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.

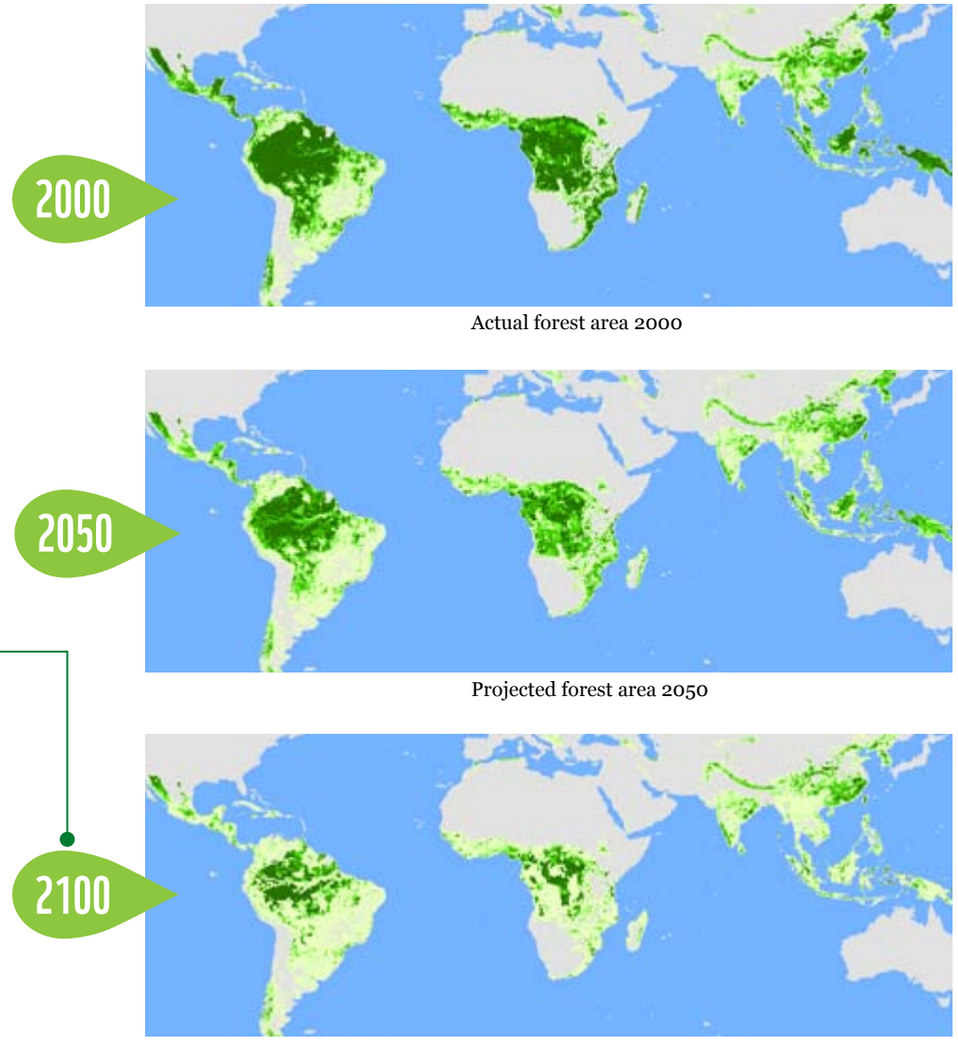
Many forests are ancient, living monuments to the Earth's long history. Others are still young, growing quickly over once-degraded land, holding deserts at bay. Pure rivers run through them. A proportion of the world's forests are managed, sustainably and with care, for timber, food, medicines, as sources 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

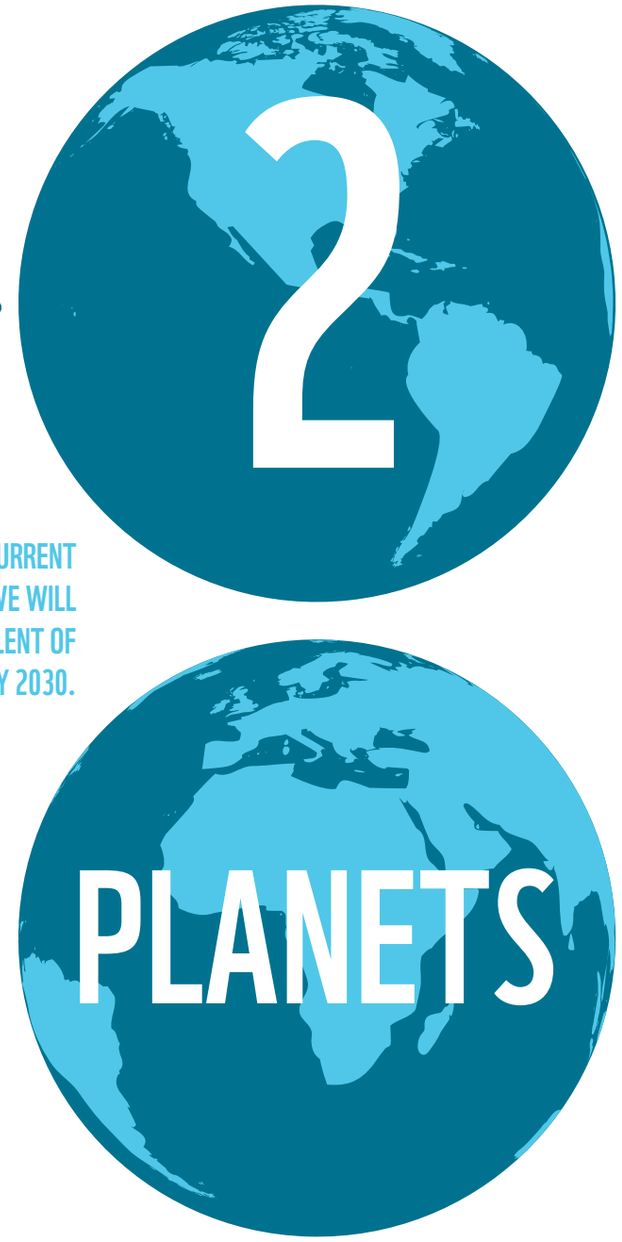
WWF aspires to a future where humanity's global footprint stays within the Earth's ecological limits and the planet's natural resources are shared equitably. People everywhere can lead happy, healthy lives using their fair share of the Earth's resources, leaving space for wildlife and natural landscapes.

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.



THE LIVING FORESTS VISION

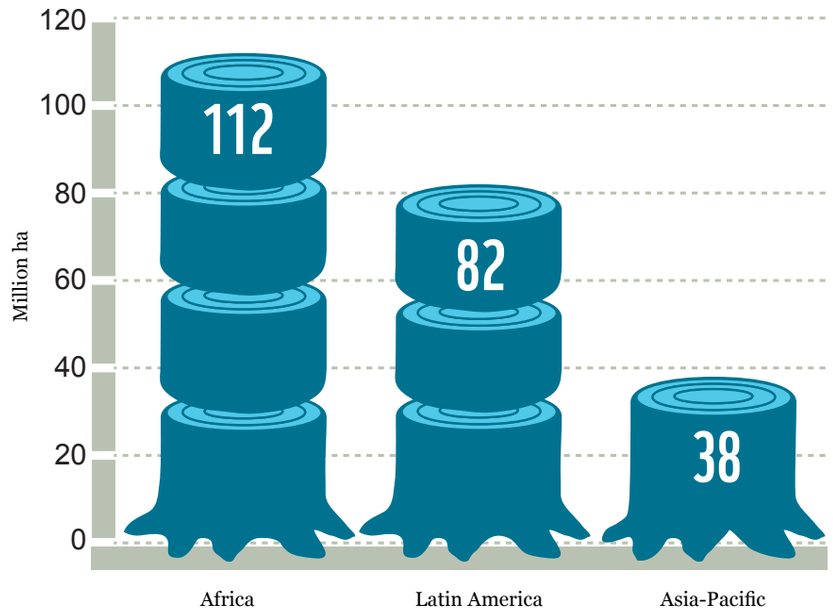
We believe forests make a vital contribution to this vision. However, their full potential will only be realized if we halt **deforestation** and forest **degradation**.

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.

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



Projected tropical deforestation, by region, between 2010 and 2050 under the Do Nothing Scenario (see page 7).

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.

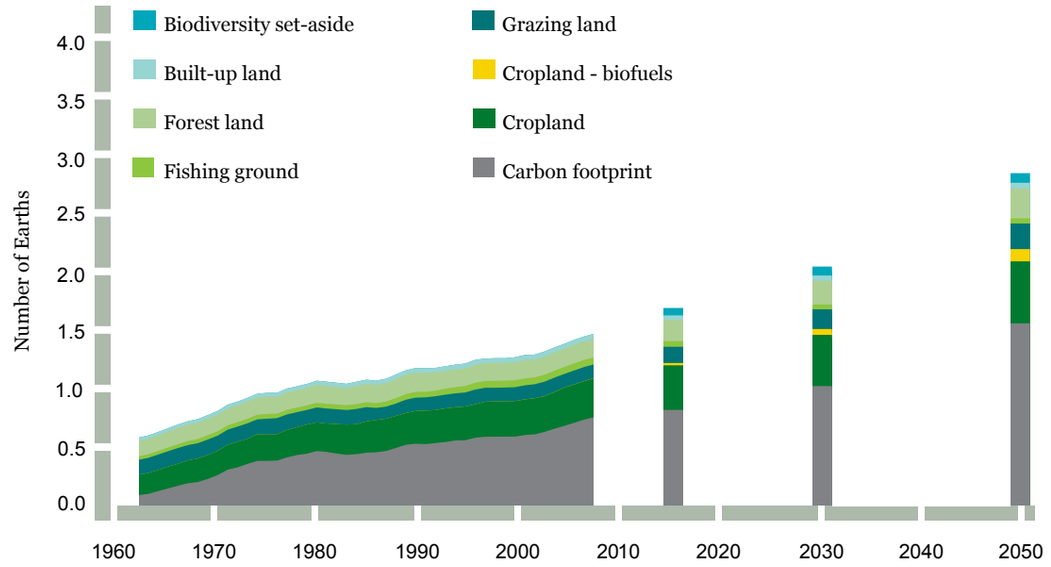
THE LIVING FORESTS CHALLENGE

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]

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

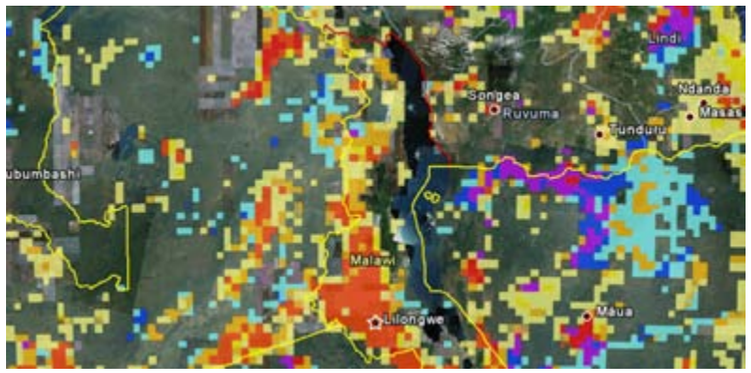
Models help us to develop and compare different future scenarios, look at the implications of particular policies, test assumptions and start conversations. Models are not perfect representations of reality: they inform the debate rather than make exact predictions.

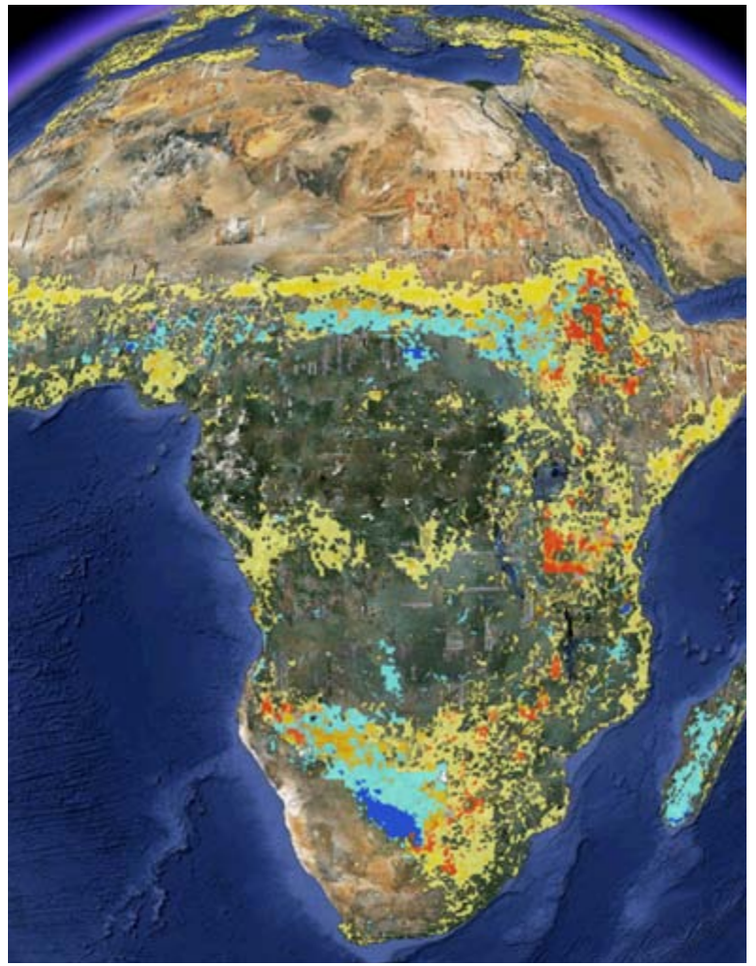
The Living Forests Model draws on IIASA's G4M and GLOBIOM models[9a] to show geographically explicit land-use change under different scenarios. The G4M model projects future deforestation and land-use change by extrapolating from historical trends and taking into account future projections for population, 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

2050

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

3

SCENARIOS WERE DEVELOPED FOR REDUCTIONS IN FOREST LOSS AND DEGRADATION

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:

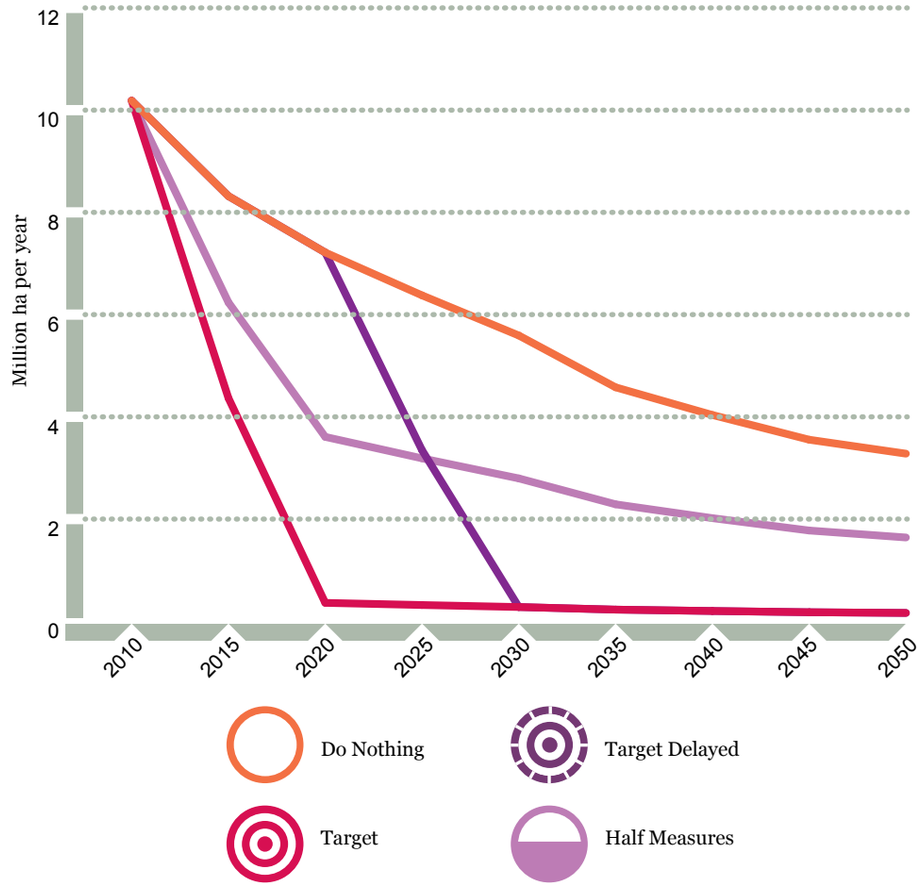
- by 2050, world population reaches 9.1 billion and per-capita GDP almost triples
- demand for commodities is driven by changes in affluence (measured by GDP) and human population growth
- aggregate historical trends in agricultural productivity gains continue[11]
- the average human diet in a country 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

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.



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.

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.

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

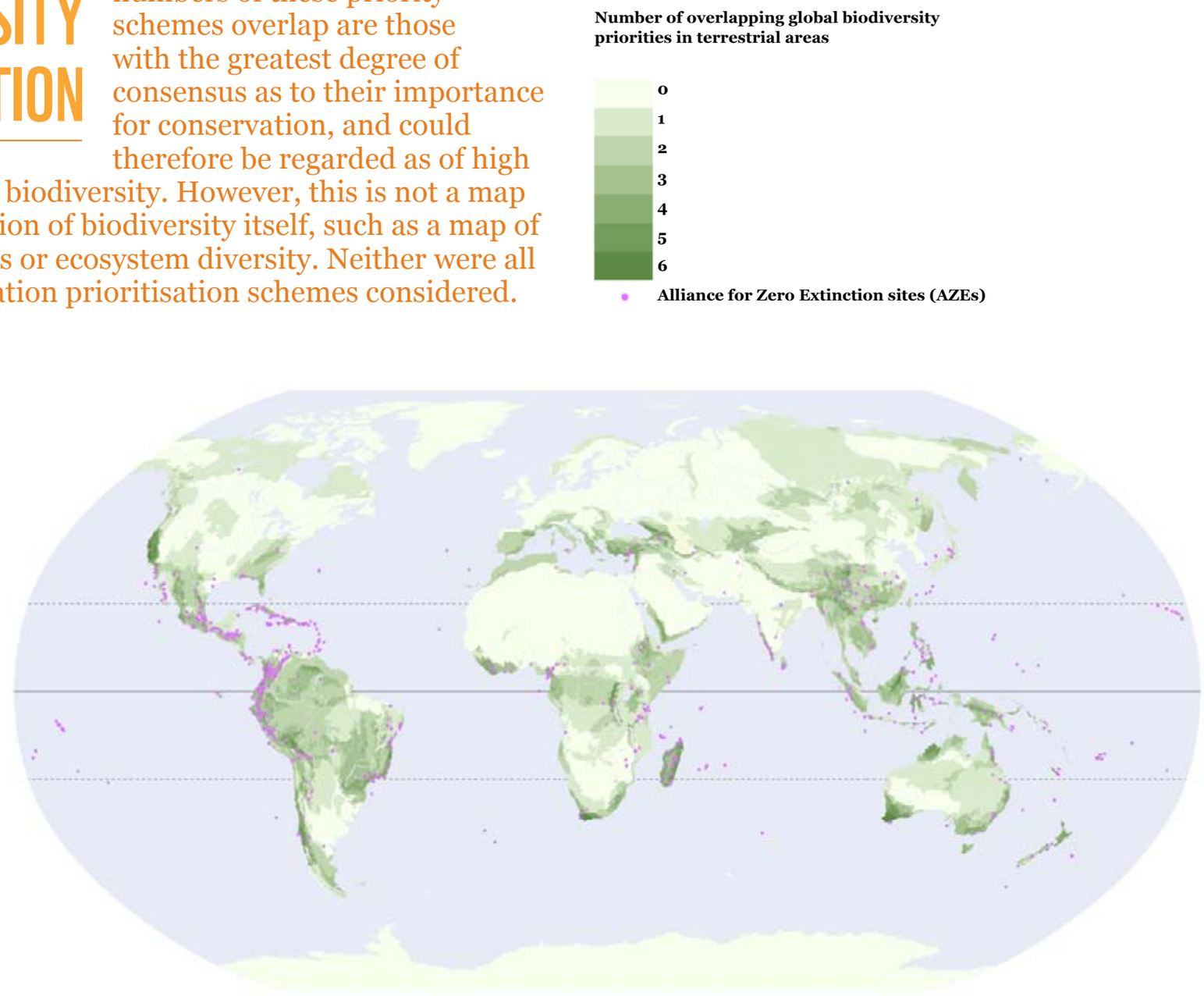
Amphibian Diversity Areas: Duellman, W.E. (ed) (1999). *Patterns of distribution of amphibians: a global perspective.* John Hopkins University Press, Baltimore, USA.

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

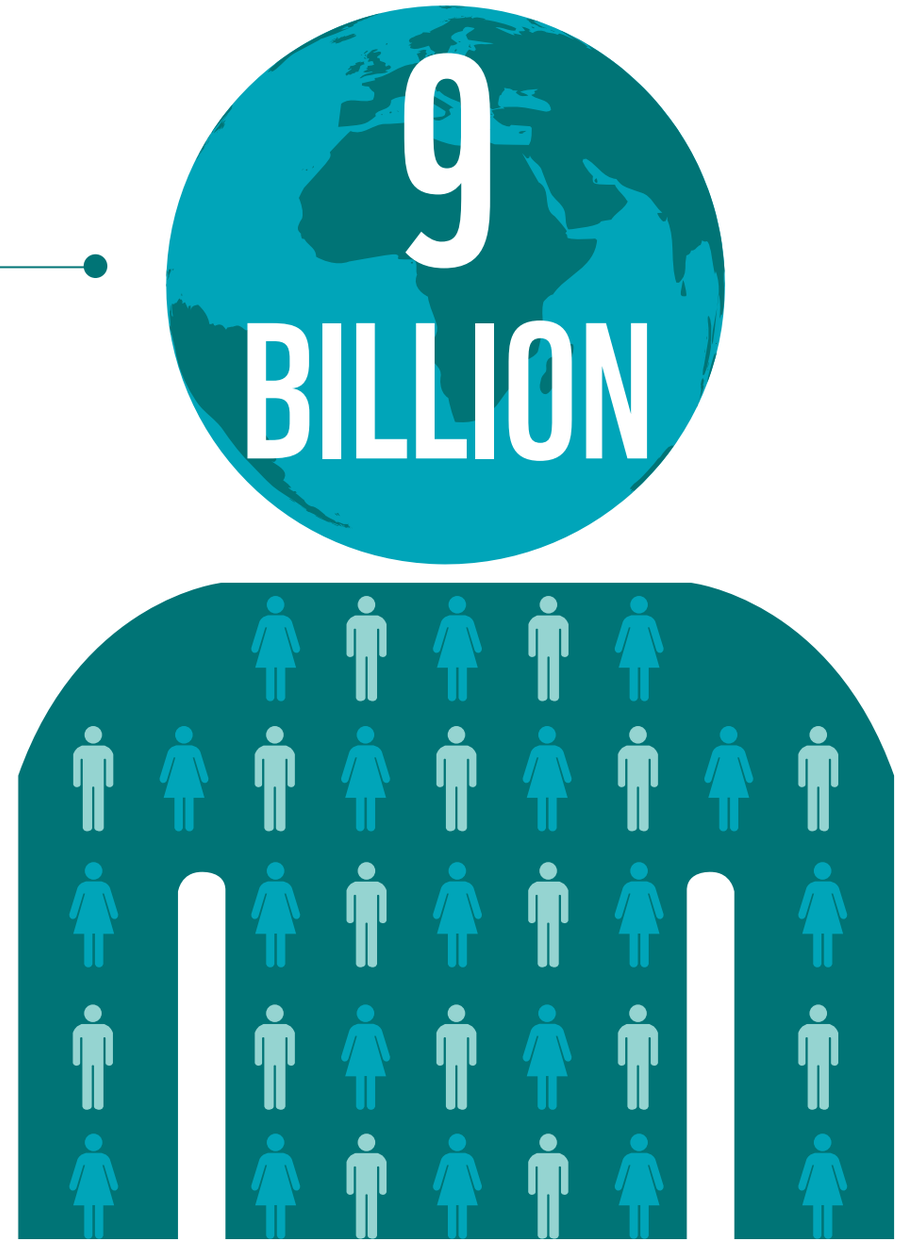
The stark **Millennium Ecosystem Assessment** conclusion that 60 per cent of the world's ecosystem services are degraded has led to the development of models and strategies to put us on a different path.

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]

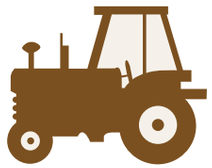
THE GLOBAL POPULATION WILL SURPASS 9 BILLION BY 2050



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.

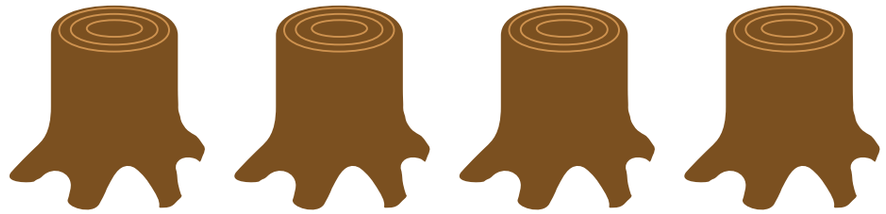
1. **Biodiversity:** ZNDD strategies should never be at the expense of biodiversity conservation; examples of this would include agricultural expansion in highly biodiverse **grasslands** to take pressure off forests or replacing pristine natural forests with heavily managed secondary forests or plantations. 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.

PROHIBIT TRADE IN ILLEGALLY SOURCED TIMBER

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**.

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



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.

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.

Forest degradation often begins a slippery slope to deforestation

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.

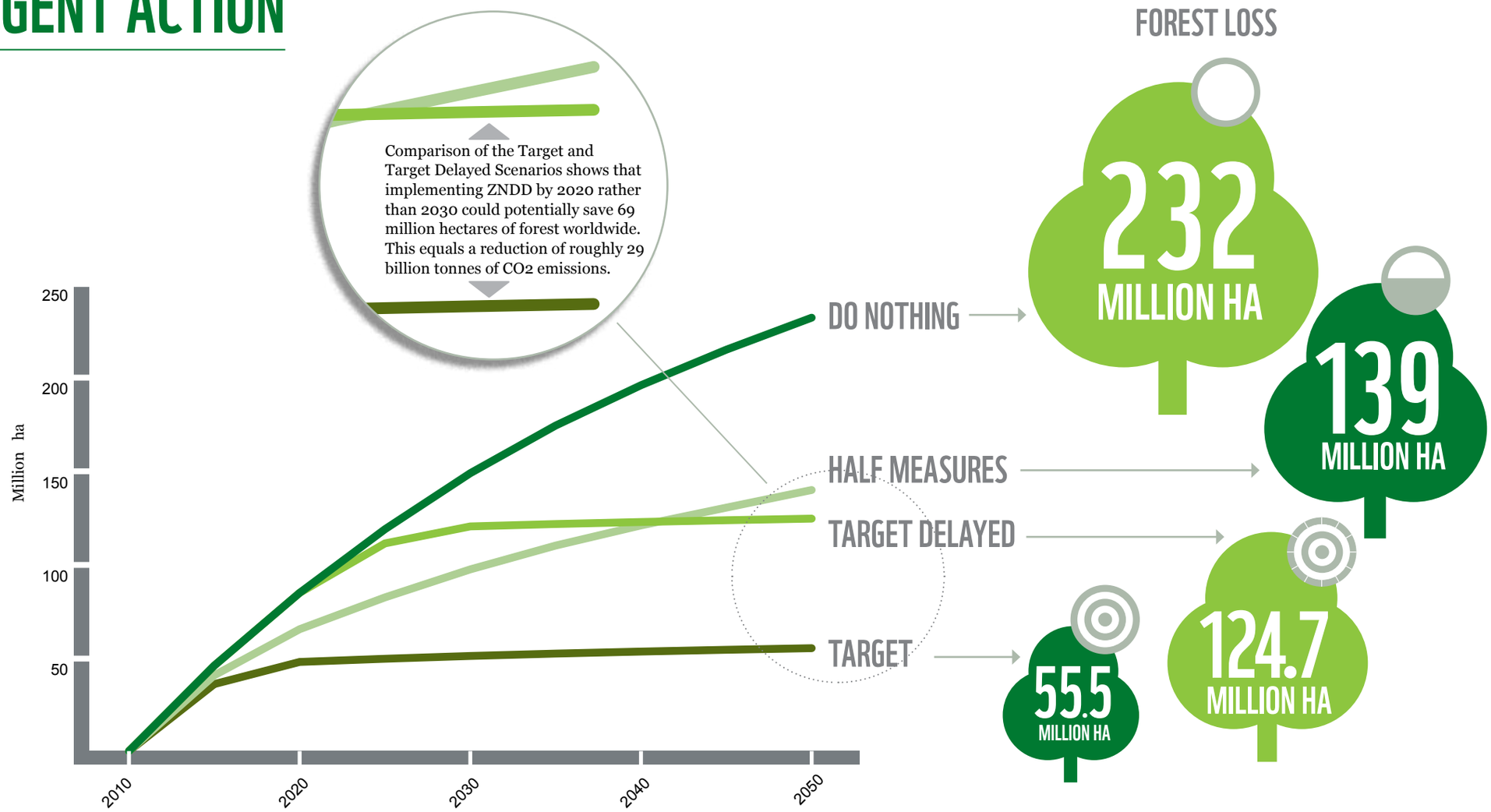
LARGE CANOPY GAPS CAN DRY OUT RAINFORESTS LEAVING THEM VULNERABLE TO FIRE

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.

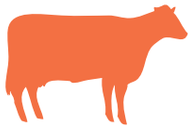
Tens of thousands of tigers once roamed the forests of Asia. Today, with huge swaths of their habitat lost to agriculture, timber plantations and human settlement, wild tigers number only 3,200. Achieving ZNDD by 2020 will curb the current alarming loss of species and address the looming climate crisis.

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.

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:

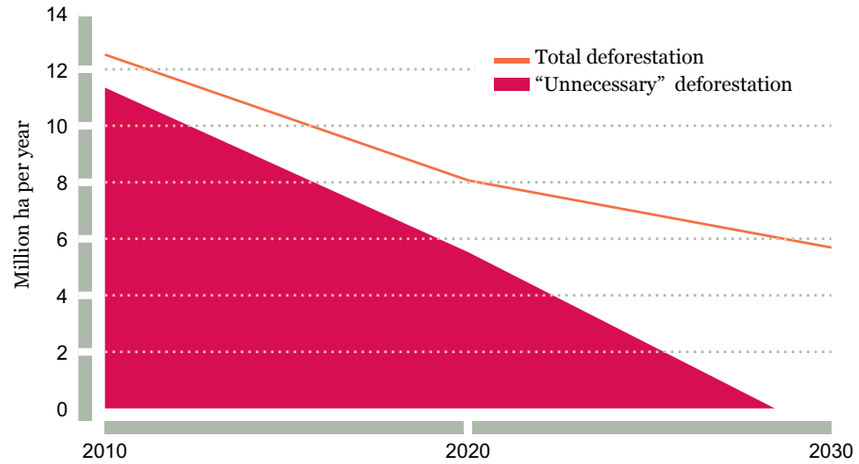
- **Poor forest management:** destructive harvesting and poor silviculture leading to declining timber yields, poor regeneration or vulnerability to disease, fire or encroachment
- **Inefficient livestock production:** either low-stocking density causing more forests to be cleared, or high-stocking density 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

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.

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 in 2030	feasibility in 2030 if agriculture stagnates	feasibility in 2050	feasibility in 2050 if food commodity index increases capped at 10%
target	✓	✗	✓	✓
target with pro-nature	✓	✗	✓	✗
target with pro-nature plus	✓	✗	✗	✗
target with bioenergy plus	✓	✗	✓	✓
target with diet shift	✓	✓	✓	✓
target with diet shift and pro-nature	✓	✓	✓	✓
target with diet shift and pro-nature plus	✓	✓	✓	✓

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.

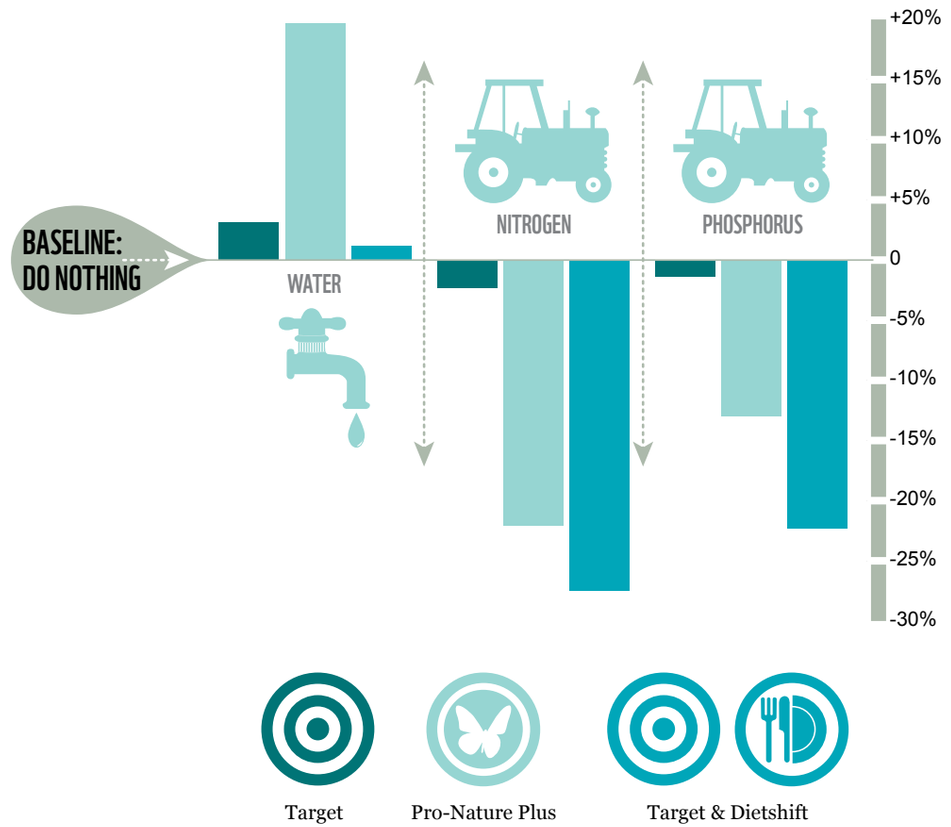
DOES PRODUCING MORE ON LESS LAND MEAN INCREASED AGRICULTURAL POLLUTION AND WATER STRESS?

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

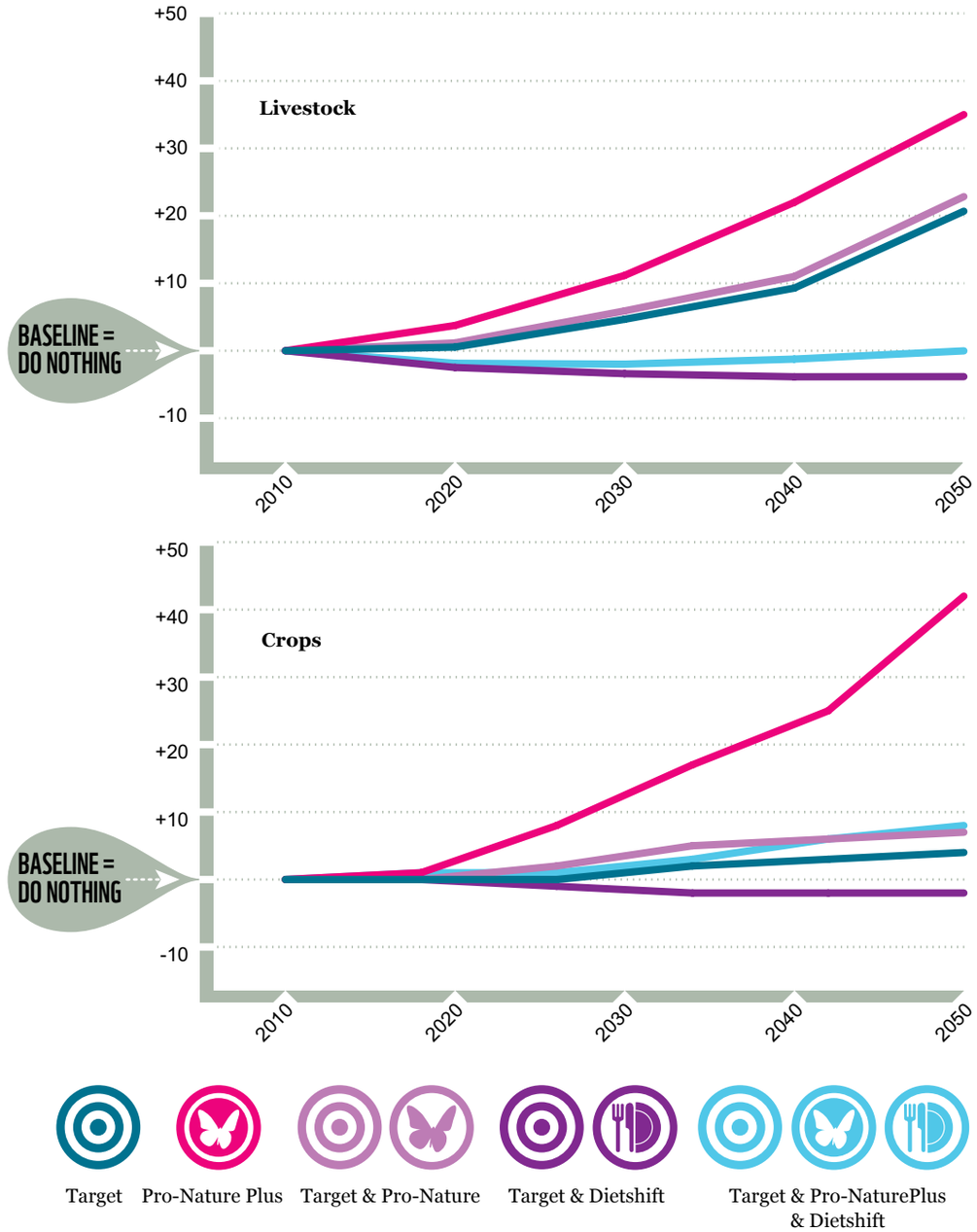
The Target Scenario alone makes little overall difference to crop prices, though the base price of meat is projected to rise by just over one-third (35 per cent) between 2010 and 2050. However, the Target Scenario coupled with the Pro-Nature Plus Scenario, the strictest biodiversity conservation scenario, 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?

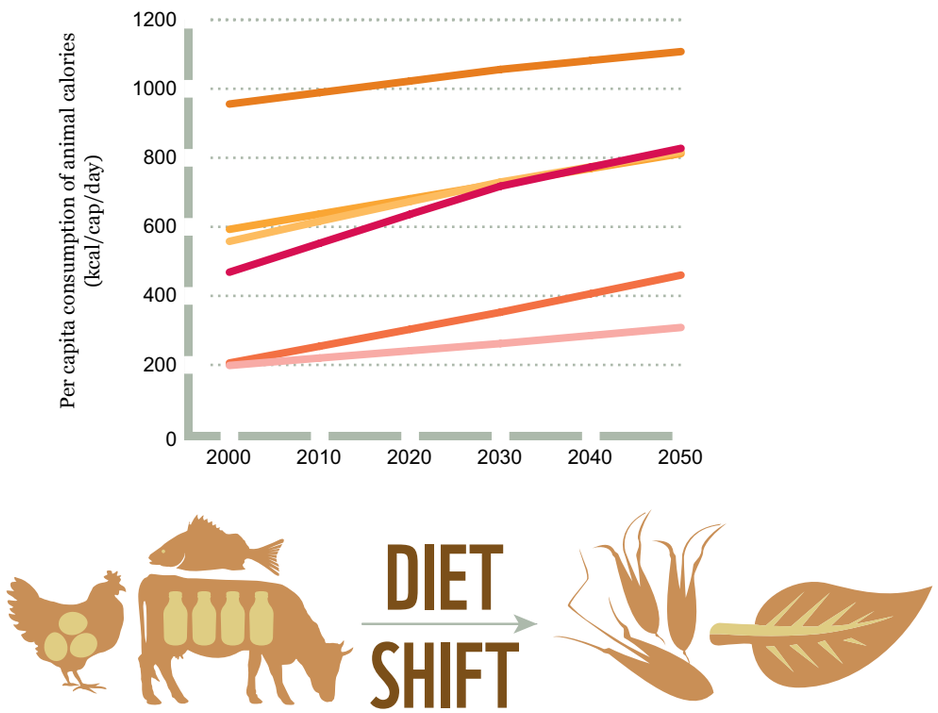
WE NEED A CHANGE IN GLOBAL POLICY AND ECONOMIC INCENTIVES THAT DRIVE FOOD CONSUMPTION PATTERNS, WHICH ALLOW MANY TO GO HUNGRY WHILE OTHERS CONSUME TO EXCESS

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?

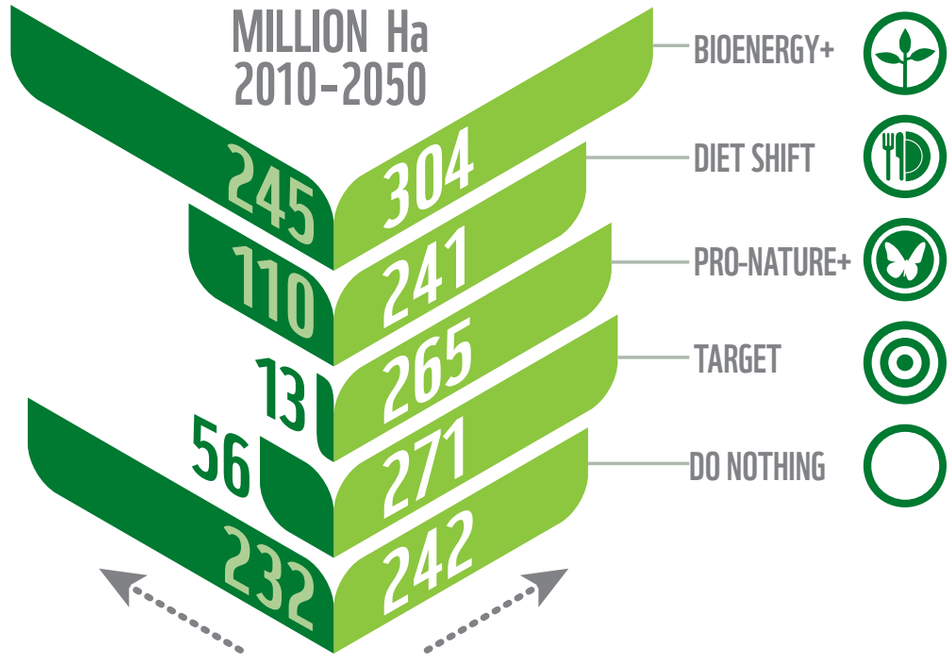
The dual imperatives of ZNDD and meeting global demand for materials and energy pose both challenges and business opportunities for the forest products sector.

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 ACHIEVE100% RENEWABLE ENERGY WITHOUT DEFORESTATION?

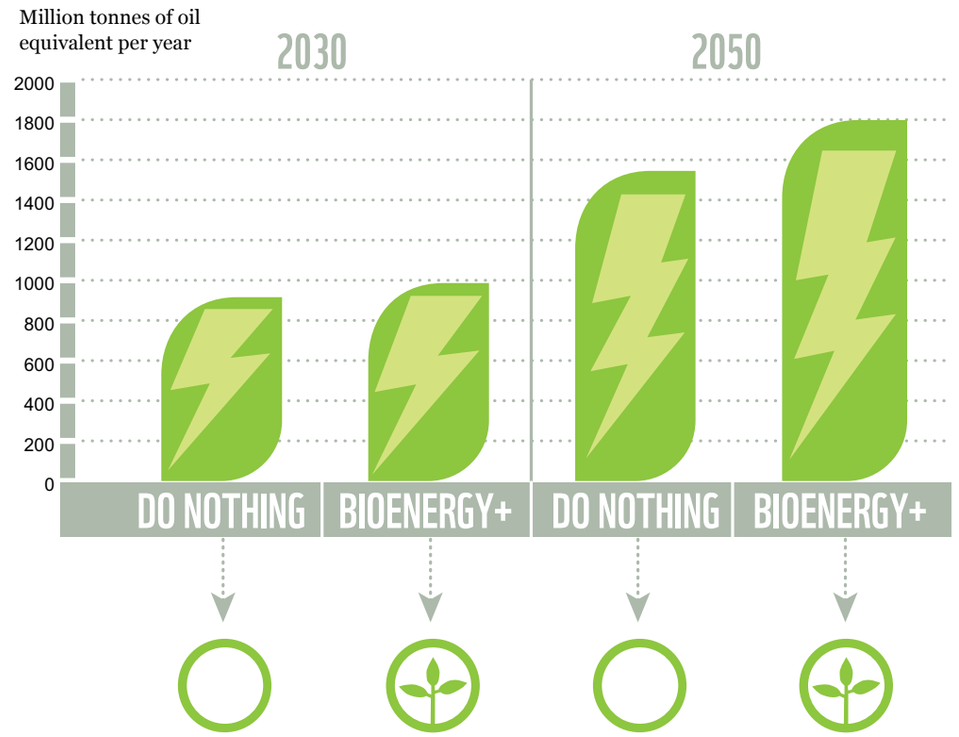
ZNDD will affect global energy markets and policies, through its impact on land availability for bioenergy crops and fast-growing tree plantations and the supply of wood from existing natural or semi-natural forests. Bioenergy is being promoted as an inevitable component of future energy supplies, but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

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).

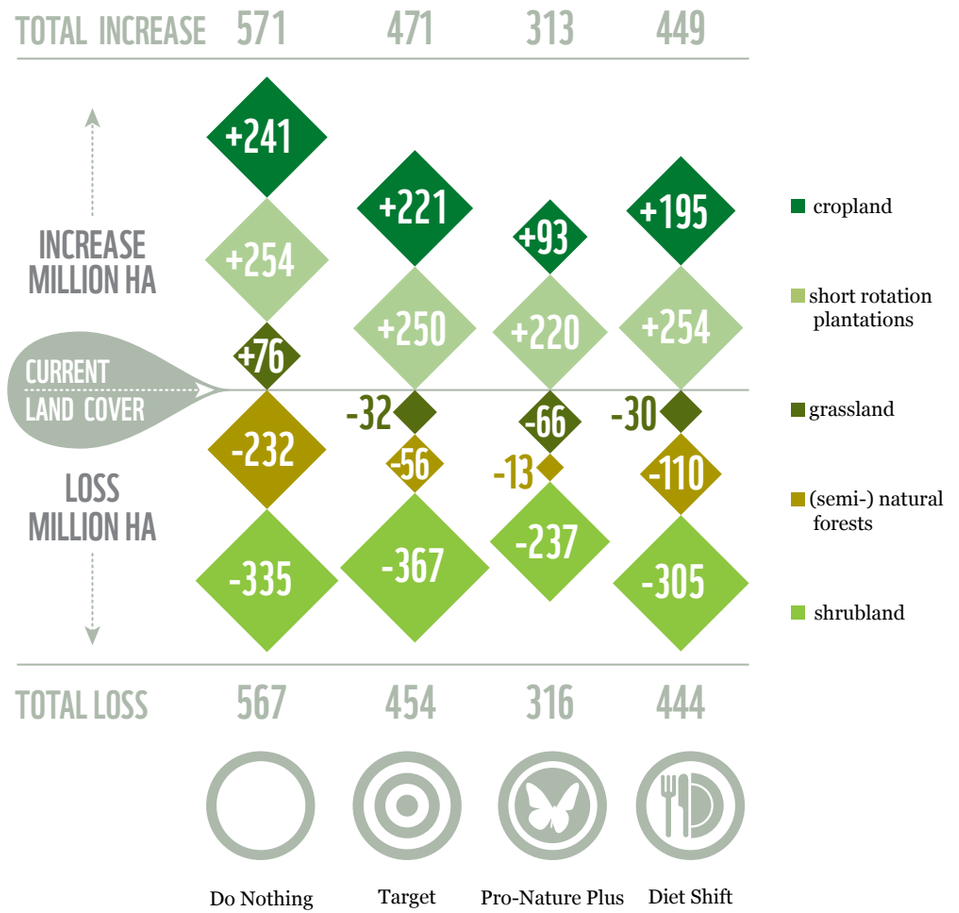
5%

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

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.

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?

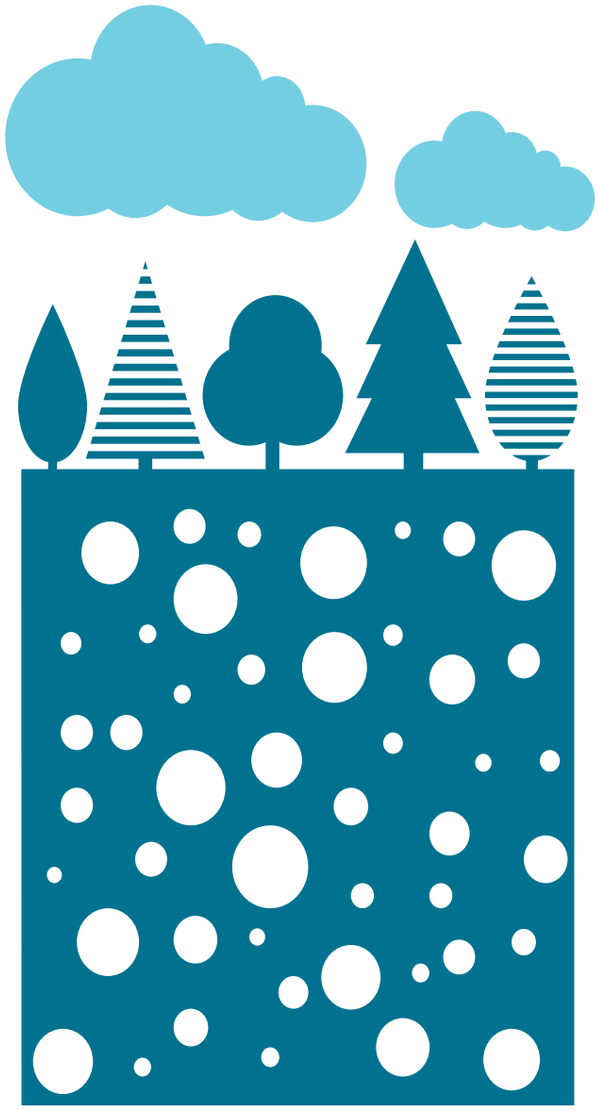
Forests have a vital role to play in the fight against global warming, being the largest terrestrial store of carbon and deforestation being the third-largest source of GHG emissions after coal and oil. Loss and degradation of natural vegetation, particularly forests and tropical peat, contributed 7.4 **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.

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

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*.

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

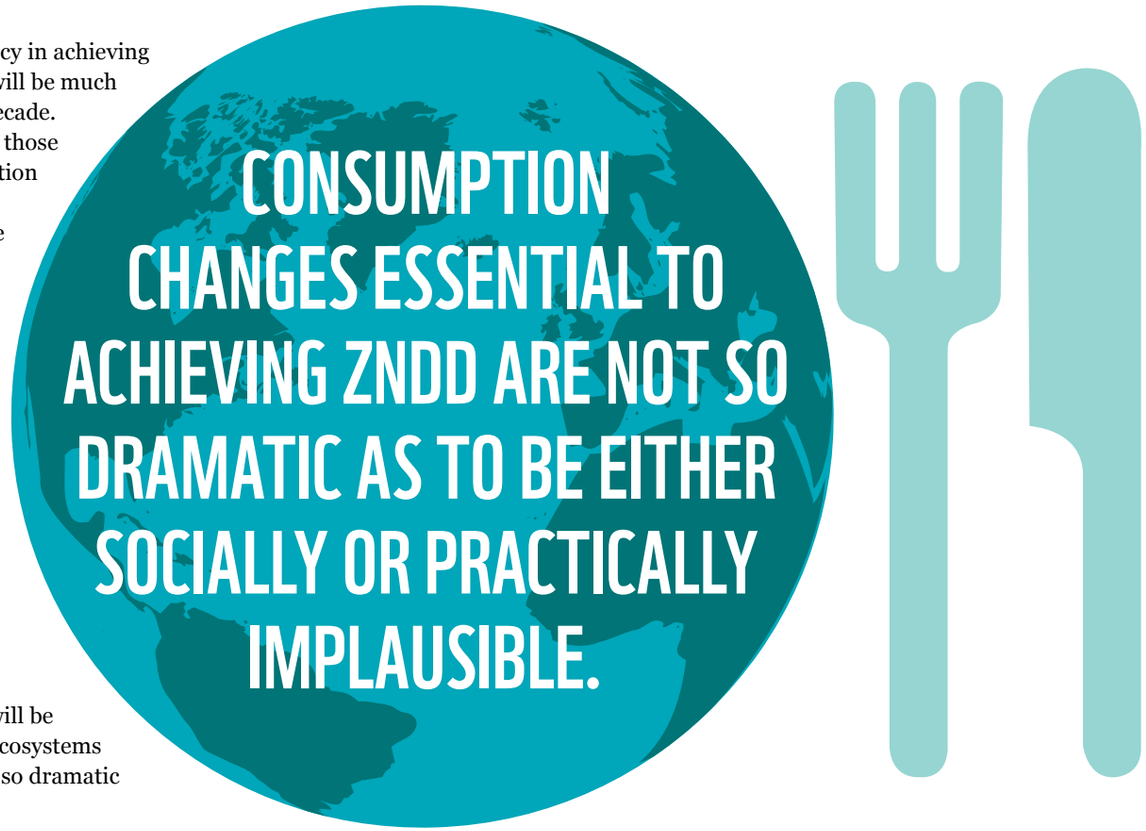
The Living Forests Model Target Scenario suggests ZNDD is technically possible by 2020, without food and material shortages, but with some sacrifices. There are many challenges, especially in reducing forest loss without undermining biodiversity or the livelihoods of vulnerable people.

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.

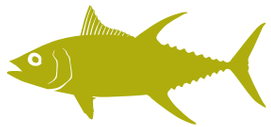
Over the next 40 years, the challenge of achieving ZNDD will expand from being primarily social and political to demanding a stronger technical component, with scientists seeking ways of meeting any food and energy shortfalls without clearing more natural forest. Governance of these processes and of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



BIOCAPACITY

BOREAL FOREST

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: 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].

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].

FOOD SECURITY

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].

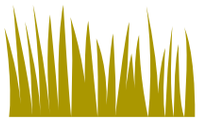
Empty forests: Apparently intact forests that no longer maintain their original community of fauna and flora due to human disturbances (such as hunting, harvesting and others)[48].

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.



GRASSLAND

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].

ILLEGAL LOGGING

$GtCO_2e$: 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.

PLANTATION

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].

TROPICAL FOREST

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]

REFERENCES AND ENDNOTES

1 Ramankutty, N. et al (2002); The global distribution of cultivatable lands: current patterns and sensitivities to possible climate change, *Global Ecology and Biogeography* 11: 377-397

2 Van Aalst, M. (2006); The impacts of climate change on the risk of natural disasters, *Disasters* 30(1): 5-18

3 Renner, M. (2002); *The Anatomy of Resource Wars,* Worldwatch Paper 162, Worldwatch Institute, Washington DC

4 WBCSD (2010); *Vision, 2050*, World Business Council for Sustainable Development, Geneva, Switzerland (http://www.wbcsd.org/DocRoot/opMs2lZXoMm2q9P8gthM/Vision_2050_FullReport_040210.pdf)

5 GFN (2010); *The 2010 National Footprint Accounts*, Global Footprint Network, San Francisco, USA (www.footprintnetwork.org); WWF (2010); *Living Planet Report*, WWF, Gland, Switzerland

6 FAO (2010); *Global Forest Resources Assessment 2010,* FAO Forestry Paper 163, FAO Rome

7 Carle, J and Holmgren P (2008); Wood from Planted Forests - A Global Outlook 2005-2030, *Forest Prod. Journal*. 58(12):6–18, (http://www.forestprod.org/dec08-f.pdf)

8 Potapov, P., et al (2008); 'Mapping the world's intact forest landscapes by remote sensing'. *Ecology and Society,* 13, no. 2, 51pp [online] (http://www.ecologyandsociety.org/vol13/iss2/art51/)

9 Stolton, S and N. Dudley [eds.] (2010); *Arguments for Protected Areas*, Earthscan, London

9A Kindermann, G. E, M. Obersteiner, E. Rametsteiner and I. McCallum. (2006); Predicting the deforestation-trend under different carbon-prices. Carbon Balance and Management 1, no. 1, www.scopus.com
Kindermann, G., M. Obersteiner, B. Sohngen, J. Sathaye, K. Andrasko, E. Rametsteiner, B. Schlamadinger, S. Wunder and R. Beach (2008); Global cost estimates of reducing carbon emissions through avoided deforestation, Proceedings of the National Academy of Sciences of the United States of America 105:30, 10302-10307
Havlík, P., A. Uwe, E S Schneider, H Böttcher, S Fritz, R Skalský, K Aoki, S De Cara, G Kindermann and F Kraxner (2010); Global land-use implications of first and second generation biofuel targets, Energy Policy 4, http://linkinghub.elsevier.com/retrieve/pii/S030142151000193X

10 Except where otherwise stated, projected numbers for future population and economic growth are drawn from Staff Working Document SEC(2011) 288 final accompanying *A Roadmap for moving to a competitive low carbon economy in 2050*, European Commission (2010) (http://ec.europa.eu/clima/documentation/roadmap/docs/sec_2011_288_en.pdf).

11 Specific assumptions include 0.5 per cent annual growth in input neutral crop productivity, 50 per cent of livestock present in the International Livestock Research Institute/FAO livestock system can migrate into a more productive system (e.g. extensive cattle to mixed intensive) in a given decade and 0 per cent annual growth in input neutral productivity of plantations. Within the model, the demand for animal calories is divided into calories from animal products (including meat, seafood, eggs, and dairy products) and calories from crop-related foods. Average per person daily calorie consumption in each world region is based on FAO projections (FAO (2006); *World Agriculture: towards 2030/2050 – Interim report*, FAO, Rome, Italy). The calories people consume include waste. For an in-depth study of FAO projections, see Grethe, H., Dembélé, A., Duman, N. (2011); *How to Feed The World's Growing Billions - Understanding FAO World Food Projections and their Implications*, Heinrich Böll Foundation and WWF Germany

12 Gross loss is capped at 650,000 ha per year. This is a 95 per cent reduction on a baseline gross deforestation rate of 13 million ha/year as estimated by the FAO (FAO (2010); *Global Forest Resources Assessment 2010*, FAO Forestry Paper 163, FAO Rome).

13 The point of convergence in average daily consumption of animal proteins is well within the bounds of recommended intake by the World Health Organisation (http://whqlibdoc.who.int/trs/WHO_TRS_935_eng.pdf).

14 Singer, S (editor) (2011); *The Energy Report: 100% renewable by 2050,* WWF, Ecofsy and OMA

15 UN (2009); *World Population Prospects. The 2008 Revision*, United Nations, Department of Economic and Social Affairs Population Division, New York, 2009

16 FAO (2009); *How to Feed the World in 2050*; FAO, Rome

17 IFPRI (2009); *Climate Change: Impact on Agriculture and Costs of Adaptation*, International Food Policy Research Institute, Washington, D.C.

18 FAO (2009); *How to Feed the World in 2050*; FAO, Rome

19 FAO (1998); *Global Fiber Supply Model*, FAO, Rome

20 Singer, S (editor) (2011); *The Energy Report: 100% renewable by 2050*, WWF, Ecofsy and OMA

21 McKinsey & Company (2009); *Pathways to a Low-Carbon Economy. Version 2 of the Global Greenhouse, Gas Abatement Cost Curve - January 2009*, McKinsey and Company

22 Leadley, P, H M Pereira, R Alkemade, J F Fernandez-Manjarres, V Proenca, J P W Scharlemann and M J Walpole (2010); *Biodiversity Scenarios: Projections of 21st century change in biodiversity and associated ecosystem services*, Technical Series no. 50, Secretariat of the Convention on Biological Diversity, Montreal

23 Lundqvist, J., C. de Fraiture and D. Molden (2008); *Saving Water: From Field to Fork – Curbing Losses and Wastage in the Food Chain*, SIWI Policy Brief, SIWI

24 Strassburg, B.B.N., Kelly, A., Balmford, A., Davies, R.G., Gibbs, H.K, Lovett, A., Miles, L., Orme, C.D.L., Price, J., Turner, R.K. and Rodrigues, A.S.L. (2010); Global congruence of carbon storage and biodiversity in terrestrial ecosystems. *Conservation Letters*, 3(2), 98-105

25 UNEP (2011); UNEP Yearbook 2011: *Emerging Issues in our Global Environment, UNEP*, Nairobi

[26] J. Rockström, W. Steffen, K. Noone, Å. Persson, F. Stuart Chapin, III E.F. Lambin T.M. Lenton, M. Scheffer, C. Folke, H.J. Schellnhuber, B. Nykvist, C.A. de Wit, T. Hughes, S. van der Leeuw, H. Rodhe, S. Sörlin, P.K. Snyder, R. Costanza, U. Svedin, M. Falkenmark, L. Karlberg, R.W. Corell, V.J. Fabry, J. Hansen, B. Walker, D. Liverman, K. Richardson, P. Crutzen and J.A. Foley (2009); A safe operating space for humanity, *Nature* 461, 472-475

[27] http://www.epa.gov/rlep/faq.html

[28] Grethe, H., Dembélé, A., Duman, N. (2011); *How to Feed The World's Growing Billions - Understanding FAO World Food Projections and their Implications*, Heinrich Böll Foundation and WWF Germany

[29] http://www.newgenerationplantations.com/pdf/NGPP_Synthesis_Report09.pdf

[30] UNEP-WCMC (2008); *State of the World's Protected Areas: an annual review of global conservation progress*, UNEP-WCMC, Cambridge

[31] McKinsey & Company (2009); *Pathways to a Low-Carbon Economy. Version 2 of the Global Greenhouse, Gas Abatement Cost Curve - January 2009*, McKinsey and Company

[32] FAO (2010); *Global Forest Resources Assessment 2010*, FAO Forestry Paper 163, FAO Rome

[33] http://www.hcvnetwork.org/resources/national-hcv-interpretations/FSC-US%20HCVF%20Assessment%20Framework%20July%202010.pdf

[34] Oli, K. P.; Dasgupta, J.; Dhakal, T. D.; Kollmair (2007); *Glossary of Access and Benefit Sharing Terms*, ICIMOD (http://books.icimod.org/uploads/tmp/icimod-glossary_of_access_and_benefit_sharing_terms.pdf)

[35] WWF (2010); *Living Planet Report*, WWF, Gland, Switzerland

[36] Convention on Biological Diversity, art 2: http://www.biodiv.org/convention/articles.asp?lg=0&a=cbd-02

[37] http://wwf.panda.org/what_we_do/footprint/climate_carbon_energy/energy_solutions/renewable_energy/clean_energy_facts/bioenergy_facts/

[38] IPCC (2003); *Good Practice Guidance for LULUCF – Glossary*, IPPC

[39] http://www.cbd.int/doc/meetings/for/lgb-01/official/lgb-01-02-en.pdf

[40] http://www.fsc.org/glossary.html?&tx_datamintsglossaryindex_pi1[idxchar]=C

[41] http://www.nyo.unep.org/action/ap1.htm

[42] http://www.fao.org/forestry/11280-03f2112412b94f8ca5f9797c7558e9bc.pdf

[43] http://www.mpl.ird.fr/crea/taller-colombia/FAO/AGLL/pdfdocs/landglos.pdf

[44] FAO (2001); *Global Forest Resources Assessment FRA 2000 – Main report*, Rome

[45] FAO (2001); *Global Forest Resources Assessment FRA 2000 – Main report,* Rome

[46] http://wwf.panda.org/about_our_earth/teacher_resources/webfieldtrips/ecological_balance/eco_footprint/

[47] Hassan, R, R Scholes and N Ash (Eds). 2005. Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group v. 1 (Millennium Ecosystem Assessment), Island Press

[48] Redford, K H (1992); The Empty Forest; *BioScience*, 42:6; 412-422

[49] ftp://ftp.fao.org/es/ESA/policybriefs/pb_02.pdf

[50] Hassan, R, R Scholes and N Ash (Eds) (2005); *Ecosystems and Human Well-Being: Current State and Trends: Findings of the Condition and Trends Working Group v. 1 (Millennium Ecosystem Assessment)*, Island Press

[51] http://www.mpl.ird.fr/crea/taller-colombia/FAO/AGLL/pdfdocs/landglos.pdf

[52] Definition applied by the International Labour Organisation (ILO) Convention (No. 169) concerning Indigenous and Tribal Peoples in Independent Countries

[53] http://www.cbd.int/invasive/terms.shtml

[54] http://www.fao.org/DOCREP/005/Y4307E/y4307e05.htm

[55] http://www.un.org/millenniumgoals/

[56] http://www.maweb.org/

[57] http://wwf.panda.org/about_our_earth/ecoregions/about/habitat_types/selecting_terrestrial_ecoregions/habitat01.cfm

[58] http://www.biodiv.org/programmes/areas/forest/definitions.asp

[59] http://www.fao.org/forestry/site/6388/en

[60] FAO (2001); *Global Forest Resources Assessment FRA 2000 – Main report*, Rome

[61] Dudley, N (Editor) (2008); *Guidelines for Applying Protected Area Management Categories*, IUCN, Gland, Switzerland

[62] http://www.ser.org/content/ecological_restoration_primer.asp

[63] http://wwf.panda.org/about_our_earth/about_forests/types/

[64] http://www.fao.org/docrep/w7732e/w7732e04.htm

[65] http://wwf.panda.org/about_our_earth/about_forests/types/

[66] http://assets.panda.org/downloads/wwf_2020_zero_net_deforest_brief.pdf

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