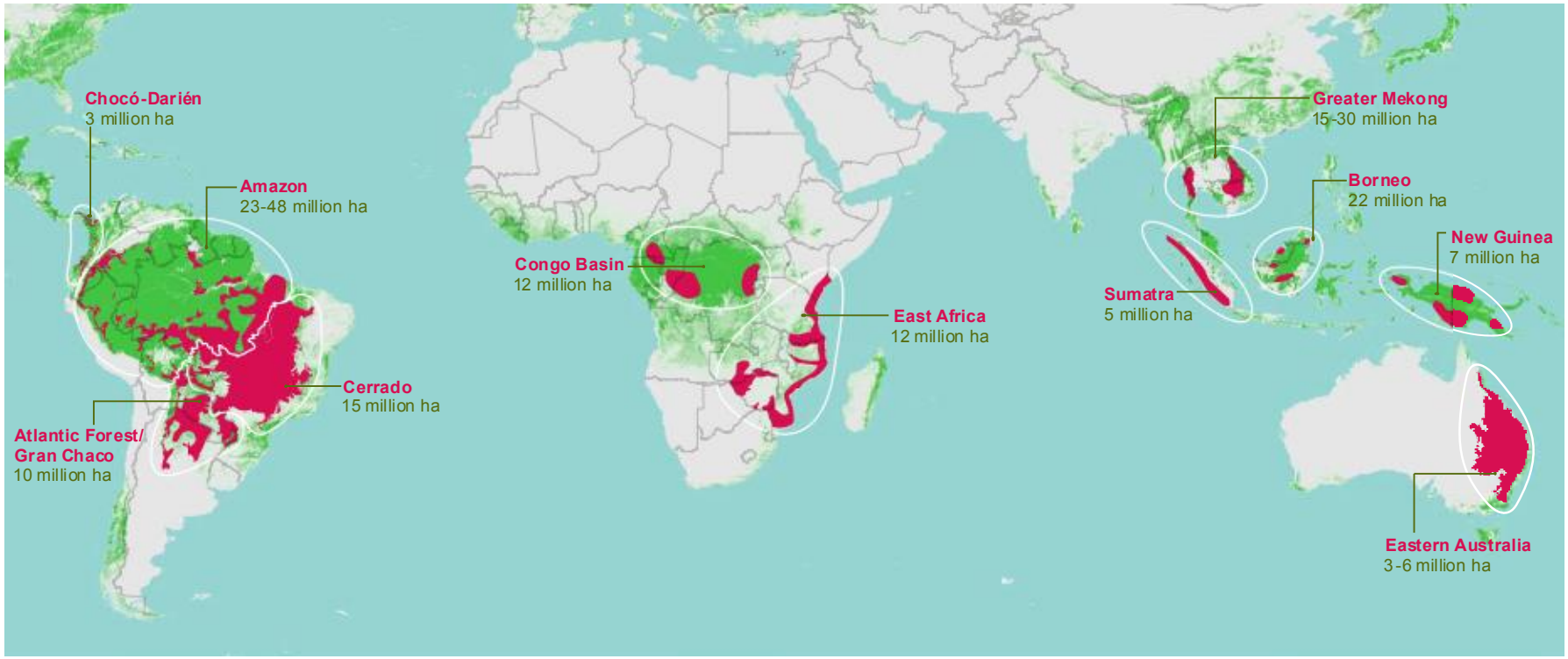
Scattered forest front: progressive loss of forest patches in a forest-grassland ecosystem.

Zero Net Deforestation and Forest Degradation (ZNDD)
WWF envisions a world where humanity lives within the Earth's ecological limits and shares its resources equitably. We advocate ZNDD by 2020 as a critical milestone toward this goal (see chapter 1 of the *Living Forests Report*).[1] ZNDD means ***no net forest loss through deforestation and no net decline in forest quality through degradation.*** With the International Institute for Applied Systems Analysis (IIASA), we developed the **Living Forests Model** to consider a range of future forest scenarios and to project the effects of changes in diet, bioenergy, conservation policy, and fuelwood and timber demand.

The model shows that with better forest stewardship and more productive use of arable land, the current and projected demand for food, fuel and fibre could be met without further net loss of forests. Achieving ZNDD by 2020 depends on preventing further forest loss due to poor planning, weak governance, excessive consumption, inequitable or insecure land tenure and user rights, unregulated or illegal forest clearing, poor forest management, inefficient agriculture and over-harvesting of fuelwood. In the longer term, maintaining near zero forest loss will require forestry and farming practices that produce more with less land, water and pollution, along with new consumption patterns that meet the needs of the poor while eliminating waste and over-consumption by the affluent.

MAP OF DEFORESTATION FRONTS

WWF has drawn on projections in the Living Forests Model, a major literature survey and interviews with dozens of experts around the world to identify 11 places with major deforestation fronts, highlighted in this map. These places are where the bulk of global deforestation is projected to take take place over the two decades, from 2010 to 2030, under business-as-usual scenarios and without interventions to prevent losses.



THE WORLD'S MAJOR DEFORESTATION FRONTS

The table below lists the deforestation fronts and projections of likely losses, if current trends continue or changes modelled in projections come about. Projections are based on extrapolation from recent trends, expert opinion and scenario analyses where available. Most of the deforestation fronts are in the tropics, where rates of forest loss between 2010 and 2030 are expected to be highest. These figures project, from the deforestation fronts alone, losses between 2010 and 2030 of up to 170 million ha. In addition, several temperate and boreal regions are undergoing considerable degradation, even though overall forest cover is not significantly changing. These are discussed on page 6.

Table 1: Deforestation fronts and projections of loss from 2010 to 2030

Deforestation front	Projected loss (million ha) 2010 to 2030
Amazon	23-48
Atlantic Forest/Gran Chaco	10
Borneo	22
Cerrado	15
Chocó-Darién	3
Congo Basin	12
East Africa	12
Eastern Australia	3-6
Greater Mekong	15-30
New Guinea	7
Sumatra	5
Total from 11 deforestation fronts	127-170

Sources for the figures are given in the sections on the individual deforestation fronts.

THE AMAZON IS THE LARGEST DEFORESTATION FRONT. MORE THAN A QUARTER OF THE BIOME WILL BE WITHOUT FORESTS IF CURRENT TRENDS CONTINUE.

DEFORESTATION PRESSURES

	Livestock	Large-scale agriculture	Small-scale agriculture & colonization	Unsustainable logging	Pulp plantations	Fires	Charcoal and fuelwood	Mining	Infrastructure	Hydroelectric power
Amazon	■	■	■	■		■		■	■	■
Atlantic Forest/ Gran Chaco	■	■		■	■	■	■	■	■	■
Borneo		■	■	■	■	■		■	■	■
Cerrado	■	■					■	■	■	■
Chocó-Darién	■	■	■	■				■	■	
Congo Basin	■	■	■	■			■	■	■	
East Africa	■	■	■	■		■	■	■	■	
Eastern Australia	■		■	■				■		
Greater Mekong		■	■	■	■		■		■	■
New Guinea		■	■	■	■	■				
Sumatra		■	■	■	■	■			■	

Table 2: Summary of main pressures on forests in different deforestation fronts

The most common pressures causing deforestation and severe forest degradation are: large and small-scale agriculture; unsustainable logging; mining; infrastructure projects; and increased fire incidence and intensity. New roads can have a small direct impact but a large indirect effect through opening up forests to settlers and agriculture. Poor forest management, destructive logging practices and unsustainable fuelwood collection degrade forests and often instigate an increasing spiral of degradation that eventually leads to deforestation ("death by a thousand cuts"). Table 2 gives a summary of these pressures.

■ Primary cause of forest loss and/or severe degradation

■ Important secondary cause of forest loss and/or severe degradation

■ Less important cause of forest loss and/ or severe degradation

□ Not a cause of forest loss and/or severe degradation

DEGRADATION - BOREAL AND TEMPERATE FORESTS

Boreal forest in Northern Alberta, Canada near Fort McMurray. The largest forest in the world stretches around the north of Russia, Canada, Alaska and Scandinavia. Huge areas are still in a natural state. But a combination of old-growth logging, mining, and increases in fire due to climate change threaten this pristine habitat.

The deforestation fronts are predominantly in the tropics and sub-tropics because this is where most outright deforestation – the permanent loss of forest cover – is likely to take place between 2010 and 2030. At a global level, forest cover in temperate regions is increasing from a low base that is due to historical deforestation. However, forest *degradation* is still occurring in many temperate countries, through replacement of native forests with plantations of commercial species and because of increased fire, pollution, invasive pests, poor management and over-exploitation. Because this publication is focused on fronts for outright forest loss and the most severe forms of forest degradation, it does not address forest degradation more generally. The causes and vectors of forest degradation will be the subject of future investigation by WWF.

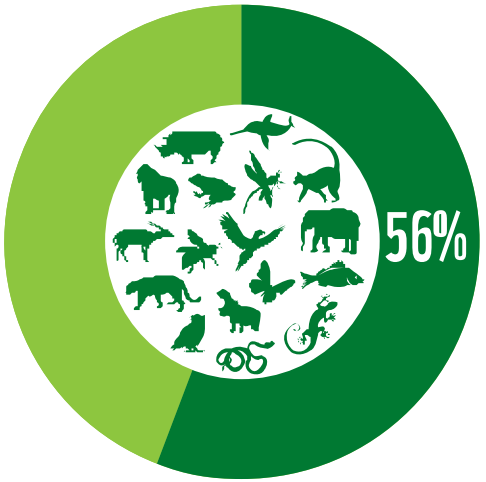
Do we have a boreal deforestation front?

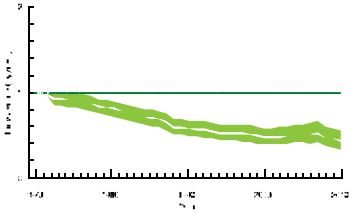
Boreal forest covers 1,200-1,600 million ha of Russia, North America and Scandinavia; comprising roughly a third of remaining global forest.[2] Although overall forest cover in the region remains fairly stable, major changes are occurring, particularly through damage to pristine forests as a result of human-induced fires;[3,4] logging ;[5,6] and mining.[7] From 2011 to 2013, Russia and Canada accounted for 6.8 million hectares of tree cover loss, 34 per cent of the global total, mostly due to fire.[8] However, most of these losses are not associated with permanent conversion of forest to other land uses. Areas where tree cover loss has occurred will mostly be left to regenerate, though this will take a long time due to the slow growth rates of boreal trees. Most boreal tree cover loss does not therefore qualify as permanent forest loss as defined for the purpose of this report (see page 2). However, it could be argued that some boreal forest areas are becoming deforestation fronts due to severe degradation: a fully functioning forest may take hundreds of years to re-establish after a fire or clear felling, if at all.

Climate change is also likely to make fundamental changes to forests in the boreal region,[9] which may affect regeneration. While the region has relatively low levels of biodiversity at a global scale, it is the world's last non-tropical forest with large, free-ranging populations of major predators and herbivores; this gives it high conservation value. For now, we treat boreal forest as a "degradation front", and thus separate from our main analysis. This may change following further research into climate change impacts on boreal forest regeneration.

BIODIVERSITY AT RISK IN DEFORESTATION FRONTS

The 11 deforestation fronts contain some of the richest biodiversity in the world, including large numbers of endemic species. This makes them especially important in the context of sharply falling species populations.





Key

Tropical Living Planet Index

Confidence limits

This is based on trends in 3,811 populations of 1,638 species (WWF, ZSL, 2014).

THE TROPICAL LIVING PLANET INDEX SHOWS A DECLINE OF 56 PER CENT BETWEEN 1970 AND 2010[10]

Diversity: All the deforestation fronts are highly diverse. For instance, the **Gran Chaco** is the largest dry forest in South America, containing around 3,400 plant species, 500 birds, 150 mammals and 220 reptiles and amphibians.[11] The **Congo Basin** supports the highest biological diversity in Africa: over 400 mammal species, more than 1,000 bird species, and likely over 10,000 plant species. It is the last stronghold for forest elephant, gorilla, forest buffalo, bongo and okapi.[12] **New Guinea** is also recognized for its concentration of biodiversity: Papua New Guinea alone harbours an estimated 6 per cent of the world's species.[13] Although only 11.7 per cent remains, the **Atlantic Forest** still hosts a strikingly high biological diversity, including around 20,000 tree and shrub species, 270 mammal species,[14] 1,020 bird species and 340 amphibian species. Across these deforestation fronts, new finds occur daily. In the **Greater Mekong**, for example, 126 new species were found in 2011, including fish, snakes, frogs, bats and 82 plants. Even large mammals there remain undescribed. A joint government-WWF expedition discovered the saola (*Pseudoryx nghetinhensis*) in 1992 on the border of Lao PDR and Vietnam; it was finally photographed alive in the wild for the first time in late 2013.

Endemic species: The 11 deforestation fronts harbour unique species, many of them endangered or near extinction. Over 52 per cent of the tree species, 80 per cent of primate species, 124 forest-dependent bird species[15] (70 per cent of them threatened or endangered[16]) and 92 per cent of amphibians found in the **Atlantic Forest** are endemic.[17] Similarly, in the Brazilian **Cerrado**, there are an estimated 4,400 endemic species of higher plants, representing 1.5 per cent of the world's total vascular plant species.[18] In **East Africa**, the miombo ecosystem alone contains around 8,500 plant species, of which over half are endemic.[19]

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Mountain gorilla family in Virunga National Park, Democratic Republic of Congo.

TURNING BACK DEFORESTATION FRONTS

In deforestation fronts, forests are often squandered due to poor governance of land and economic activity impacting forests (see chapter 1 of the *Living Forests Report*).

The full value of forest biodiversity and ecosystem services is not recognized by local or export markets. Nor is this value safeguarded effectively in public policies and governance systems. Forests are replaced by other land uses that generate higher short-term financial returns, or face gradual depletion through unsustainable harvesting, hunting, fires and other disturbances. Thus forest loss occurs in spite of the risks that declining forest ecosystem services pose to society.

Reversing deforestation fronts will require measures to remedy the fundamental market and governance failures that drive poor land-use choices and practices. But where to start?

Land-use decisions are influenced by many actors: property owners or communities with land or resource access rights deciding how to use their land; governments shaping economic policies, regulations and spatial plans; investors assessing the risk and return of a business activity in a given place; corporations managing global supply chains and anticipating market trends; and consumers deciding what to buy or which politicians to elect.

Coherent and fair incentives to maintain the integrity of forest ecosystems will need to integrate these diverse interests and actors and shape the myriad systems influencing land-use choices. Systemic, integrated approaches to improved land-use decision-making are needed both in specific places and in global supply chains. In this chapter, we describe five measures with strong potential to prevent deforestation: strengthened protected area networks, valuation of ecosystem services, REDD+, deforestation-free supply chains, and forest safeguards for roads and other infrastructure. Finally, we propose the landscape approach as a potential framework for integrating these different intervention strategies to find enduring responses to deforestation pressures.

REVERSING DEFORESTATION FRONTS WILL REQUIRE MEASURES TO REMEDY THE FUNDAMENTAL MARKET AND GOVERNANCE FAILURES THAT DRIVE POOR LAND-USE CHOICES AND PRACTICES.

Community meeting at Nazare village discussing project development. Capim River, Paragominas, Para State, Brazil.
Good governance – by governments, communities and industry – lies at the heart of efforts to reduce deforestation rates.

PROTECTED AREAS AS DEFENCES AGAINST DEFORESTATION

Effective protected area networks are a means of ensuring that representative sanctuaries of biodiversity survive in deforestation fronts. They can also serve as reservoirs for future restoration. Expanding and strengthening protected area networks is therefore one of the most important strategies available to mitigate the impact of deforestation fronts.

Research suggests that most protected areas, most of the time, conserve ecosystems and wildlife better than alternative management approaches.[20] Deforestation fronts contain protected areas that have retained forests, even though forest loss is occurring right up to their borders.[21] A recent World Bank study[22] found protected areas more effective in preventing forest conversion than other land-use designations, with size, national park status, and management by indigenous people included among the key success factors.

However, poorly governed and under-resourced protected areas are unlikely to withstand intense deforestation pressures and not all protected areas have been effective in conserving natural ecosystems,[23] including within deforestation fronts.[24] Documented examples of protected area downgrading, downsizing and degazettement (PADDD[25]) in deforestation fronts, including the Greater Mekong, Amazon, Congo Basin and Coastal East Africa, can be found at: **www.padddtracker.org**. Along with expanding the area under protection, success depends on strengthening management and building capacity.

Any investments in protected areas as defences against deforestation thus need to be predicated on careful assessment of the conditions for success of the protection options under consideration. For example, indigenous peoples' reserves often serve as very effective conservation instruments,[26] but require different political and institutional enablers from protected areas on state-owned land. Strict protection areas will face different challenges than less formal "protected landscape" approaches.[27] Protected areas that are pristine due to their remoteness will require new and strengthened management to remain effective when the development frontier presses up against their boundaries. In critical situations, where a wave of deforestation is affecting an area, the need to respond quickly will often be in tension with the time required to run truly inclusive processes, build political will and create the capacities and institutional foundations for enduring and effective forms of protected area governance.

Even well-governed protected areas are not a panacea. In deforestation fronts, protected areas can easily become islands in generally converted landscapes, lacking the connectivity and size needed to conserve ecological systems and biodiversity. Hence, protected area networks need to be recognized more broadly as cornerstones of sustainable land-use mosaics, and valued additionally for the provision of ecosystem services in support of inclusive "green economies". Such economies would reverse the business-as-usual projections for deforestation fronts by setting an alternative development trajectory where natural capital is maintained and the depletion of ecosystem services associated with deforestation avoided.

To support such economies, countries will often need to enlarge their protected area networks, enable local people to become more involved in their governance, and generate more funding for management activities needed to secure and maintain the health of ecosystems within and around protected areas.

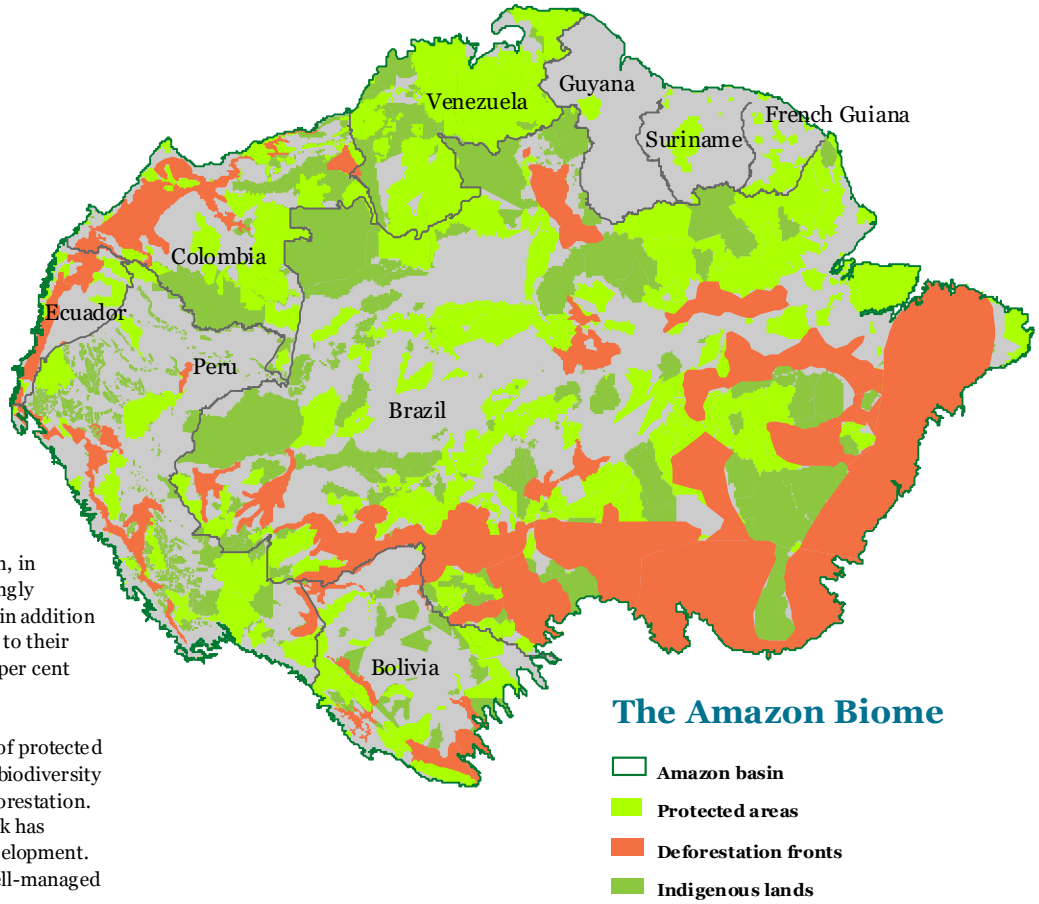
AMAZON PROTECTED AREAS AND INDIGENOUS TERRITORIES – A "BIODIVERSITY SAFETY NET"

Protected areas and indigenous territories are the most proven mechanisms for conserving natural ecosystems and cultures.

In the Amazon in particular, indigenous territories – which, in 2010, represented 31.1 per cent of the biome – are increasingly recognized for their importance in conserving ecosystems, in addition to their primary role of securing indigenous peoples' rights to their ancestral lands. By 2013, other protected areas covered 25 per cent of the Amazon biome.

Combined with community-conserved areas, this network of protected areas and indigenous territories represents the Amazon's "biodiversity safety net", and serves as an important defence against deforestation. For example, in Rondonia in northwest Brazil, this network has helped curb rampant deforestation from infrastructure development. In the heart of the Amazon, blocks of well-designed and well-managed protected areas enhance the resilience of the region.

As economic development in the Amazon increases, policy and conservation measures must be strengthened to ensure that protected areas and indigenous territories continue to effectively safeguard forests and the livelihoods of those who depend upon them.



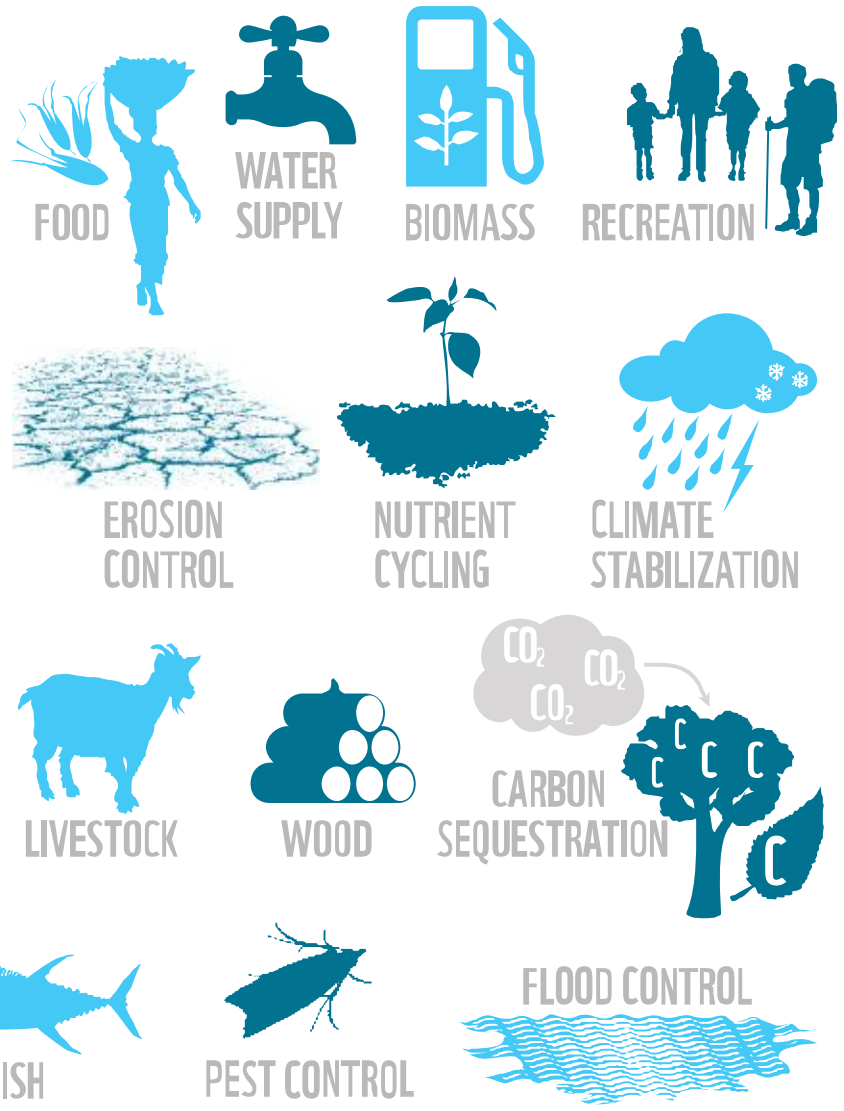
VALUING ECOSYSTEM SERVICES

Avoiding projected forest loss in the 11 deforestation fronts would maintain a suite of benefits.

Forests deliver a range of critical ecosystem services: carbon sequestration; food security; water services; disaster risk reduction; tourism; and a host of cultural and social benefits.[28] Governments have formally recognized some of the highest quality natural forests in the world as homelands of indigenous peoples. Others are protected to secure clean, plentiful supplies of drinking water for cities located downstream, or because they conserve crop wild relatives needed for agricultural improvement programmes. Others protect sacred natural sites that are critical to the belief systems of local communities.

Understanding and valuing these benefits, including where appropriate the economic benefits, can help tip the balance in favour of land-use choices that maintain rather than convert forests. They can stimulate and provide the justification for a range of place-based solutions, which include creating new protected areas, other forms of legal or voluntary set-asides, implementing sustainable forestry practices and restoring forests.

The Economics of Ecosystems and Biodiversity (TEEB) process generated a series of studies that outlined the range of economic benefits provided by natural ecosystems and brought these to the attention of new audiences around the world.[29] Tools of varying degrees of sophistication are available to help stakeholders assess the value of biodiversity and ecosystem services.[30] Much experience has been gained in compensating the communities or individuals who are responsible for maintaining these services, through payments for ecosystem services (PES) schemes.



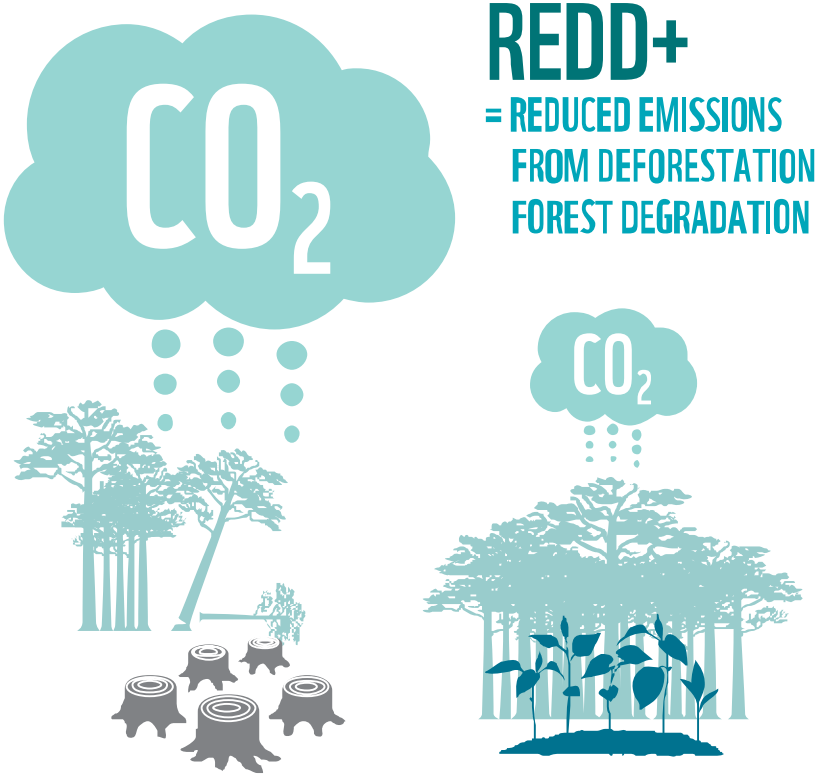
REDD+

Deforestation and forest degradation contribute significantly to global greenhouse gas (GHG) emissions.[31]

In response, the UN Framework Convention on Climate Change (UNFCCC) has developed a mechanism – known as REDD+ – for providing incentives to developing countries to reduce GHG emissions from deforestation and forest degradation, and enhance forest carbon storage by improving forest management (see Chapter 3 of *Living Forests Report*). This mechanism differs from earlier efforts to prevent forest loss, as incentives are based on results achieved (emissions reductions), and results are assessed at the national level rather than at the project level (though sub-national results may be recognized as an interim measure). Ensuring results are evident at a national level is necessary for the integrity of the global climate change regime under the UNFCCC.

Financial support for REDD+ has reached over US$9 billion.[32] This represents a significant increase in international funding for forest conservation but is still not enough to address the problem at scale.[33] While REDD+ finance can come from a wide variety of sources, to date it has mainly been public finance. Much of the REDD+ finance has gone into establishing the technical and institutional capacities of countries to implement REDD+ activities and measure their results. Norway,[34] Germany[35] and the World Bank Carbon Fund[36] have established programmes that are piloting results-based payments for REDD+ at national and sub-national scales. The recent increase in pledges[37] made by major corporations and investor groups to deforestation-free supply chains and investments (see page 15) is expected to play a vital complementary role in achieving REDD+ objectives.

Emission reductions from deforestation and forest degradation need to be measured at the national and global level. However, the first REDD+ projects were mostly smaller, unconnected projects. Increasingly, actions are at a sub-national "jurisdictional" scale. Many supporters and beneficiaries of REDD+ implementation efforts – from the World Bank Carbon Fund to large forest countries such as Brazil and Indonesia – are taking an approach that gives preference to work at state, province or district levels, in recognition of the unique advantages that work on this scale can afford (see DRC case study).[38]



Jurisdictional REDD+ programmes work on sizeable, sub-national landscapes, nested within national level frameworks. They focus on building capacities, safeguards and engagement for REDD+ from the bottom up with communities, businesses and local and national governments.

With this approach, REDD+ can be implemented and tested on a scale that is ecologically meaningful because it can contain intact ecosystems, and socially and politically meaningful because it aligns with recognized jurisdictions, such as government-designated provinces, departments or districts. Expanding jurisdictional REDD+ with existing sub-national administrations, within national development policies, could help counter threats in deforestation fronts while addressing issues related to poverty alleviation, land rights and equitable resource governance.

DEMOCRATIC REPUBLIC OF CONGO REDD+ CASE STUDY

The Democratic Republic of Congo (DRC) contains 60 per cent of the forests in the Congo Basin (roughly 150 million ha[2]), an area of immense biological richness. With only 6 per cent of Congolese having access to electricity, the remainder – nearly 67 million people – depends on the forest for firewood and charcoal. The livelihoods of 40 million people depend directly on forests: for subsistence farming, timber for homes, and firewood/charcoal for cooking and heating. This is leading to increased deforestation.

The Maï-Ndombe REDD+ project in DRC has built up the capacities needed to deliver REDD+ and created the first large-scale REDD+ and green development pilot programme in the Congo Basin. The project covers 13 million ha of forest (the size of Austria and Switzerland combined) with high biodiversity and high risks of deforestation due to its proximity to the capital Kinshasa.

The project was developed using an integrated approach bringing together government, community, civil society organizations and the private sector at local, sub-national and national levels. It aims to reduce emissions from deforestation and forest degradation of 29Mt CO_2 equivalent by 2020, while recognizing tenure security and sharing REDD+ benefits to improve long-term livelihood security, with particular attention on vulnerable groups.

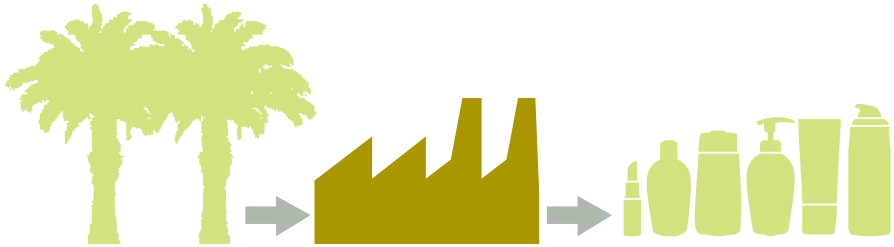
At the local level, the project started as a capacity-building exercise to empower indigenous peoples and local communities to participate effectively in the REDD+ process in ways that recognize and address their rights. It plans to address deforestation and degradation through capacity building, payments for environmental services, community forestry, reduced impact logging, creating land-use plans including conservation concessions and strengthening governance. The jurisdictional programme aims to develop "a model provincial green development program that provides alternatives and rewards performance to address the challenges of climate change, poverty reduction, natural resource conservation and protection of biodiversity".

It is an exciting time for REDD+ in DRC. Already, some of the "transformational" impacts set as objectives by the government are beginning to be realized. Communities are working together to develop land-use maps and plans. The government is recognizing their work and their value in the REDD+ process.[39] Communities are beginning to demonstrate real commitments to reductions of deforestation and forest degradation, with less slash-and-burn and more sustainable agroforestry. Global policymakers should match DRC's ambition and commitment. Several forest countries have shown their readiness for REDD+ and will soon outpace the overall process if more aggressive action on REDD+ finance is not taken at the global level.

A community land-use mapping exercise as part of the Mai-Ndombe REDD+ project in DRC.

"DEFORESTATION-FREE" SUPPLY CHAINS

Major private sector actors have pledged to eliminate deforestation from their supply chains and investments.



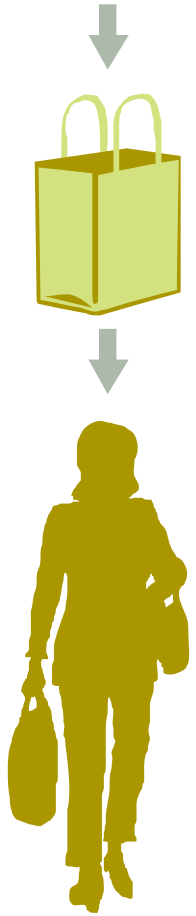
Examples include the Consumer Goods Forum's zero net deforestation by 2020 initiative;[40] the Banking Environment Initiative to provide deforestation-free financing;[41] numerous commitments by individual retailers, brands and traders;[42] and place-specific actions such as the Brazilian soy industry's moratorium on purchasing soy from lands that have been deforested in the Amazon.[43] Many producers in the forestry and agriculture sectors have also committed to cease or strictly limit forest conversion associated with their operations.

Governments can create market preferences for products sourced from legal and sustainable sources or support producer countries to take actions to limit forest loss.

Many voluntary commodity certification standards have some form of prohibition on the clearing of forests and other natural ecosystems, though these vary greatly. These include requirements on: maintaining and enhancing high conservation values; legal compliance; protection of peat soils; and respecting local and indigenous peoples' rights to give or withhold free, prior, and informed consent to activities affecting their territories. If such efforts can be mainstreamed, they offer enormous potential to decouple food and fibre production from forest loss.

Yet many private sector actors have not made robust commitments to eliminate deforestation, let alone put such commitments into practice. To transform markets, campaigners and progressive companies will need to work together to expose deforestation-linked practices and their impacts, and make it harder for those implicated to stay in business. At the same time, care is needed to avoid deforestation becoming a single-issue cause divorced from concerns over rights, livelihoods and other environmental issues.

Governments need to support the switch to deforestation-free commodities. In producer jurisdictions, they can strengthen laws, policies and governance systems to enable land zoning and permits that are consistent with maintaining forests. In consumer jurisdictions they can create market preferences for products sourced from legal and sustainable sources or support producer countries to take actions to limit forest loss. Governance measures such as the EU Timber Regulation and the Lacey Act in the United States, for example, bar trade in products containing illegally sourced wood. They are examples of consuming jurisdictions inserting governance safeguards into supply chains that start in other countries.



Fair, efficient and effective application of the notion of "deforestation-free" supply chains will require:

- Regulations and spatial-planning processes in jurisdictions within deforestation fronts that support voluntary commitments to limit forest conversion;
- Verification that builds on existing certification systems, and strengthens their safeguards on the conversion of forests and other natural ecosystems where necessary;
- Positioning of deforestation-free as a critical aspect of sustainable production, but not a proxy for, or superior trait to, full sustainability;
- Respect for the rights, needs and aspirations of indigenous, traditional and local communities in decisions over land use;
- Safeguards to prevent indirect land-use change (e.g., when farmers displaced by deforestation-free commercial developments encroach deeper into the forest);
- Complementary measures to ensure that a narrow focus on deforestation does not neglect measures to prevent forest degradation (the source of 50 per cent of forest-related GHG emissions), or create additional pressures on grasslands and other non-forest ecosystems (leakage);
- Efficient integration of deforestation-free safeguards with other pre-project processes (e.g., environmental and social impact assessments, high conservation value (HCV) assessments, participatory mapping of community lands);
- That companies previously involved in deforestation redress their social and environmental legacies before they qualify as deforestation-free suppliers.

FOREST-FRIENDLY INFRASTRUCTURE

We are living in an explosive era of infrastructure expansion,[44] and dams, roads, railways, canals, ports, pipelines and mines are potentially a major cause of future forest loss.

Infrastructure projects in remote areas are often magnets for people seeking employment and other economic opportunities. When governance conditions are weak, people who move to such areas in search of work, or remain after temporary jobs conclude, may clear forests to build settlements, secure land, graze livestock or plant crops and gardens. To eke out a living, they may exert further pressure on nearby forests by hunting and gathering wild foods or cutting fuelwood or high-value timber.[45] Large mines can signal the presence of valuable ores and minerals and trigger artisanal mining rushes that devastate large tracts of forested land, as is happening in Peru.[46] New highways and access roads can make once-remote forests accessible to settlers, and make farming and extractive activities more commercially viable due to easier transport to urban markets or ports. Roads can also fragment intact forests and disrupt wildlife migration. In all such instances, infrastructure is an indirect cause of forest loss.

So, what can be done to reduce the impacts of infrastructure on forests without undermining local economic opportunities? Those financing, building or regulating infrastructure can actually do quite a lot to mitigate social and environmental impacts.

The starting point is upfront impact assessment. An assessment can cover an individual project, the cumulative impact of a series of projects, or comprise a strategic review of proposed development plans or policies at macro-scale. Whatever the scale, an assessment can inform decisions on whether a proposal goes ahead, how it is managed during implementation, and how it can be integrated into the wider land-use mosaic and spatial plans. Potential negative impacts can be addressed through a sequence of measures known as the "mitigation hierarchy". In order of priority, these are:

- Avoiding or preventing harm by exploring alternative locations, layouts, technologies, sequencing and timing (e.g., re-routing highways around indigenous reserves, restricting third-party use of project access roads, "fix it first" policies to upgrade existing transport links rather than develop new ones);
- Minimizing harm by reducing spatial extent, duration and/or intensity of human interference (e.g., repatriation of migrant workers when construction is complete, creating wildlife crossings under or over major highways);
- Restoring or repairing harm that cannot be avoided or prevented (e.g., decommissioning access roads when they are no longer needed, forest restoration after mining operations have finished);
- Offsetting residual negative effects through positive interventions (e.g., reintroduction of species or other conservation measures in the wider landscape).

Many of these measures will also help investors and project managers to mitigate financial risks, and to some degree are already embedded in best practice safeguards and guidelines.[47] However, much can be done to improve the quality of assessments and effective application of mitigation measures.

Forest safeguards can be created or greatly strengthened in the regulatory systems governing infrastructure approval, installation and operation in many countries. They can be better addressed in the operational systems of those installing and managing infrastructure. Greater transparency and effective stakeholder consultation, not just "box ticking", are key areas where improvements are needed.[48] The systematic strengthening of forest safeguards in infrastructure regulation and practice is thus one of the major opportunities to prevent further forest loss.

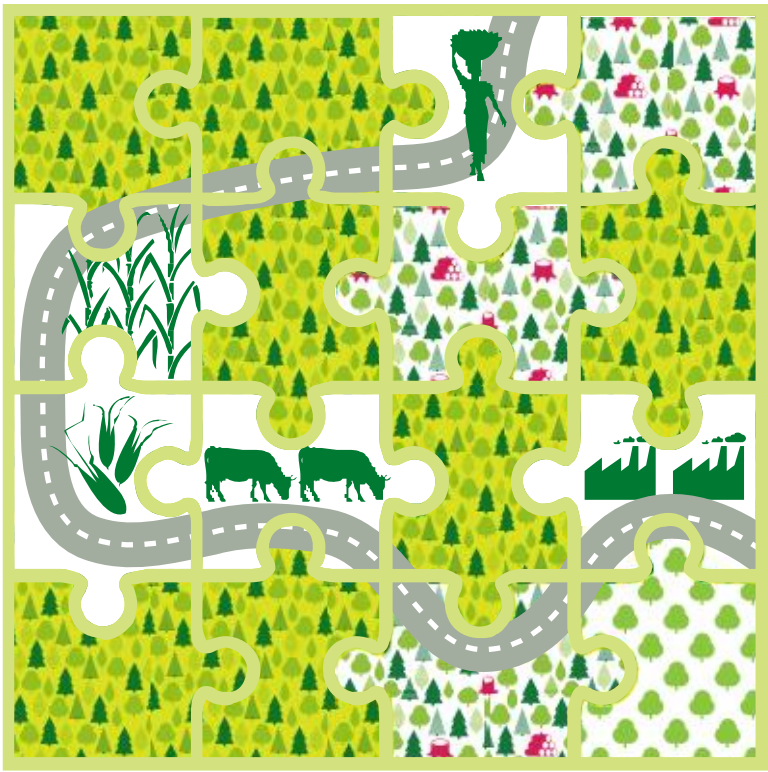
OPTIMAL LAND-USE CHOICES AND LANDSCAPE APPROACHES

The landscape is the scale at which supply chains and investment portfolios from multiple sectors intersect with the specifics of local governance regimes, ecological dynamics and the rights, needs and aspirations of local people.

From a conservation perspective, the landscape is often an area large enough to maintain viable populations of key species and healthy ecological processes. It is a scale where sustainable land-use mosaics can be developed, and inclusive processes facilitated to inform and negotiate trade-offs over impacts and benefits of competing land uses. Jurisdictional REDD+ (see page 13) can also be effectively implemented at a landscape level.

The "landscape approach"[49] is a term used to describe collaborative initiatives in specific places that span multiple sectors and go beyond the scale of individual farms, forest management units and protected areas. Essentially, it means coherent intervention at a landscape scale to secure food, fibre and energy production, improvements in social welfare, water security and ecosystem conservation.

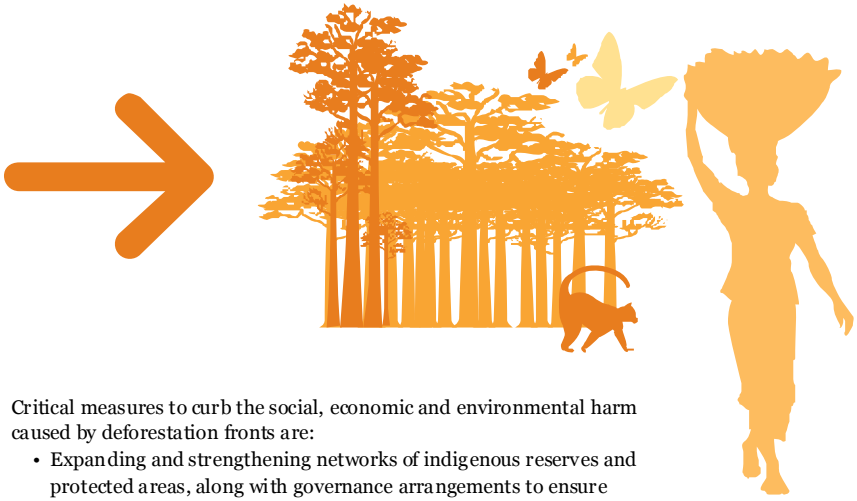
Applying a landscape approach to prevent large-scale deforestation is ultimately about encouraging land-use choices that retain forests for multiple purposes and optimize the productive capacity of the surrounding landscape. It can combine official protection of critical sites, voluntary "deforestation-free" measures, sustainable forest management within production forests, REDD+ and other measures to secure payments for environmental services.



A landscape approach should result in smart land-use choices that maintain and enhance ecological values such as biodiversity, ecosystem services and resilience, environmental flows and water quality in rivers, groundwater quality, soil health and stored carbon. In the socio-economic sphere, it should lead to land-use choices that respect the rights and aspirations of indigenous peoples and local communities and secure local livelihoods and equitable distribution of the benefits of productive activity.

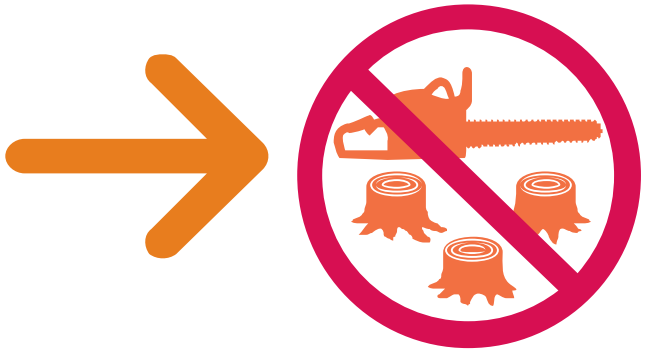
WAYS FORWARD

Earlier chapters in the *Living Forests Report* have shown that ZNDD is possible without disastrous consequences for supplies of food, energy and wood products, or for biodiversity in other biomes. This chapter casts further light on the scale of the challenge in realizing ZNDD in practice.



WWF is using deforestation fronts to prioritize our efforts to achieve ZNDD in the places where, without conservation efforts, losses will be greatest. Within deforestation fronts, we need location-specific strategies that focus on the most important direct and indirect drivers of forest loss. Such strategies may have to be modified over time as events unfold. Care will be needed to avoid leakage, or the displacement of deforestation from one area to another.

Achieving ZNDD certainly won't be easy. Decisions made in deforestation-front countries and in the domestic and export markets for their products will determine whether tropical forests retreat to a few isolated remnants or continue to play a central role in providing ecosystem services, resources, income and cultural value.



Critical measures to curb the social, economic and environmental harm caused by deforestation fronts are:

- Expanding and strengthening networks of indigenous reserves and protected areas, along with governance arrangements to ensure these networks are able to withstand intense deforestation pressures;
- Presenting public and private sectors with stronger evidence and valuation of ecosystem services from forests, and risks to business and society of depleting natural capital, so they are more likely to be factored into decisions affecting land use;
- Rolling out REDD+, with safeguards, on a far larger scale;
- Mainstreaming the concept of "deforestation-free" as a critical element of sustainable supply chains and financing and ensuring it is applied in ways that protect forests while balancing the interests of all stakeholders;
- Developing forest-friendly infrastructure that mitigates social and environmental impacts without undermining local economic opportunities;
- Using landscape approaches to integrate these elements and enable solutions at an adequate scale to achieve sustainable land-use mosaics and balance trade-offs among competing land uses.

Deforestation front focus

AMAZON

The Amazon is a complex natural region, comprising an array of interdependent ecosystems. It is hugely important in terms of the ecosystem services it provides, including ecological processes, biodiversity and cultural diversity.

Since 2005, there has been an important reduction in the rate of deforestation across parts of the Amazon region, but deforestation and forest degradation continue at an alarming rate, threatening to overturn gains that have been made. The Amazon is the biggest deforestation front in the world, according to WWF projections, and interventions are urgently needed to prevent a large-scale, irreversible ecological disaster.

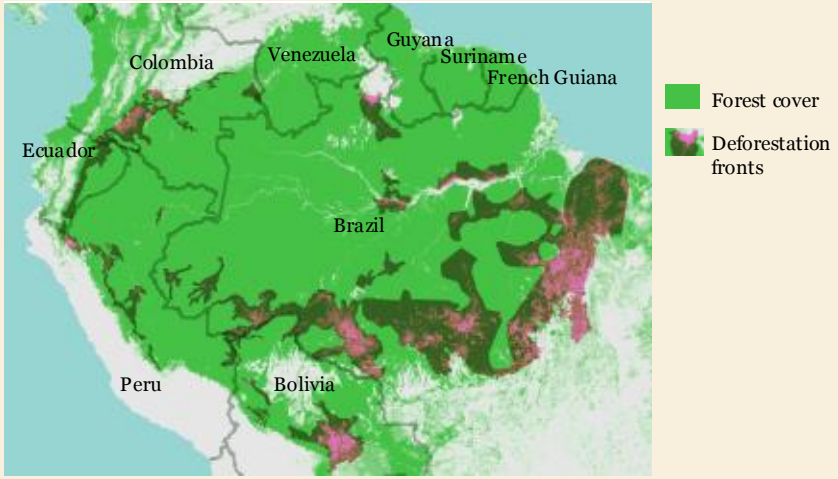
Forest losses from 2001 to 2012 averaged 1.4 million ha per year[50] for the Amazon biome, resulting in a total loss of 17.7 million ha in those 12 years. Brazil was responsible, on average, for 75 per cent of accumulated deforestation, with Brazil, Peru and Bolivia together accounting for 90 per cent.

Recent WWF estimates suggest that 27 per cent – more than a quarter – of the Amazon biome will be without trees by 2030, 13 per cent from new deforestation,[51] if the average deforestation rate for the last 10 years for each country continues. This would give a total area lost to deforestation from 2010 to 2030 of 23 million ha.[52] If construction goes ahead on planned hydroelectric dams and major new paved roads – such as the Carretera Marginal de la Selva, running from Peru through Ecuador to Colombia; the Trans-Amazon highway; the Manaus-Porto Velho "BR 319"; and the Cuiabá-Santarem "BR 163" – coupled with the new Interoceanic Highway running through Brazil, Bolivia and Peru, deforestation could double to 48 million ha between 2010 and 2030, or 100 million by 2050.[53]

The Andean-Amazon deforestation area – spanning 670 million ha[54] from Colombia to Bolivia – includes sub-fronts moving in from the southeast, Brazil and Bolivia, the Andean piedmont and from the north in Colombia and Ecuador. Deforestation has been growing particularly in the Andean-Amazon countries, namely Peru – due to expansion of palm oil, agriculture, illegal logging and informal mining – parts of Bolivia,[55] Colombia and, to a lesser degree, Venezuela, Guyana, Suriname and French Guiana.[56] Though the deforestation rate in Brazil has decreased, changes to the Forest Code in 2012 have been associated with increased deforestation, including within the Amazon biome.[57]

CREDIT: ADRIANO GAMBARINI / WWF-BRAZIL

Crops and pasture meet natural forest in Mato Grosso in the Brazilian Amazon.



Deforestation front focus

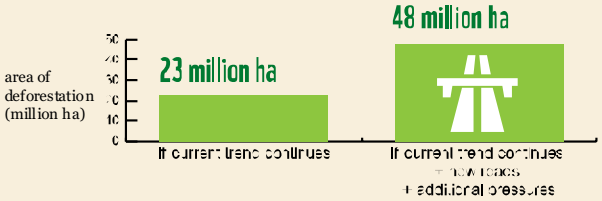
AMAZON

Brazil Amazon deforestation projections if conservation measures are not introduced
(includes deforestation in both Cerrado and Amazon biomes)

2020[58]	25%
2030[59]	31%
2050[60]	40%

Amazon key data

Countries	Brazil, Bolivia, Peru, Ecuador, Colombia, Venezuela, Guyana, Suriname and French Guiana
Area of deforestation front	670 million ha
Deforestation, 2001-2012	17.7 million ha
Deforestation (projected), 2010-2030	23-48 million ha
Top causes	Cattle ranching, agriculture



Amazon deforestation pressures

Pasture and **cattle ranching**,[61] specifically farm gate beef and dairy, is the dominant cause in many areas[62] and is also linked to land speculation in some countries.

Expansion of **mechanized agriculture**, particularly for animal feed[63] and biofuels,[64] using soy,[65,66,67,68] oil palm[69,70,71] and also corn, is a key cause, with increased production linked to subsidized resettlements in some countries.[72] **Indirect land-use change** can be significant,[73] e.g., if soy replacing pasture[74] results in cattle rearing moving into natural forest.[75]

Small-scale agriculture is expanding in regions such as northern and eastern Bolivia,[76] Colombia, Ecuador, Peru and the Guianas, where high levels of poverty, pressure for land, unsustainable practices and problems of control are leading to an expansion.

Dams and **hydropower expansion**, including settlement around dams and associated infrastructure, is a major driver behind deforestation. The area at risk from deforestation impact occurs between 40 and 100km from hydroelectric dams.[77] There are 154 constructed dams, and another 298 either under construction or planned in the Amazon biome.[78] Dam impacts often overlap with protected areas and indigenous territories.

Roads give access to remote areas, bringing people and land speculation inwards. Mechanisms to manage or reduce the impacts of new roads are often absent or poorly implemented. The fronts showing the greatest deforestation rates are areas with more roads, showing a strong correlation between deforestation and the presence of roads and projections of new roads. Nearly 95 per cent of deforestation in Brazil Amazon was found to be within 5.5km of roads and 1km of navigable rivers.[79]

Forest fires due to poorly controlled burning for land clearance and management are a contributing factor to both deforestation and forest degradation.[80]

Road development accompanies mines, oil and gas drilling, often deepening deforestation. Mining is significant in places[81] such as Peru, where artisanal and small-scale alluvial **gold mining** has increased 400 per cent since 1999.[82]

Unsustainable legal and illegal timber trade contributes to forest degradation and can be the first stage of forest conversion [83]

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

ATLANTIC FOREST/GRAN CHACO

The Atlantic Forest is one of the richest rainforests in the world, with high levels of endemism and richer biodiversity per area than the Amazon.[84] However, the region also hosts 75 per cent of the Brazilian human population and remaining forest fragments are under intense pressure. The neighbouring Gran Chaco is the largest dry forest in South America, covering some 100 million ha in Argentina (62 per cent), Paraguay (25 per cent), Bolivia (12 per cent) and Brazil (1 per cent).[85] But unless policies change, both ecosystems could virtually disappear outside protected areas.

© MICHEL GUNTHER / WWF-CANON

Deforestation of the Atlantic Forest for cattle grazing. Bahía, Brazil.

Ironically, Gran Chaco has suffered partly as a result of tighter controls to protect remaining fragments of Atlantic Forest – a classic example of "leakage" and the reason WWF has combined these two distinct ecosystems as a single deforestation front.

In the Gran Chaco biome in particular, deforestation rates are exceptionally high. A recent study of deforestation dynamics in the biome found that 11.7 million ha (7.9 million ha in Argentina, 3.3 million ha in Paraguay, and 0.5 million ha in Bolivia) were converted between 1976 and 2011. The study concluded that 23 per cent of the Gran Chaco biome had been lost in Argentina, 19 per cent in Paraguay and 3.5 per cent in Bolivia.[86]

The Atlantic Forest is now confined to only 11.7 per cent (16.3 million ha) of its original extent in Brazil, 24.9 per cent (1.2 million ha) in Paraguay,[87] and 38.7 per cent (1 million ha) in northern Argentina.[88] This is mainly due to agricultural expansion during the colonial period, industrialization and urban development. Although 9 per cent of the region's territories are covered by protected areas, over two-thirds are under sustainable use, which usually means farmland and does not necessarily protect forest. Just 2.5 per cent (3.3 million ha) is in national parks where use is more restricted, including 700 mainly small strictly protected areas[89] (1.6 per cent). Atlantic Forest continues to be converted. In Brazil, losses over the previous few years have been around 20,000 ha per year, and WWF projects losses to 2030 could be around 425,105 ha. In Argentina, deforestation rates in the biome averaged 5,485 ha a year from 2006 to 2011.

Based on current and recent rates of forest loss, WWF estimates deforestation to equal 10 million ha between 2010 and 2030 for the Atlantic Forest and Gran Chaco. Solutions to address deforestation will require interventions at the regional level; tackling one deforestation issue without considering the wider regional and global context can simply result in the problem being shifted somewhere else.

Restoration efforts are also under way, at least in the Brazilian Atlantic Forest. In 2009, these were integrated into the Atlantic Forest Restoration Pact, when more than 160 institutions – including WWF, the government and universities – set a target to restore 15 million ha of degraded lands by 2050; 60,000 ha are already under restoration in more than 80 projects covering several states. The Brazilian government also created a Rural Environmental Registration* requirement for rural properties that encourages restoration in compliance with the National Forest Code.

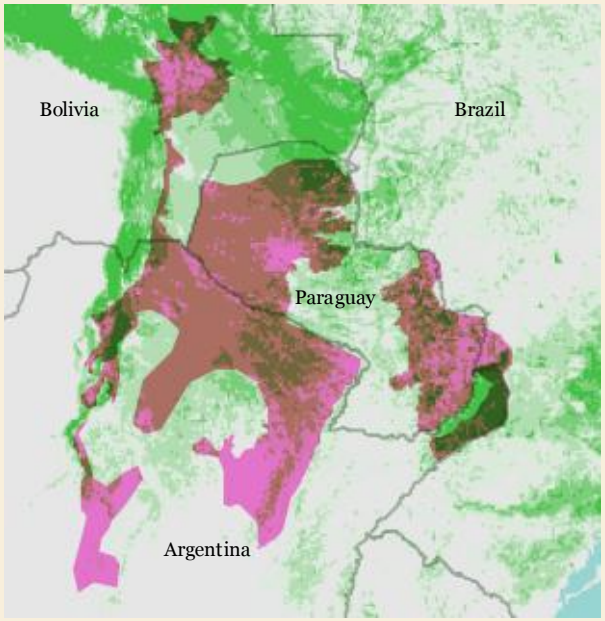
*Rural Environmental Registry is an online system through which rural property owners must register their land. CAR is a federal system, but states are responsible for implementation. CAR is configured to use high-resolution satellite images that are then registered by the property owner and contain all of the relevant information for compliance with the law, including the location of Areas of Permanent Protection and Legal Reserves.

Deforestation front focus

ATLANTIC FOREST/GRAN CHACO

Atlantic Forest/Gran Chaco key data

Countries	Argentina, Bolivia (for Chaco), Brazil and Paraguay
Deforestation (projected), 2010-2030	10 million ha
Top causes	Agriculture, livestock, infrastructure



Forest cover Deforestation fronts

Atlantic Forest/Gran Chaco deforestation pressures

	Agricultural expansion, particularly for **soy**[90] but also maize, sunflower, wheat, rice and oats is the main driver of deforestation in Argentina and Paraguay.[91,92] Resistance to forest clearing has sometimes been violently suppressed, including suppression of land protests related to soy.[93]
	Clearance for **pasture**, including **overgrazing**, causes further impacts on forest cover.[94]
	Roads and **pipelines**[95] threaten to increase forest loss.
	Fire and a consequent increase in **invasive species**[96] is a key contributor.
	Firewood collection and **charcoal production** are sources of both forest clearance and degradation, particularly in Gran Chaco.[97]
	Logging, including illegal operations, continues in both regions.[98]
	Pulpwood plantations continue to be linked to conversion in the west Argentinean Chaco.[99]
	Mining is increasing, for example in the Bolivian Chaco.[100]
	Proposed dams and associated infrastructure are a potential cause of future forest loss.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

BORNEO

A century ago, most of Borneo was covered in forest. The island has since undergone a massive transformation as coastal lowland forests have been cleared, converted to other land uses or degraded. The rate of deforestation and degradation has accelerated, with 30 per cent of Borneo's forests lost in the last four decades.

Twenty million ha were lost between 1985 and 1997.[101] Deforestation has continued since 2000,[102] particularly in Central Kalimantan,[103] West Kalimantan and Sarawak.[104] Between 2003 and 2008, a further 5.8 million ha were deforested[105] in Borneo as a whole. By 2010, 53 per cent of the island's original forest remained, of which about half was thought to be "intact," some 21 million ha; 42 per cent of this intact forest is slated to be logged and 16 per cent further converted into timber plantations.[106,107]

A recent analysis for one area of West Kalimantan projecting business-as-usual scenarios found that by 2030, the area of forest likely to be cleared for oil palm would reduce the remaining natural forest cover to 4 per cent.[108] Other projections suggest that 45 per cent of Kalimantan peat swamp forest in Indonesia could be lost by 2030;[109] in Malaysian Borneo, most new plantations are expected in Sarawak.[110] Although the Indonesian government has decreed[111] that Indonesia's Kalimantan provinces should remain 45 per cent forested, this is not reflected in district and provincial development plans, nor in the numerous, often overlapping permits granted for mining and agriculture.

Industrial conversion of forests into palm oil, timber and pulpwood plantations is the main cause of deforestation. Other pressures include conversion for small-scale agriculture, fires, illegal logging, and new roads and dams. In Indonesia, in particular, these pressures are exacerbated by weak governance. Permits purporting to allow land conversion are often in conflict with sectoral regulations, spatial plans, community land claims and permits granted in other sectors.

If current deforestation rates continue unabated, 21.5 million ha will be lost between 2007 and 2020, reducing remaining forest cover to just 24 per cent of the island.[112] Recent private sector commitments to halt deforestation and government policy changes suggest a slowdown in these rates is probable. For example, through the "Heart of Borneo" declaration, the governments of Brunei Darussalam, Indonesia and Malaysia have committed to manage and conserve forest resources in the inland portion of the island where most forest cover is retained.[113] Proposed measures to back this declaration could reduce deforestation rates significantly. Accordingly, WWF projects forest loss of 22 million hectares for the period 2010 to 2030 in Borneo.

© ALAIN COMPOST / WWF-CANON

Cleaning forest fire for palm oil plantation Central Kalimantan, Indonesia.

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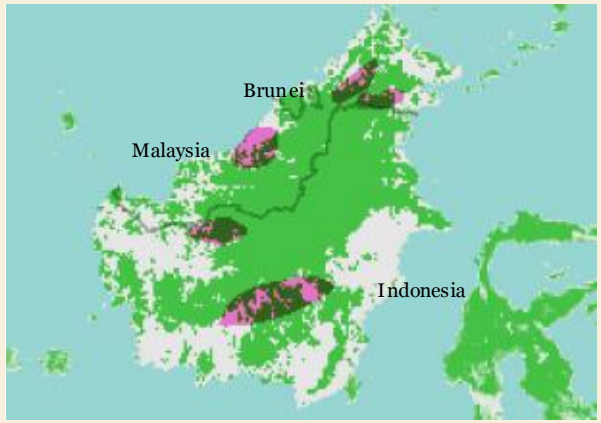
Burning palm-oil plantation. Palangkaraya, Central Kalimantan, Indonesia.

Deforestation front focus

BORNEO

Borneo key data

Countries	Indonesia (Kalimantan), Malaysia (Sabah, Sarawak) and Brunei
Deforestation, 2003-2008	5.8 million ha
Deforestation (projected), 2010-2030:	22 million ha
Top causes	Conversion for palm oil, unsustainable logging



Forest cover Deforestation fronts

Table symbols

- Primary cause of forest loss and/or severe degradation
- Important secondary cause of forest loss and/or severe degradation
- Less important cause of forest loss and/or severe degradation

Borneo deforestation pressures

Conversion for **palm oil** plantations is the largest cause of deforestation across all regions of Borneo.[114,115,116] Palm oil plantations cover 11.7 million ha in the Indonesian part of Borneo alone,[117] with significant increases in the last decade.[118] The profits from logging and conversion to palm oil plantation greatly exceed foreseeable revenues from carbon markets and other payment for ecosystem services (PES) schemes,[119] creating additional challenges for forest conservation. Most new plantations are expected to be in Sarawak.[120]

Uncontrolled small-scale conversion is also a significant pressure, including within some protected forests.[121]

Repeated cycles of **unsustainable, often illegal, logging** result in severe forest degradation,[122] and forests that have been logged over and abandoned are vulnerable to encroachment and conversion to other land uses.[123]

Indonesia's two biggest **paper** players have pledged near zero deforestation;[124,125] however, third parties continue to clear forests set aside for conservation in the concessions of these companies, and their suppliers continue to clear forests not designated for protection due to flawed conservation and social value assessments.[126,127] The future impacts of the sector on Borneo's forests remain uncertain due to the gap between plantation wood supply and planned milling capacity, and government plans in Indonesia to allocate more forested land for pulpwood plantation development.

Fire is used to **clear land**, but often spreads to burn out of control on drained, or temporarily dry, peatlands[128] – around 1 million ha were drained for Indonesia's failed mega rice project and large areas have been drained for plantations. Also at risk are forests made drier and more flammable due to El Niño events or because of large canopy gaps resulting from poor logging practices and encroachment. Fire impacts have been greatest in West Kalimantan, Central Kalimantan and Sabah, and burnt tracts of forest are often not given the opportunity to recover.[129]

Mining, for **coal**, **gold** and other **minerals**, is significant in some areas and, if economic development plans are realized, is set to be a very important direct or indirect cause of forest loss in some parts of the island. Large mining companies are at least willing to "minimize" the environmental impacts of their mining activities, while small-scale mining appears to be completely ignorant about this.

Dam building is increasing, including on the territories of indigenous peoples.[130]

Road development is an important contributory cause, with 95 per cent of deforestation in Borneo occurring within 5km of the forest edge.[131] Malaysian Borneo contains 364,000km of roads in forests.[132] New roads make previously remote forest areas accessible to settlers, illegal logging and land claims.

Deforestation front focus

CERRADO

The richest savannah in the world, the Cerrado high plateau of Brazil and Bolivia is not nearly as recognized as the Amazon, but it is under just as much threat. The rate of vegetation conversion in the Cerrado far exceeds that of the Amazon, with native habitats and rich biodiversity being destroyed faster than the neighbouring rainforest.

The Cerrado encompasses the area west of the Brazilian Highlands to Santa Cruz, Bolivia. The Brazilian portion originally covered 200 million ha,[133] but half of it has already been converted to agriculture.[134] The remainder is severely fragmented,[135] with few contiguous areas over 1,000 ha.[136] In the Bolivian portion, deforestation statistics specific to the Cerrado biome are not readily available. However, studies on Eastern Bolivia highlight significant recent deforestation correlated with suitability of land for mechanized agriculture, including proximity to roads and markets.[137]

In Brazil, between 2002 and 2010, almost 10 million ha – 4.9 per cent of the original Cerrado area[138] – were cleared. If the current rate of loss continues, WWF estimates that much of the Cerrado's natural savannah, woodland and forest outside protected areas, totalling 15 million ha, will disappear by 2030.[139,140] The Brazilian government is reported to have policies that 35 per cent of the forest should remain as permanent forest estate[141] but even if the government's aim for retaining natural ecosystems is achieved, an additional 11.2 million ha of the Cerrado will be converted over the next few years.

The Cerrado has fewer protected areas than other Brazilian ecosystems – 8.9 per cent in total with just 2.9 per cent under strict protection. Landowners are, by law, supposed to keep 20-35 per cent of land under native vegetation (including as legal reserves), depending on location.[142] But these laws are not rigorously enforced.[143]

© ZIG KOCH / WWF

Aerial view of Cerrado savannah, Juruena National Park, Brazil.

Deforestation front focus

CERRADO

Cerrado key data

Countries	Brazil, Bolivia
Ratio of protected areas	8.9% (2.9% under strict protection)
Deforestation (projected), 2010-2030	15 million ha
Top causes	Conversion to soy plantations, cattle ranching

Forest cover Deforestation fronts

Cerrado deforestation pressures

Cattle ranching[144] is one of the main causes of conversion, totaling 60 million ha to date.

Conversion of forest to **soy plantations** for food, animal feed and biofuels[145] – totalling 12-14 million ha[146] – has now overtaken cattle ranching as the primary cause of forest loss.[147] Brazil is the world's second largest producer of soybean, and with half of it coming from the Cerrado, it is now probably the main cause of conversion.[148] **Sugar** and **grain** production are contributing causes.

WWF's research suggests that the root cause of agricultural expansion into the Brazilian Cerrado was a need for foreign exchange, related to a balance-of-payment deficit and the debt crisis. This was exacerbated by a high international price for soybean, political influence of large landowners and the transfer of the national capital to Brasilia, which brought pressure to develop the region.[149] This led to a range of pressures, including **road building** from the 1950s onwards,[150] **development policies** focused on agricultural expansion and the growing market for **soy**.[151]

Dams and **hydropower expansion**, including settlement around dams and associated infrastructure, is linked to forest loss.

Road development and in-migration associated with mining is a cause of deforestation in some areas.

Degradation is caused by cutting trees for fuelwood and charcoal, mostly for **industrial uses**.[152]

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

CHOCÓ-DARIÉN

The tropical rainforests of the Chocó-Darién run along South America's northwestern Pacific coast from northwestern Ecuador through Colombia, connecting to eastern Panama. These are among the most biologically diverse regions in the world, boasting more than 8,000 plant species, close to 600 bird species and the highest rainfall levels on Earth.

The Chocó-Darién extends over 16.9 million ha, with forest cover maintained in about two-thirds of the region (12.5 million ha remains under forest cover). Scenario-based analyses demonstrate that forest loss over the next 30-40 years could reach more than 3 million ha based on current pressures, with more optimistic scenarios estimating potential loss of just over 1.5 million ha.[153] This corresponds to 18 per cent and 9 per cent of the ecoregion, respectively, potentially leaving less than half of the ecoregion under forest cover. Agriculture, roads and electricity grid infrastructure (power lines), mining and oil exploration are the largest drivers of the projected forest loss.[154]

Deforestation in the Ecuadorian Chocó has been most significant while forest clearance is now gathering pace in Panama and Colombia. Ecuador has lost most original forest[155] and, following intense clearing,[156] has just 2 per cent of its coastal forest remaining.[157] In Colombia, deforestation is occurring in the Pacific lowlands, and is associated with mining, infrastructure development and agricultural expansion.[158,159] At the national level, the colonization frontline in Colombia was advancing at around 0.84km/year[160] and from 2002 to 2007, 91,756 ha was lost in national parks.[161] In Panama, the deforestation from 1992 to 2008 was 881,226 ha. In some cases in the Darien and Panama provinces (the regions with the highest land use dynamics[162]), forests were replaced by teak plantations.[163] Some areas remain relatively pristine and protected areas provide some protection,[164] but the situation is changing due partly to pressures from mining and growing interest in agro-industry development.

Based on current and recent loss, WWF estimates deforestation will be 3 million ha in the Chocó-Darién as a whole by 2030. Projections in Colombia are that by 2030, national deforestation will equal 3.4 million ha[165] including in biodiversity hotspots in Quibdó-Tribugá and Patía-Mira regions.[166]

© PABLO CORRAL / WWF

Indigenous communities like this Awa man depend on the forests of Chocó-Darién for their livelihoods, but are threatened by development of infrastructure and extractive industries.

Deforestation front focus

CHOCÓ-DARIÉN

Chocó-Darién key data

Countries	Colombia, Ecuador and Panama
Deforestation (projected), 2010-2030	3 million ha
Top causes	Mining, infrastructure, agriculture

Forest cover Deforestation fronts

Chocó-Darién deforestation pressures

Agriculture, including **coca production**,[167] and colonization is estimated to cause 90 per cent of deforestation in Ecuador and Colombia and is a major cause of forest loss in Panama.

Expansion of **cattle ranching** is a significant cause.

Mining is a contributor to deforestation, particularly in Colombia[168] and Ecuador;[169] there were 564 mining contracts awarded in Colombia from 1990 to 2011; 1,092 in Ecuador (1992-2011), including 140 active affecting over 100,000 ha; and 42 in Panama. Colombia also has 20 oil blocks over 12.2 million ha, including 17 in reserved areas.[170]

Timber demand often fuels unsustainable logging.[171]

Analysis in the Ecuadorian Chocó found that population density, costs of travelling and distance to rivers are significantly related to forest loss.[172,173] **Road construction** and proximity to roads was found to be the largest single factor in deforestation.[174] Colombia has 18 road projects in the region, Ecuador has 9 and Panama is planning a major connecting road.[175]

OTHER

Population growth, **land scarcity** and **poverty** are all critical underlying causes,[176] coupled with armed conflict and narcotic production.[177]

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

CONGO BASIN

The Congo Basin* contains 20 per cent of the world's tropical forests[178] – some 301 million ha[179] – and makes up one of the most important wilderness areas left on Earth. A mosaic of rivers, forests, savannahs, swamps and flooded forests, the Congo Basin forests span six countries – Cameroon, Central African Republic, Democratic Republic of Congo (DRC), Republic of the Congo, Equatorial Guinea and Gabon – and are home to species such as mountain and lowland gorillas, bonobos, okapis, chimpanzees and elephants.

Change is coming to the Congo Basin, but sporadically, influenced by politics and economics in individual countries. In this region, deforestation is less a *front* than many individual *incursions*, and has proceeded more slowly than in other fronts. Losses were estimated as 0.19 per cent from 1990 to 2000, and 0.14 per cent from 2000 to 2010, with forest decreasing everywhere.[180] Deforestation rates are thus historically low, but some estimates show degradation is an increasing problem and is generally under-reported.[181,182] DRC has the highest deforestation, 6-7 million ha since 2000,[183] followed by Cameroon[184] and Equatorial Guinea.[185]

Drawing on published analysis,[186] WWF estimates that a minimum of 12 million ha are likely to be lost by 2030, with forests retreating to a core and contiguous forest fragmenting into three areas: one between Gabon, Cameroon and the Republic of Congo, and one each in eastern and western DRC. However, volatile politics and nervous investors make future projections difficult. A series of national and regional conflicts have resulted in many refugees,[187] which can increase or decrease overall rates of forest loss. Moreover, population in Congo Basin countries is expected to double between 2000 and 2030, leading to 170 million people concentrated mainly in urban areas (70 per cent of the population in Gabon and Congo are urban-dwellers), making forests close to large cities particularly at threat.[188]

* "Congo Basin" is used not as a hydrological definition but to describe the lowland dense humid forests of Central Africa.

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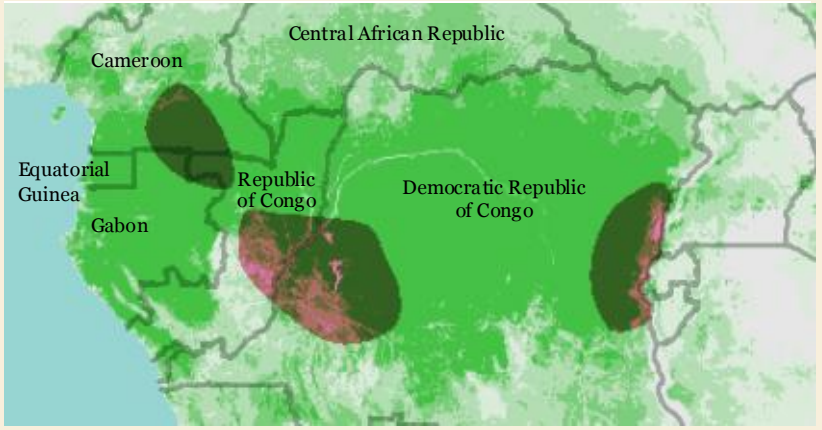
African forest elephant; Dzanga-Sangha Special Reserve, Central African Republic



Deforestation front focus

CONGO BASIN

Congo Basin key data

Countries	Cameroon, Central African Republic, DRC, Republic of Congo, Gabon
Countries with most deforestation	DRC, Cameroon, Equatorial Guinea
Deforestation (projected), 2010-2030	12 million ha
Top causes	Small-scale agriculture, fuelwood

© MICHEL GUNTHER / WWF

View of Minkébé Forest, Gabon

Congo Basin deforestation pressures

This is the leading cause of deforestation in the region, caused mainly by **shifting cultivation**; some of the forest returns during fallow periods make overall deforestation estimates hard to calculate.[189]

Fuelwood comprises an estimated 90 per cent of timber harvest[190] in the Congo Basin.

Large **agricultural plantation development** is likely to become more important, including for **palm oil;** 1.6 million ha of projects have been announced since 2009,[191] with four companies currently trying to secure 180,000 ha for palm oil in southern Cameroon[192] and large projects planned in DRC, including a Chinese company (ZTE) seeking 1 million ha for oil palm development.[193] **Rubber** and **soy** are also gaining importance.

Much of the **timber industry** is inefficient[194] and some probably unsustainable.[195] Illegal logging is suspected to be widespread,[196] accounting for up to half the timber extraction, mainly going to China[197] but some to the EU despite the existence of controls.[198] If the region experiences significant economic growth, the domestic market could also put pressure onto forest resources.

Large-scale mining, mainly by Chinese and Australian companies,[199] and **artisanal mining**[200] are both important. The latter is often in protected areas.[201] Mining permits sometimes overlap with conservation areas.[202] For example, over 120 exploration permits have been issued in Cameroon in the last two years[203] with overlapping conservation and mining permits,[204] and the nature of operations in DRC has also caused concern.[205]

Population increase and **infrastructure development** are important secondary causes of deforestation. Rising population is leading to expansion of urban areas, and threatening forests close to large cities and in other development areas. Realization of currently planned and funded transport infrastructure in the region is projected to increase deforestation by up to three times.[206]

Cattle may become more significant if the climate becomes drier as projected, although ranching is currently constrained by tsetse fly.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

EAST AFRICA

Eastern Africa has a diversity of forest types – vast open miombo woodlands, remnant coastal forests and unique mountain forest in the Eastern Arc. The deforestation threat extends to all forest types.

Remote sensing analysis found forest losses from 2000 to 2012 were concentrated in Mozambique (2,155,200 ha), Tanzania (1,990,300 ha) and Zambia (1,316,300 ha),[207] although precise figures are hard to calculate in this region.[208] Underlying drivers were population growth,[209] poverty,[210] perverse economic incentives,[211] weak institutions, environmental degradation[212] and climate change.[213]

The inland miombo woodlands are located mainly in the Zambesian Regional Centre of endemism with 8,500 floral species – 54 per cent of which are endemic – and no less than 20 biodiversity hotspots. It currently covers 380 million ha and is the dominant forest type of the region.[214,215] The miombo is home to more than 40 national parks, with protected areas covering 22 per cent of the region. When effective, these are vital in reducing the rate of deforestation. However, a combination of deforestation, release of soil carbon[216] and climate change could create a "tipping point" of degradation for miombo.[217]

The coastal forests of Tanzania and Kenya have been reduced to 10 per cent of their original area;[218] the whole biome is now thought to cover 625,000 ha – 58,700 ha in Kenya, 62,900 ha in Tanzania and 477,800 ha in Mozambique.[219] Protected areas exist but demonstrate varying levels of effectiveness.[220] The Eastern Arc forests have also undergone major conversion, with Tanzania losing close to 80 per cent;[221] current total estimates are that little more than 500,000 ha remain.[222]

In addition to outright land conversion, the region's forests are under pressure from over-harvesting for timber and fuelwood. Much of the logging is illegal – whether for precious timber destined for Asian markets[223] or to make charcoal for local use.[224] Overharvesting by licensed operators is also a problem due to poor enforcement of regulations.

Across Africa, oil, gas and mining projects are driving investment in new and improved infrastructure. "Development corridors" are intended to leverage this to spur local development through small to medium enterprises in industries such as agribusiness and tourism.[225] Forests within these development corridors are vulnerable to loss or severe degradation through conversion to agriculture or colonization by settlers seeking employment and other economic opportunities. The East African deforestation front thus extends inland from the coast into miombo woodlands along the following development corridors:

JOHN KABUBU / WWF-COASTAL EAST AFRICA

A forest cleared for farming and charcoal production in Rufiji, Tanzania

- Mtwara (Malawi, Mozambique, Tanzania, Zambia)
- Nacala (Malawi, Mozambique, Zambia)
- Beira (Mozambique, Zimbabwe)
- Limpopo (Mozambique, Zimbabwe).

Zambia and northwest Zimbabwe are in the centre of the miombo, but have road and rail connectivity to the west and east coasts. Zambia plans to leverage its central location to become the region's logistical hub for freight (e.g. through the Chipata-Mchinji railway link to the Nacala corridor). Zimbabwe is also experiencing rapid growth in transport links (e.g. Victoria Falls and Kariba airports), settlement and other infrastructure (e.g. hydropower in the Batoka gorge). Transportation infrastructure is likely to compound the levels of deforestation in the miombo woodlands of both countries through increased accessibility, new settlements, conversion to agricultural land and related edge effects in forested areas.

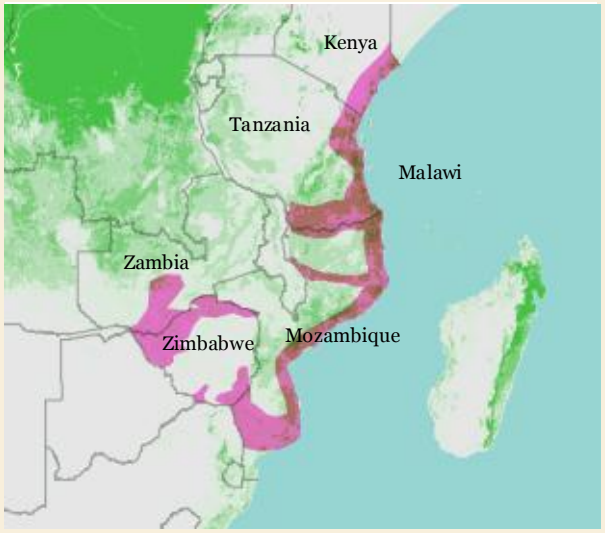
WWF projects potential forest loss in the East Africa region of up to 12 million ha between 2010 and 2030, which is echoed by other researchers,[226] but impacts will vary by country and forest type. Projections are based on continuation of recent trends in coastal areas, particularly in Mozambique, and accelerated rates of loss further inland, associated with infrastructure and development corridors extending into miombo woodlands.

Deforestation front focus

EAST AFRICA

East Africa key data

Countries	Kenya, Malawi, Mozambique, Tanzania, Zambia, Zimbabwe
Dominant forest type	Miombo (380 million ha)
Deforestation, 2000-2012	Around 6 million ha
Deforestation (projected), 2010-2030	12 million ha
Countries with most deforestation	Mozambique, Tanzania, Zambia
Top causes	Crop and livestock expansion



Forest cover Deforestation fronts

East Africa deforestation pressures

In development corridors and areas of high population density, **small-scale agriculture** and **in-migration** are a major cause of deforestation.[227,228,229] Out-grower schemes for cotton, tobacco[230] and other cash crops are creating and expanding farming blocks in Zambia and Zimbabwe.

Livestock expansion is a leading cause of deforestation.[231]

Uncontrolled fires have been identified by stakeholders as a major issue in the miombo,[232] with larger, more intense fires associated with human activity.

Charcoal use is increasing,[233] most commonly near roads[234] and cities.[235] Much of it involves illegal logging.[236]

Unsustainable commercial logging, often illegal, is causing severe degradation to forests in the region.[237]

Infrastructure development is significant, including new roads, rail links and dams, some of which are funded by China.[238]

Large-scale mining and related infrastructure development as well as in-migration are increasing and contributing significantly to deforestation,[239] for example the mining projects at Lumwana and Kalumbila by Barrick Gold and First Quantum in northwest Zambia.

A growth in **plantation** and **biofuel** crops, as well as **pulp**[240] and **bioenergy**[241] **plantations**, is also occurring.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

EASTERN AUSTRALIA

Australia is the only place on Earth where all three major divisions of mammals are present: the egg-laying monotremes (platypus and echidna); the marsupials; and the placental mammals. At least 130,000 species of native animals and plants, nearly 8 per cent of all life on Earth, are found in Australia.[242]

Of the 1,250 plant and 390 animal species listed as threatened by the Australian government (excluding extinct and marine species), 964 plant species (77 per cent) and 286 animal species (73 per cent) have deforestation and resulting fragmentation or degradation of their habitats listed as threats.[243]

The forests and woodlands of eastern Australia comprise the six WWF terrestrial ecoregions within the Australian states of New South Wales (NSW) and Queensland: *Queensland tropical rain forests, Eastern Australia temperate forests, Brigalow tropical savannah, Eastern Australia mulga shrublands, Southeast Australia temperate forests* and *Southeast Australia temperate savannahs* (see map).

At least 10 per cent of native Australian terrestrial species are endemic to this region, and 24 per cent have the majority of known records in this region.[244]

One of the symbols of Australia, the koala, although not confined to this front, was recently listed vulnerable to extinction due to deforestation in Queensland and NSW and consequent fragmentation.[245]

Two of the ecoregions, *Queensland tropical rainforests* and *Eastern Australian temperate forests*, comprise the *Forests of Eastern Australia* global biodiversity hotspot.[246] About 70 per cent of this hotspot is cleared or disturbed and only 18 per cent protected.

Deforestation in the northern ecoregions[247] is a substantial contributor of sediment pollution affecting the Great Barrier Reef. Soil surface rainfall runoff is shown to increase between 40 and 100 per cent due to deforestation in this area.[248] Beyond the short-term effect of deforestation on soil erosion, using the cleared land for livestock and crops means a continual flow of sediment, nutrient and agri-chemical pollution to the Reef.[249]

Until the enactment of new laws in NSW and Queensland in 2005, land clearing was rampant. At its peak in Queensland in 1999, nearly half a million hectares were cleared per year. In 1990, emissions from deforestation were 25 per cent of Australia's total greenhouse gas emissions. By 2012 this had sunk to 6 per cent, although total emissions remained much the same.[250]

Despite a major reduction in deforestation rates in Australia due to such laws, recent and projected weakening of key legislation in the frontline states of Queensland and NSW threatens a resurgence in deforestation.

Queensland saw a pronounced fall in clearing rates following a ban in 2006 on large-scale deforestation for agriculture, but a change in laws has led to a resurgence of clearing, both legal and newly legalized. There's no reliable information yet as to whether there was a shift back toward clearing of primary forest. However, WWF expects such a shift to occur because the 2006 ban on large-scale clearing of primary forests was partly removed in 2013.

In NSW, rates of deforestation are much lower than in Queensland, around 50-100,000 ha per annum, including both primary and secondary forest. Large-scale deforestation for agriculture was heavily restricted in 2005. Although new approvals have contracted dramatically, actual deforestation has been slow to respond due to exemptions and ongoing clearing under earlier approvals.[251] Of immediate concern in NSW is that what gains have been made are under threat of being lost due to a current proposal to repeal the deforestation laws and replace them with weaker substitutes.[252]

Deforestation across the entire front ranges from over 3 million ha of all forests lost from 2010 to 2030 to 3 million ha of primary forests in addition to over 3 million ha of secondary forests cleared by 2030. These projections depend on whether Queensland and NSW decide to change their land clearing laws. WWF conservatively has not included, in clearing of secondary forests, any reclearing of forests cleared within the same time period. Permanent offsets for reforestation were also excluded where known (NSW only).

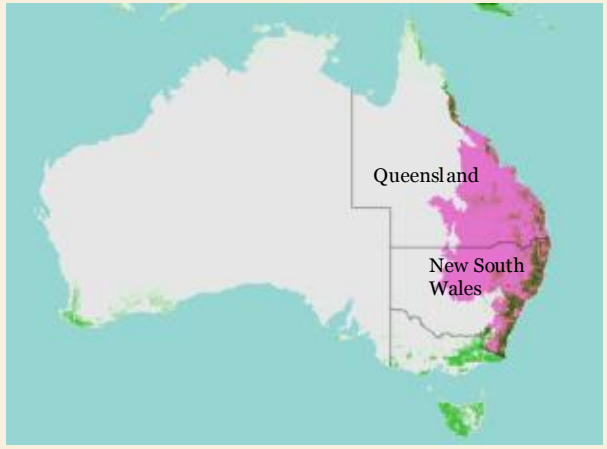
The Cathedral Fig Tree, a massive green fig tree (*Ficus virens*) in the Daintree Rainforest on the Atherton Tablelands, Queensland, Australia.

Deforestation front focus

EASTERN AUSTRALIA

THEO ALLOFS/GETTY IMAGES

Koalas were recently listed vulnerable to extinction due to deforestation.



Forest cover Deforestation fronts

Eastern Australia deforestation pressures

Pasture creation for livestock is the dominant driver, accounting for 88 per cent of clearing of both primary and secondary forests and woodlands. In Queensland, mature mulga forest is bulldozed to feed stock directly on the foliage, while opening up land for pasture. This exemption continued despite the 2006 ban on broadscale clearing in that state.

Forestry and **conversion to plantations** is a significant driver in New South Wales Eastern Temperate Forests, but relatively minor in Queensland.

Cropping is a relatively minor component but dominates in some key areas, and is greater in NSW than in Queensland.

Mining is a minor component overall, but open cut **coal mines** are significant in some portions of the central Brigalow Savannah and in the Eastern Temperate Forests.

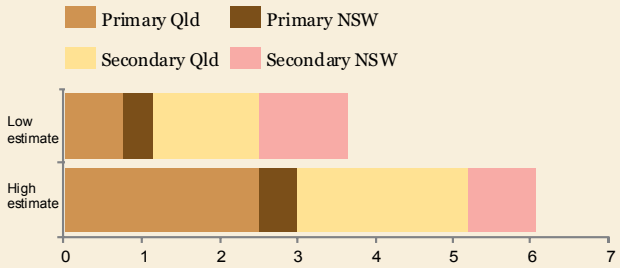
Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Eastern Australia key data

States	New South Wales (NSW), Queensland
Type of forests most at risk	Sub-humid eucalypt and acacia forests and woodlands
Key species affected	Tree-dependent birds, koalas, possums and gliders
Deforestation (projected), 2010-2030	3-6 million ha
Main driver	Pasture for livestock



Estimated areas likely to be cleared 2010-2030 (million hectares)

Deforestation front focus

GREATER MEKONG

Tigers, elephants, saolas, Mekong Irrawaddy dolphins, and thousands of other lesser-known but equally threatened species form a complex web of life in the Greater Mekong. The region encompasses the countries of Cambodia, Lao PDR, Myanmar, Thailand and Vietnam. The economies in the region are booming, but with this comes the complex task of balancing legitimate needs for development while safeguarding forest ecosystems and ecosystem services.

© WWF-CAMBODIA

Rubber plantation after deforestation, Eastern Plain Landscape, Cambodia

Before the 1970s, most of the Greater Mekong was highly forested. However, today most of the region's natural forests have been reduced, severely fragmented or degraded,[253,254] including from the impacts of wars.[255] Only about half of the Greater Mekong land area is currently forested, with only 13 per cent of primary forests remaining.[256] This, alongside poaching and wildlife trade, is creating a biodiversity crisis.[257] Primary forest has virtually disappeared in Vietnam, is extremely low in Cambodia, and scarce in Lao PDR, Myanmar and Thailand.[258] Natural regeneration[259] and plantation establishment in China[260] and Vietnam[261] has recovered some area under trees, but not natural forest.

Between 1973 and 2009 forests in the Greater Mekong declined by almost a third: 43 per cent in Vietnam and Thailand; 24 per cent in Lao PDR and Myanmar; and 22 per cent in Cambodia. Intact forest area was reduced from 70 to 20 per cent of the region,[262] leaving around 98 million ha of forest.[263] Mangroves have been severely affected,[264] partly by wartime defoliants,[265] with the Lower Mekong countries losing an estimated 222,650 ha between 1980 and 2005. Illegal logging, including in protected areas, is a major problem in Cambodia,[266] Myanmar[267] and Lao PDR,[268] but prevalent throughout the region.[269]

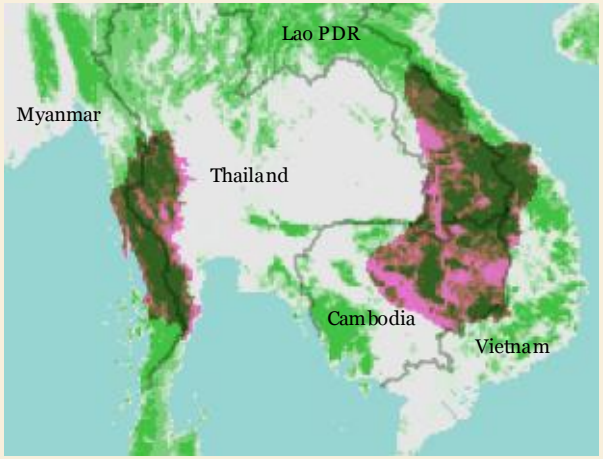
WWF projects further losses of 15-30 million ha by 2030, with only 14 per cent of remaining forest consisting of core, intact areas.[270] Losses are likely to remain highest in Cambodia, Lao PDR and Myanmar, where 2010-2020 deforestation is projected at 4.8 million ha.[271] A critical cause amplifying deforestation pressures is weak governance, anarchic development and economic dependence on natural resources.[272]

Deforestation front focus

GREATER MEKONG

Greater Mekong key data

Countries	Cambodia, Lao PDR, Myanmar, Thailand, Vietnam
Countries with highest deforestation currently	Cambodia, Lao PDR, Myanmar
Deforestation, 1973-2009 (excluding China)	49 million ha
Deforestation (projected), 2010-2030	15-30 million ha
Top causes	Crop plantations, agriculture, unsustainable and illegal logging



Forest cover Deforestation fronts

Greater Mekong deforestation pressures

Conversion of forest for **crop plantations** and **agriculture**, namely **sugar**, **rice**, **rubber**[273] and **biofuels**[274], is a key cause of deforestation in the region. In Myanmar alone, over 2 million ha of forest have been allocated to agriculture;[275] between 2011 and 2013, 1.15 million ha of primary forest was cleared each year for timber production and conversion to agriculture.[276]

Rapid development of roads and infrastructure leads to **new settlements** that encroach on forest for small-scale agriculture development.

Legal and policy restrictions on logging in Vietnam, China and Thailand, coupled with **growing demand**,[277] are driving unsustainable[278] and **illegal**[279] **logging** for export and indirect land-use change in Cambodia, Lao PDR and Myanmar.[280] Illegal logging, including within protected areas, is prevalent throughout the region.[281]

Establishment of **tree plantations** (acacia, eucalyptus), many of which are still small scale,[282] is a growing threat, particularly in Vietnam and Lao PDR, where it is supported by government incentives.

Fast economic growth in the Mekong region is translated on the ground into rapid and often anarchic development of **roads and infrastructure**.

Dam development has a relatively small impact on total forest cover, but can be an important factor in fragmentation and loss of connectivity,[283] and is a factor in forest loss in Thailand.[284]

Wood energy and charcoal consumption is stable and even growing in some countries, accelerating forest degradation.

OTHER

Mangroves are replaced with **shrimp farms** and **rice production**.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

NEW GUINEA

New Guinea and the islands around it span two countries. The eastern portion comprises the country of Papua New Guinea (PNG), while the western part forms the Indonesian provinces of Papua and West Papua. A treasure trove of biological and cultural diversity, New Guinea and its neighbouring islands are home to the largest remaining tracts of tropical forest in the Asia-Pacific region and more than one in six of the world's language groups.

© BRENT STIRTON / GETTY IMAGES

Pukapuki man in a traditional dug-out canoe. Papua New Guinea

Land use is shaped by two very different economic systems – the first involves most of the rural population and centres on traditional subsistence gardening, hunting and gathering; while the second is focused on industrial, export-oriented resource extraction and plantations.

The New Guinea region retains significant forest cover (some 82 million ha), but faces a growing deforestation threat. According to data from Global Forest Watch, the region lost around 1 million ha of forest from 2001 to 2012 (the Indonesia provinces of Papua and West Papua lost 373,000 ha, while PNG lost 630,000 ha).[285] The rate of forest loss could surge, however, if current proposals for agricultural development are realized. According to a 2010 plan, the government of PNG expects to see substantial growth in its four major export crops (palm oil, coffee, cocoa and copra) by the year 2030, with an expansion in plantations of 5–6 per cent annually.[286] Special Agricultural Business Licences (SABLs) have been granted for over 5 million ha of customary land.[287]

Large-scale agricultural developments are also proposed in the Indonesian provinces of Papua and West Papua. For example, the Merauke Integrated Food and Energy Estate concept, launched in 2010 by the Indonesian government, aims to transform 1.2 million ha of forest land in West Papua province into large-scale agribusiness estates.[288] The future of this proposal is uncertain. As of March 2015, the Merauke district government had zoned only 258,000 ha for agricultural development, and while over 850,000 ha of palm oil and sugarcane permits had been granted, most were inactive.[289] A study of various government planning and investment maps for Papua province in 2009 found up to 2.8 million ha were proposed for plantation development.[290]

In both PNG and Indonesia, much uncertainty remains over the extent to which the proposals will become reality. They are the subject of various official inquiries and legal challenges, and their commercial viability is questionable. With many of PNG's SABLs, for example, there is mounting evidence that they are merely ploys to gain permits to clear-fell timber, with the leaseholders having little capacity or interest in developing the cleared land for agriculture.[291,292] In Indonesia, allocation of new concessions for logging or conversion of native forests is under a moratorium, which will expire in 2015. The moratorium maps indicate that over 600,000 ha of forest in the province of Papua alone would be vulnerable to potential clearance for tree plantation if the moratorium is allowed to expire.[293]

Studies have also identified commercial logging and expanding subsistence agriculture as major causes of deforestation and forest degradation.[294] However, there is debate about the extent to which these activities cause outright forest loss, due to the many variables affecting regeneration dynamics after forests are degraded by logging or cleared for shifting cultivation.[295,296]

WWF projects that the New Guinea region could lose up to 7 million ha of forest between 2010 and 2030. This is based on the following assumptions: (a) some, but by no means all, current land clearing proposals are realized; (b) the total land area cultivated for subsistence agriculture continues to expand gradually due to population pressures and other causes; and (c) loss of a portion of the forests in timber concessions continues due to encroachment, fire and illegal logging, mainly after the cessation of commercial logging operations.

Deforestation front focus

NEW GUINEA

New Guinea key data

Countries	Papua New Guinea, Indonesia
Deforestation, 2001-2012	1 million ha
Deforestation (projected), 2010-2030	7 million ha
Top causes	Agriculture, clear-fell timber harvesting

Forest cover Deforestation fronts

New Guinea deforestation pressures

Under various project proposals and plans, up to 10 million ha of currently forested land is slated for **agricultural development**, but many of these are unlikely to proceed due to legal challenges, operational risks and lack of commercial viability.

Due to rising populations, a gradual expansion of the total area under **subsistence agriculture**, including **slash and burn**, is likely to result in future forest loss.

Most **timber harvesting** permits authorize selective logging only so do not result in large areas of outright forest loss. However, based on historical trends, a significant portion of the forests in timber concessions is likely to be later converted to subsistence agriculture or degraded beyond the point of recovery by **illegal logging or fire**.

While there are no pulp mills, **acacia plantations** in the Indonesian portion supply woodchips for export mainly to China, to meet growing demand from expanding pulp and paper mills.[297] Potential future expansion of **pulp plantations** could lead to forest conversion.

Heavily degraded forests are often drier and more vulnerable to **permanent fire damage** than healthy closed-canopy forests.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

Deforestation front focus

SUMATRA

The Indonesian island of Sumatra is the sixth largest island in the world and holds some of the richest and most diverse tropical forests on the planet. They provide livelihoods to millions of people and give shelter to critically endangered species such as the Sumatran rhino, elephant, orang-utan and tiger.

Sumatra, especially Riau province,[298] has become the centre of Indonesia's paper and palm oil production.[299] Vast stretches of acacia and oil palm monocultures have replaced natural forests and some of the world's largest pulp mills and palm oil refineries line the rivers and coasts. Riau province alone hosts over 200 crude palm oil extraction mills.[300]

Sumatra's ecosystems are not well represented in its protected area system.[301] Most parks and reserves straddle the island's mountain ridge, few cover its vast low-lying areas and peat swamps. From 1985, as the palm and paper sectors took hold, Sumatra suffered large-scale deforestation and many of its ecosystems became critically endangered.[302, 303] By 2014, Sumatra had lost 13.9 million ha (55 per cent) of its natural forests. Only 11.5 million ha of natural forest remained in severely fragmented blocks, covering 26 per cent of the island.[304] Protected areas, especially those recognized at the national level, have proven more resistant to deforestation than other areas though even they are being cleared for agricultural plantations.[305,306,307]

In Sumatra, outright deforestation was often preceded by industrial selective logging followed by illegal logging. From there deforestation has usually progressed along two paths: (1) a government declaration that the area is degraded, the rezoning of the area for conversion into pulpwood or palm oil plantations, and clearing of remaining forest for plantation development; or (2) settlement of an area by migrants, and deforestation for small-scale agriculture, oil palm and rubber plantations.

While some arms of the government have developed plans to stabilize and even reverse forest loss,[308,309] the status of these plans remains unclear and the desired impact has not materialized. All of Sumatra's remaining forests are in great danger of deforestation if business as usual continues and lack of governance prevails. Elevation and soil type are no deterrents. The last forests to go will be the protected areas with the steepest slopes.

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Palm oil plantation. Tesso Nilo, Riau province, Sumatra.

Based on WWF data,[310] Sumatra lost 1.7 million ha of natural forest between 2008 and 2014. The deforestation rate outside protected areas was 2.9 per cent per year, mainly for pulp and palm oil production in Riau and Jambi provinces. Inside protected areas, it was 0.4 per cent. Assuming similar future rates of deforestation, WWF projects up to 5 million ha of deforestation between 2020 and 2030.

Deforestation front focus

SUMATRA

Sumatra key data

Countries	Indonesia
Deforestation, 1985-2014	13.9 million ha natural forest loss (55% loss)
Deforestation (projected), 2010-2030	5 million ha
Top causes	Small-scale agriculture, infrastructure development

Forest cover Deforestation fronts

Sumatra deforestation pressures

Palm oil from small producers is driving deforestation even into protected forests and national parks.[311,312]

Road construction has been linked to deforestation[313,314] and its impact will accelerate as the Trans-Sumatra toll road is realized[315] and if a new bridge connects the island to mainland Malaysia.[316]

Licensed **selective logging** has all but ceased; less than 10 per cent of the permits remain active. Encroachment and illegal logging in retired logging concessions are rampant. Most have been rezoned for legal deforestation for pulpwood or palm oil plantation development.[317]

Indonesia's two biggest **paper** players have pledged near zero deforestation,[318,319] though third parties continue to clear forests set aside for conservation in the concessions of these companies, and their suppliers continue to clear forests not designated for protection due to flawed conservation and social value assessments.[320,321] The future impacts of the sector on Sumatra's forests remain uncertain due to the gap between plantation wood supply and existing and planned milling capacity, and government plans to allocate more forested land for wood supply and plantation development.

Fires are often set to clear land for small-scale agriculture operations and to clear logging debris, but are also often found in large commercial concessions.[322] When these fires "escape" they can severely degrade nearby natural forests and drained peatlands.

Large palm oil producers such as Asian Agri, Golden Agri Resources, Musim Mas and Wilmar have recently pledged to halt forest conversion and pursue Roundtable on Sustainable Palm Oil certification. However, these voluntary commitments are at odds with policies of some government agencies that support further expansion of agriculture into forest areas. Furthermore, many palm oil mills continue to accept palm oil bunches from smallholders who have acquired land through illegal forest conversion.

Primary cause of forest loss and/or severe degradation

Important secondary cause of forest loss and/or severe degradation

Less important cause of forest loss and/or severe degradation

GLOSSARY, NOTES AND ACRONYMS

Biodiversity: a shortened form of biological diversity, describing variation within and between species and at ecosystem level.

Deforestation: Conversion of forest to another land use or long-term reduction of tree canopy cover. This *includes* conversion of natural forest to tree plantations, agriculture, pasture, water reservoirs and urban areas; but *excludes* logging areas, where the forest is expected to regenerate naturally or with the aid of silvicultural measures.

Degradation: Changes within the forests that negatively affect the structure or function of the stand or site, and thereby lower the capacity to supply products and/or ecosystem services.

Living Forests Model: developed for WWF by the International Institute for Applied Systems Analysis (IIASA[323]) the model draws on G4M and GLOBIOM models[324] to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, GDP and infrastructure. GLOBIOM is an economic model that allocates land and resources optimally based on projected commodity and ecosystem service demands under future GDP, population and policy scenarios.

Protected area: a clearly defined geographical space that is recognized, dedicated and managed through legal or other effective means in order to achieve the long-term conservation of nature with associated ecosystem services and cultural values.[325]

Zero Net Deforestation and Forest Degradation (ZNDD): WWF defines ZNDD as ***no net forest loss through deforestation and no net decline in forest quality through degradation***. ZNDD provides some flexibility: it is not quite the same as no forest clearing anywhere, under any circumstances. For instance, it recognizes people's right to clear some forests for agriculture, or the value in occasionally "trading off" degraded forests to free up other land to restore important biological corridors, provided that biodiversity values and net quantity and quality of forests are maintained. In advocating ZNDD by 2020, WWF stresses that: (a) most natural forest should be retained — the annual rate of loss of natural or semi-natural forests should be reduced to near zero; and (b) any gross loss or degradation of pristine natural forests would need to be offset by an equivalent area of socially and environmentally sound forest restoration. In this accounting, plantations are not equated with natural forests as many values are diminished when a plantation replaces a natural forest.

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Contributors
Editor in Chief: Rod Taylor
Technical Editors: Nigel Dudley, Sue Stolton
Deforestation fronts researcher: Sophie Clay
GIS: Aurelie Shapiro, WWF-Germany
Editorial Team: Huma Khan, Barney Jeffries

Thanks to colleagues at WWF including: Naikoa Aguilar-Amuchastegui: WWF Forest Climate Programme (FCP); Lucy Aquino: WWF-Paraguay; Mauro Armelin: WWF-Brazil; Will Ashley-Cantello: WWF-UK; Jean Bakouma: WWF-France; Cesar Balbuena: WWF-Paraguay; Thomas Barano: WWF-Indonesia; Sarah Bladen: formerly WWF Greater Mekong Programme, Hanoi; Neil Burgess: UNEP-WCMC formally WWF Conservation Science Programme; Henry Chan: WWF-Malaysia; Stuart Chapman: WWF Greater Mekong Programme; Sandra Charity: WWF Living Amazon Initiative; Paul Chatterton: WWF Forest and Climate Programme; Tim Cronin: WWF-Australia; Pete Cutter: formerly WWF Greater Mekong Programme, Bangkok; Andre da Silva Dias: WWF Living Amazon Initiative; Adrian Dellecker: WWF International; Kalame Fobissie: WWF-CARPO; Elaine Geyer-Allely: WWF International; Peter Graham: WWF Forest and Climate Programme; Kwai Hin Han: WWF-Malaysia; Nyeema Harris: Luc Hoffmann Institute; Mary Lou Higgins: WWF-Colombia; David Hoyle: WWF-Cameroon; Milward Kuona: WWF Miombo Programme; Thibault Ledecq: WWF Greater Mekong Programme; Sabien Leemans: WWF-Belgium; Anna Carolina Lobo, WWF-Brazil, Marc Languy: WWF Congo Basin Programme; Karen Lawrence, WWF-UK; Gretchen Lyons: WWF International; Tom Maddox: WWF-Indonesia; Claudio Maretti: WWF Living Amazon Initiative; Mayra Milkovic: Fundacion Vida Silvestre, Argentina; Federico Monte Domecq Rolon: WWF-Paraguay; Geoffrey Mwangela: WWF-Tanzania; Emmanuelle Neyroumande: WWF-France; Nyambe Nyambe: WWF-Zambia; Denise Oliveira: WWF Living Amazon Initiative; Bruno Perodeau: WWF-CARPO; Miriam Prochnow: Apremavi, Brazil; Anwar Purwoto: WWF-Indonesia; Juan Carlos Riveros Salcedo: WWF-Peru; Steven Price: WWF-Canada; Enos Shumba: WWF Miombo Programme; Michael Stuewe: WWF-US; Cesar Freddy Suarez: WWF-Colombia; Mario Barroso: WWF-Brazil; Martin Taylor: WWF-Australia; Daniel Tiveau: WWF-Cameroon; Yumiko Uryu: WWF-Indonesia; Jaap van der Waarde: WWF-Netherlands; Linda Walker: WWF-US; Stephan Wulffraat: WWF-Indonesia; Timothy Geer: WWF International; Ivy Wong: formerly WWF-Malaysia; Mark Wright: WWF-Guianas; Julia Young: WWF-UK; WWF-India.

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