STATE OF THE TROPICS

Primary Forests

Key findings

- Biodiversity encompasses existing life forms, the ecological roles they perform, and the genetic diversity they contain.
- Tropical forest ecosystems host at least two-thirds of the Earth's terrestrial species and provide significant local, regional and global human benefits.
- Human exploitation of forests has been at the expense of biodiversity and the natural regulation of ecosystem functions.
- Primary forests, in particular tropical moist forests, include some of the world's most species rich, diverse terrestrial ecosystems.
- Around 7.8 million square kilometres (or 57%) of global primary forest is estimated to be in the Tropics. Brazil accounts for 35% of primary forests globally, and 60% of primary forests in the Tropics.
- The world's area of primary forest decreased by about 420,000 square kilometres in the ten years to 2010, reducing the total area of primary forest by 3.7%. The vast majority of losses in this period were in the Tropics. Almost 70% of losses in the Tropics were in South America.
- Available data suggest the rate of loss of primary forests is slowing in the Tropics.
- The Tropics accounted for 60% of forests reserved for the conservation of biodiversity in 2010, or 2.8 million square kilometres.
- The concept of biodiversity hotspots is useful in identifying regions most at risk of biodiversity loss.

A number of leading institutions from across the world have joined forces to assess and report on the critical questions facing one of the world's most important and fastest growing regions: the Tropics.

Over the past half-century the Tropics has emerged as an increasingly critical region. More than 40% of the world's population now lives in the Tropics and this is likely to be close to 50% by 2050. The region generates around 20% of global economic output and is home to some 80% of the world's biodiversity.

However, the resources to sustain larger populations and economic growth are imposing ever-increasing pressures. Issues of concern include relatively poor health outcomes, with more than one billion people suffering from tropical diseases, unacceptable levels of infant mortality and reduced life expectancy; extreme poverty; poor educational outcomes; environmental degradation; and, in some cases, political and economic instability.

The Project

In early 2011 a group of leading institutions decided to examine the condition of life in the Tropics. The group met in Singapore in mid-2011 to scope a project, and decided to share their expertise to prepare a report assessing a broad range of environmental, social and economic indicators.

This work will culminate with the release of the ***State of the Tropics Report***, which will shine a light on the critical importance of the people and issues of the tropical world, and contribute to efforts to improve the lives of the peoples of the Tropics and their environment. During 2012 and early 2013, a series of briefings on indicators underpinning the report will be released, including this one which looks at the extent of primary forests.

The institutions involved in the project are: Escuela Superior Politiécnica del Litorial (Ecuador), Instituto Nacional de Pesquisas da Amazônia (Brazil), James Cook University (Australia), Liverpool School of Tropical Medicine (England), Mahidol University (Thailand), Nanyang Technological University (Singapore), National University of Singapore, Organization for Tropical Studies (Costa Rica), University of Hawaii – Manoa (USA), University of Nairobi (Kenya), University of Papua New Guinea and University of the South Pacific (Fiji).

Background

More than 2,000 years ago Aristotle described the world as being divided into three zones – the Frigid Zone, The Temperate Zone and the Torrid Zone. He decided that the Torrid Zone was too hot for civilised habitation, and that humans could only live and work productively in the Temperate Zone. While Aristotle's Torrid Zone was not precisely defined geographically, it is clear his uninhabitable region was what we know as the Tropics.

Other ways of viewing the world have subsequently waxed and waned: north/south was a focus of attention during early European expansion; east/west as this expansion accelerated and political and economic systems developed; as we became aware of economic, social and political inequalities there was a focus on a first world/third world perspective; and, in the post-WWII environment, it has been on OECD/non-OECD or developing/developed countries dichotomies.

Each of these world perspectives generated temporally relevant insights, but also papered over Aristotle's fundamental insight – his lateral view of a world. We might expect Aristotle's three geographic and climatic zones to share common problems and challenges, and for there also to be issues unique to each zone.

The range and significance of issues facing nations and territories in the Tropics suggests it is now time to examine the world using Aristotle's insight, viewing the Tropics as a discrete region and defining its characteristics and issues. With the exception of Europe and Antarctica all continents are partly in the Tropics, and there are 144 nations and territories either fully or partly in the tropical region[1]. More than 40% of the world's population is estimated to already live in the Tropics – up from 30% in 1950.

While annual economic growth has been around a full percentage point higher than the Rest of the World over the past 30 years, the disparity between population (40% of the world's population) and economic output (20% of global economic output) means that, for the Tropics as a whole, people are less wealthy compared to other latitudes.

Many tropical nations face relatively greater and more imminent exposure to some of the most critical issues of our time, most notably the impacts of climate change on human and food security, such as rising sea levels, declining crop yields and the extinction of vulnerable species.

A significant proportion of the estimated 80% of the world's biodiversity that exists in the Tropics is also under threat, and climate change is likely to have a greater impact in the Tropics where many species are thermal specialists, and do not tolerate changes in climate as well as those species accustomed to more significant changes in seasonal conditions.

The Tropics

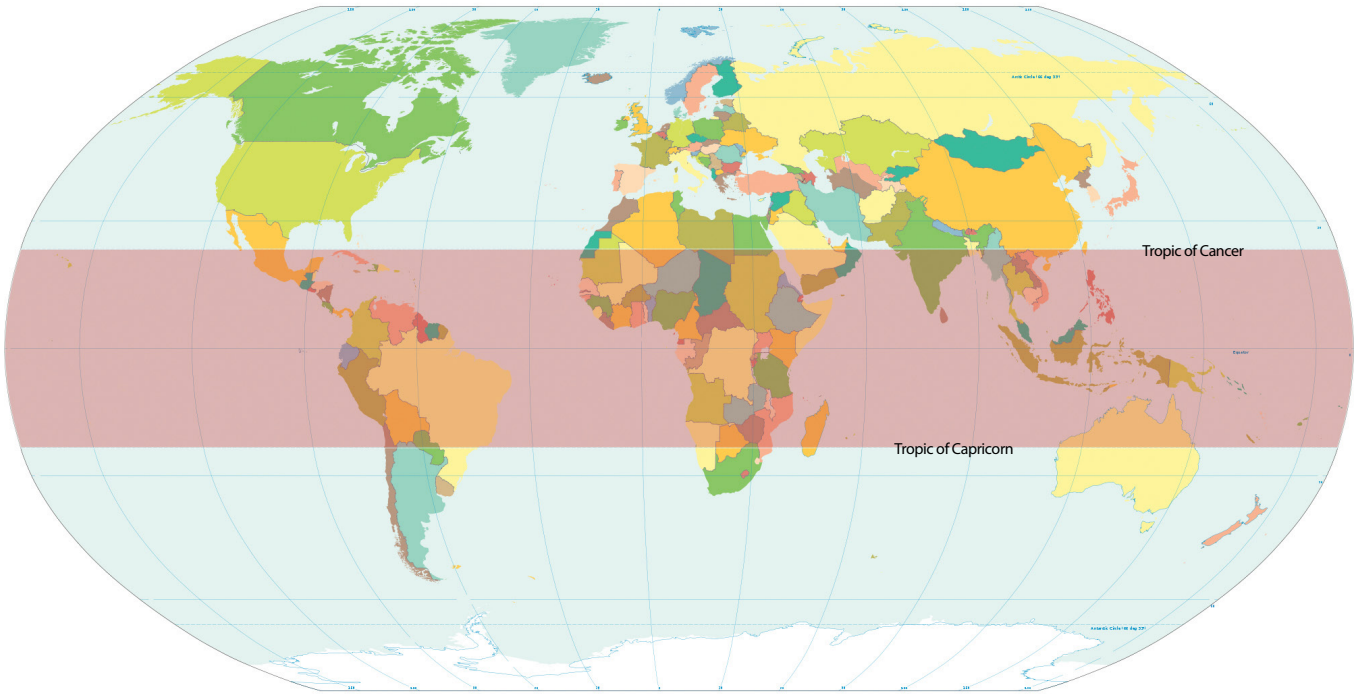
The Tropics is commonly defined as the region of the Earth surrounding the Equator within the latitudes of the Tropics of Cancer and Capricorn at +/– 23.5 degrees (see Figure 1). With its origins in astronomy, these latitudes are the limit of where the Sun reaches a point directly overhead at least once during the solar year, and are used to define the Tropics in this paper.

Although topography and other factors contribute to climatic variation, tropical regions are typically warm and experience little seasonal change in day-to-day temperature. An important feature of the Tropics is the prevalence of rain in the moist inner regions near the equator, and that the seasonality of rainfall increases with distance from the equator[2].

In the Köppen-Geiger[3] climate classification the Tropics is dominated by 'equatorial' and 'arid' climates, with the balance of the world being primarily 'warm temperate', 'snow' and 'polar' climates.

Equatorial climates have a mean temperature for all months above 18°C (64°F), and arid zones are defined with reference to both temperature and rainfall, but are characterised by a lack of water which inhibits plant and animal life.

Figure 1: The Tropics



Primary Forests

Forests, and especially primary forests, tend to be more biologically diverse than other terrestrial landscapes and make significant contributions to broader ecosystem functioning.

The concept of biological diversity, or biodiversity, encompasses the variety of existing life forms, the ecological roles they perform, and the genetic diversity they contain. It is through this diversity that natural systems are able to adapt and evolve. The extent of biodiversity in an ecosystem is often viewed as a measure of its health, with more diverse ecosystems generally considered to be more stable, productive and resistant to invasion and other disturbances.

Humans also rely on biodiversity for resources for their general health and well-being. All food and many medicines and industrial products are derived from wild and domesticated components of biodiversity, and it is also the basis for many economic, cultural and recreational activities. On a larger scale, the integrity of the many ecosystem regulatory services which support humanity rely on healthy and diverse environments.

It is now recognised that much of the human exploitation of forests has been at the expense of biodiversity and ecosystem functions, such as water and climate regulation and carbon storage.

Biodiversity is in part a function of climate, and generally there is an increase in species from the poles to the Tropics. Tropical forest ecosystems host at least two-thirds of the Earth's terrestrial species and provide significant local, regional and global human benefits from the provision of economic goods and ecosystem services.

The future of many tropical forest species is uncertain. Few areas of the Tropics have escaped human impacts, and the combined influence of high rates of deforestation, degradation, over-harvesting, invasive species and global environmental change threatens to make tropical forests the centre of current and future extinctions[4]. The future of much tropical forest biodiversity therefore depends on effective management of human impacts on these ecosystems.

Forests

Forests are a major global ecological resource at risk from human activities. In 2010 there was estimated to be 4.03 billion hectares of forests globally, down from 4.17 billion hectares in 1990, representing an average loss of 6.8 million hectares (or 0.2%) per annum. Losses in the Tropics were around 9.5 million hectares (-0.5%) per annum, and the Rest of the World reported an increase of 2.7 million hectares (0.1%) per annum, though much of this increase was in plantation forests.

In terms of biodiversity though, not all forests are the same. In the Tropics, primary forests host the greatest biodiversity, followed by selectively logged forests, secondary forests and, finally, plantation forests[5,6]. That is, even without deforestation, a transition from primary forest to degraded forest through selective logging or other practices will affect biodiversity, while plantations will add to the stock of forests but will host less biodiversity. It is important to consider these factors when assessing changes in the type of forest cover, noting that globally, the plantation area increased by 85 million hectares in the 20 years to 2010 while there was a loss of 220 million hectares of non-plantation, natural forest. Although conceptually difficult to report on a globally consistent basis (see Box 1), monitoring the extent of primary forests is an indicator of biodiversity risks.

Primary Forests

Primary forests, sometimes referred to old growth forests, are forests of native species in which there are no clearly visible indications of human activity and where ecological processes have not been significantly disturbed. Primary forests, in particular tropical moist forests, include some of the world's most species rich and diverse terrestrial ecosystems. As such, primary forests are often equated with high levels of biological diversity, though this is not always the case.

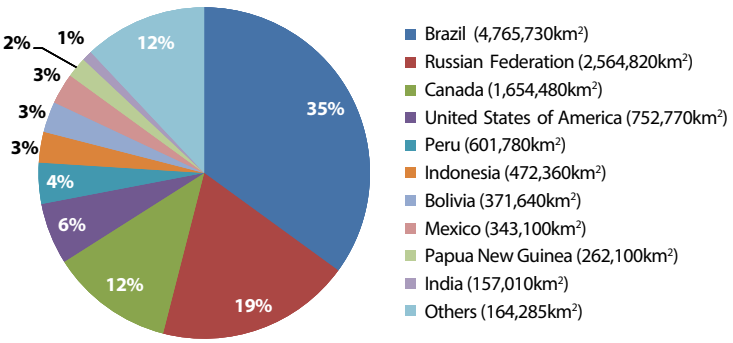
In the boreal zones and arid Tropics primary forests can be poor in terms of numbers of plant and animal species, while some modified natural forests and forests interspersed with agricultural areas may provide additional habitats and thus harbour more species. Nevertheless, the area of primary forest is considered an important indicator of the state of forest ecosystems.

Primary forests also have many essential functions other than the conservation of biological diversity, including the protection of soil and water resources, carbon sequestration and the provision of aesthetic, cultural and religious values.

The United Nations' Food and Agriculture Organisation (FAO) estimates that in 2010, primary forests accounted for 36% of forest area globally[7]. Seven of the ten nations with the largest area of primary forests are wholly or substantially located in the Tropics (see Figure 2). Around 35% of the world's primary forest is located in Brazil, much of it in the Amazon Basin. It should be noted that information is missing for some large tropical countries which might otherwise be part of the top ten nations, including the Democratic Republic of the Congo, Cameroon and Venezuela (see Box 1).

Around 57%, or 7.8 million square kilometres, of primary forest is estimated to be in the Tropics in 2010. The Russian Federation, Canada and the United States of America account for more than 85% of primary forest holdings in the Rest of the World.

Figure 2: Nations with largest area of primary forest, 2010



Source: FAO

In 2010 approximately 41% of forests in the Tropics were primary forest, compared to 27% in the Rest of the World. Of the tropical regions, South America had the highest proportion of primary forest (77%) and the Caribbean (3%) the lowest.

Globally, of the 18 nations in which primary forests are more than 50% of total forest area, 16 are in the Tropics.

In the Tropics 31 nations report no primary forests compared to 35 in the Rest of the World, which is unchanged over the 20 years to 2010.

Box 1: Data Quality and Limitations

Analysis of changes in forest cover are limited by the availability and quality of data. Data reported here are sourced from the United Nations Food and Agriculture Organisation's *Global Forest Resources Assessment 2010* (FAO 2010). These data are generally considered the most reliable cross-national estimates available over the period 1990 to 2010, but they do have some important limitations associated with self-reporting by nations, inconsistencies in how and when forest cover was evaluated[8] and non-reporting by some nations for key variables, notably the extent of primary forests. Numerous research projects have independently assessed the extent of forests, but they typically do not report globally, or report over a shorter time period or on different variables.

Major nations' not self-reporting primary forests data for FAO 2010 include the Democratic Republic of Congo (DRC), Cameroon and Venezuela. Independent assessments suggest primary forests may represent 40-45% of forests in DRC (around 65 million hectares in 2000), 65% in Venezuela (30 million hectares) and 25% in Cameroon (5 million hectares)[9,10,11]. This suggests that DRC has the fifth largest area of primary forests after the United States of America, and Venezuela the tenth, after Mexico assuming comparable methodologies (see Figure 2). As such, the actual area of tropical primary forests reported here is understated.

As an alternative point of reference to country-reported data, FAO 2010 has also used remote sensing technology to assess global forest change from 1990 to 2005[12]. The advantage of this approach is that it creates a global time series dataset collected on a consistent basis. Remote sensing results indicate total global forest area of 3.8 billion hectares in 2005 (compared with 4.06 billion hectares based on FAO2010 self-reported country assessments), with an average net loss of 4.0 million hectares per annum (-0.1%) between 1990 and 2005. Net losses in tropical forests increased from 5.6 million hectares per annum in 1990-2000 to 9.1 million hectares per annum in 2000-2005. Country-level data are not publicly available as yet.

Trends

In the ten years to 2010 FAO reports that, based on country reported data, the world's area of primary forest decreased by about 42 million hectares, a loss on average of 0.4% annually[13] (see Table 1). This represents a reduction in the total area of primary forest of 3.7%. The vast majority of the losses were in the Tropics, with almost 70% of global losses occurring in South America.

In South America the sheer vastness of primary forests combined with their accessibility are contributing to huge and ongoing losses. Although nothing rivals South America in terms of the area of primary forests being lost, in some other tropical regions percentage loss rates are high (and considerably higher than in South America), and increasing, notably in Central & Southern Africa and Oceania.

Nonetheless, driven by improvements in South America and South East Asia, the annual loss of primary forests in the Tropics fell by 389,000 hectares (8.5%) in the period 2000-2010 compared with 1990-2000, from 4.56 million hectares per annum in 1990-2000 to 4.17 million hectares in 2000-2010. More modest improvements occurred in Central & Southern Africa and South Asia, while in Oceania annual losses of primary forests increased by an additional 148,000 hectares.

In the Tropics, Northern Africa & Middle East reported the biggest improvement in the rate of primary forest loss, falling from -0.8% per annum in 1990-2000 to -0.1% in 2000-2010. Oceania and Central & Southern Africa were the only two tropical regions to report increases in the rate of primary forest losses. Declining rates of nationally-reported primary forest losses are encouraging, but alternative assessments using remote sensing technology suggest that actual losses may be considerably higher in some regions, notably in South East Asia (see Box 2).

This is concerning, as the remaining primary forests and the biodiversity they hold are especially important as in many parts of the world forests were significantly depleted prior to 1990 (the start of the time series here). For example, in Bangladesh it is estimated that total forest cover (that is, primary, secondary and plantation forests) around this period was only 10% of the original cover, and in India it was around 22%[8].

The destruction of primary forest in Asia is well-advanced, but in other regions, especially in the Amazon in South America and the Congo in Central & Southern Africa, the opportunity exists to protect a greater proportion of primary forests and biodiversity from human threats.

The loss of primary forests across the world has the potential to impact biodiversity. These risks are significantly greater in the Tropics given its greater richness of species. The biodiversity in many tropical rainforests is poorly documented, and globally it is estimated that only 14% of existing terrestrial species have been described[14].

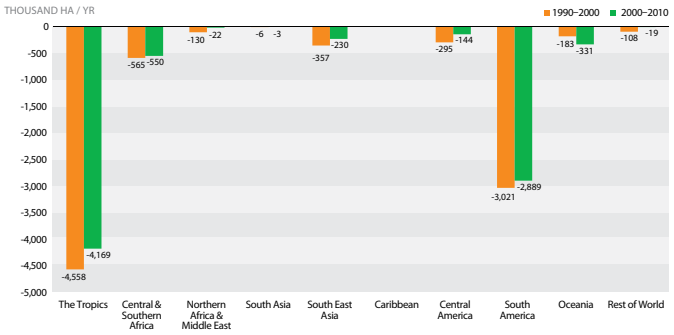
Habitat loss is a major factor contributing to extinctions, and the risk is that many species will become extinct before they are described, with potential impacts on the genetic resources available for use by humans for medicinal and other purposes.

Table 1: Primary Forests

	Area of Primary Forest (1,000 ha)				Annual Change							
					1990-2000		2000-2005		2005-2010		2000-2010	
	1990	2000	2005	2010	1,000 ha/yr	%	1,000 ha/yr	%	1,000 ha/yr	%	1,000 ha/yr	%
The Tropics	**866,960**	**821,381**	**799,183**	**779,695**	**-4,558**	**-0.5%**	**-4,440**	**-0.5%**	**-3,898**	**-0.5%**	**-4,169**	**-0.5%**
Central & Southern Africa	42,196	36,548	33,768	31,053	-565	-1.4%	-556	-1.6%	-543	-1.7%	-550	-1.6%
Northern Africa & Middle East	17,752	16,455	16,340	16,235	-130	-0.8%	-23	-0.1%	-21	-0.1%	-22	-0.1%
South Asia	10,462	10,402	10,372	10,372	-6	-0.1%	-6	-0.1%	0	0.0%	-3	0.0%
South East Asia	70,873	67,300	65,531	65,000	-357	-0.5%	-354	-0.5%	-106	-0.2%	-230	-0.3%
Caribbean	206	205	204	206	0	0.0%	0	-0.1%	0	0.2%	0	0.0%
Central America	29,480	26,526	25,693	25,087	-295	-1.1%	-166	-0.6%	-121	-0.5%	-144	-0.6%
South America	662,460	632,249	616,762	603,360	-3,021	-0.5%	-3,097	-0.5%	-2,680	-0.4%	-2,889	-0.5%
Oceania	33,531	31,697	30,513	28,382	-183	-0.6%	-237	-0.8%	-426	-1.4%	-331	-1.1%
Rest of World	**323,958**	**322,876**	**322,658**	**322,687**	**-108**	**0.0%**	**-44**	**0.0%**	**6**	**0.0%**	**-19**	**0.0%**
World	**1,190,918**	**1,144,257**	**1,121,841**	**1,102,382**	**-4,666**	**-0.4%**	**-4,483**	**-0.4%**	**-3,892**	**-0.3%**	**-4,188**	**-0.4%**

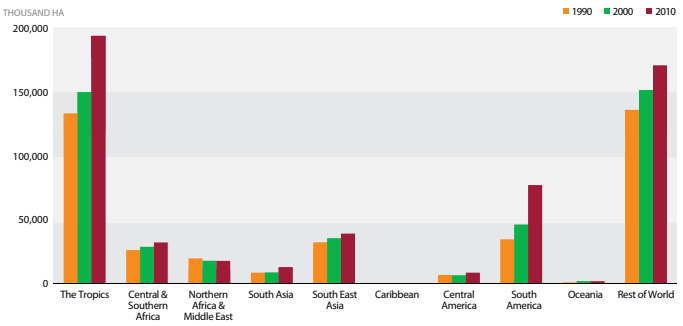
Notes: Totals may not sum due to rounding. The Russian Federation is excluded from time series analysis because there was a large difference in the reported change rate (from +1.6 million hectares per year in the 1990s to -0.5 million hectares per year in the period 2000–2005) related to a modification to the classification system introduced in 1995 rather than actual changes in primary forest area. Data for the Tropics includes Mayotte, Réunion, Grenada, Guadeloupe, French Guiana and Northern Mariana Islands. Source: FAO, State of the Tropics

Figure 3: Average annual primary forest change



Source: FAO, State of the Tropics

Figure 4: Forest area primarily designated for conservation of biodiversity



Note: Estimates are only for the 186 nations that submitted data for all three reference periods.
Source: FAO, State of the Tropics

Forests for Conservation of Biodiversity

Forests deliver a wide range of ecosystem services to the environment and to humanity, through provisioning (food, wood etc) and regulating (nutrient, water and carbon cycles) services. As such, habitat destruction through deforestation or other impacts that affect forest biodiversity may not only affect species diversity, but also the performance of broader ecological systems and regulatory processes. Focusing conservation efforts on protecting habitats is therefore more likely to conserve both biodiversity and underlying systems[15].

The importance of primary forests in protecting biodiversity is increasingly acknowledged, but demand for timber products, industrial and subsistence farm land and access to resources is putting pressure on the stock of primary forests. For example, something as simple as a road through a primary forest to a remote mine site can open up vast areas of forest to exploitation.

Growing concerns about the ever increasing impacts of anthropogenic pressures on tropical biodiversity and natural ecosystem services have led to increases in the number and extent of protected areas across the Tropics[16]. Protected areas are now a key part of global conservation efforts and, as such, an important indicator for policy makers.

Nonetheless, as with forests, not all protected areas are the same, and the performance of each will be affected by factors such as the effectiveness of management and enforcement activities, boundary demarcation and the 'health' of adjacent areas. Recent research suggests about half of all protected areas in the Tropics are effective, while the balance are experiencing declining biodiversity[16].

Using information from 186 nations that provided data for all time periods in the *Global Forest Resources Assessment 2010*, the area of forests in the Tropics reserved for the conservation of biodiversity increased by 46% in the 20 years to 2010, to 195 million hectares, representing 53% of these reserves globally (see Figure 4). The Rest of the World reported an increase of 26% and, globally it was 35%.

In the Tropics, the largest areas of forests reserved for conservation of biodiversity are in South America, followed by Central & Southern Africa and South East Asia. Northern Africa & Middle East is the only tropical region to report a decrease (-6.2%) in these reserves in the 20 years to 2010. In the past 20 years, 14 of the 20 nations that reduced the forest area set aside for conservation of biodiversity are in the Tropics.

Using FAO data for 2010, around 15% of forests in the Tropics were reserved for the conservation of biodiversity, compared to 9% in the Rest of the World. Of the tropical regions, South Asia has the highest proportion of forests reserved for the conservation of biodiversity (29%), followed by Central America (24%) and the Caribbean (19%). To some extent the increase in forest area set aside for conservation reflects the growing understanding of the risks to human wellbeing from a loss of ecosystem services associated with biodiversity decline and, particularly, changes to ecosystem regulating services. Relative to ecosystem provisioning services, knowledge of the role and value of ecosystem regulating services is relatively poor, and extensive research is required if we are to understand these complex processes.

Looking forward, in addition to maintaining the integrity of ecosystem services, greater efforts to protect primary forests from exploitation are likely to improve biodiversity outcomes. This will be critical in the Tropics, which has 21 of the 35 global biodiversity hotspots (see Box 3). Acknowledging that all forests have competing uses, any effective response to stemming biodiversity and primary forest loss will need to integrate ecological, economic and social values, and to consider prospects for conservation and sustainable use[17].

Box 2: Deforestation in Indonesia

Indonesia is one of the world's most forest-rich nations, and reliable information is critical for forest management and policy development activities, but is often not available.

Data reported to the Food and Agriculture Organisation (FAO) by the Indonesian government suggests forest losses in the order of -0.5% per annum in the ten years to 2010. Over the same period, other datasets collected with the assistance of remote sensing technologies estimate the rate of forest loss at -1.0% per annum – double that reported by the FAO – primarily in Borneo and Sumatra which accounted for 57% and 39% of losses respectively[18].

Focusing on Sumatra, between 2000 and 2010 deforestation in natural forests was almost exclusively in secondary forests (99%), and 10% of primary forest stocks were degraded to secondary forest status. This is an improvement on the ten years to 2000 when primary forests represented 5% of natural forest losses in Sumatra, and 30% of the primary forest stock was degraded. Over the 20 year period primary forest losses in Sumatra from deforestation and degradation averaged 2.6% per annum. This is especially significant as current research indicates that tropical forests in Asia host biodiversity that is the most sensitive to human impacts (notwithstanding the caveat that limited research has been undertaken in Africa)[6].

These independent assessments suggest recent deforestation rates in Indonesia are significantly greater than are being reported to the FAO. To some extent this will reflect definitional and collection variations though, looking forward, greater use of remote sensing technologies and globally consistent methodologies should see these variations come down, and a 'truer' picture of the state of the world's forests and primary forests to emerge.

Box 3: Biodiversity Hotspots

The issue of maintaining biodiversity can be framed by the question: Where would a given effort contribute the most towards slowing the rate of extinction? To answer this requires an understanding of species' distributions and endemism – the degree to which species are found only in a given place. This can be thought of as a measure of 'irreplaceability', since endemic species cannot be found anywhere else.

British ecologist Norman Myers developed the concept of biodiversity hotspots in 1988 in response to these challenges. Biodiversity hotspots are characterised by exceptional levels of plant endemism and serious levels of habitat loss. To qualify as a hotspot a region must contain at least 1,500 species of vascular plants (> 0.5% of the world's total) as endemic, and have lost at least 70% of its original habitat. By 2000, 25 hotspots were identified, expanding to 35 following more detailed analysis. These hotspots hold as endemic 50% of the world's plant and 42% of terrestrial vertebrate species, on 2.3% of the Earth's land surface. Around 77% of the Earth's terrestrial vertebrates are present in these hotspots.

As the map shows, 21 of the 35 hotspots are located in the Tropics. That is, many significant tropical ecosystems are under threat from human impacts, with habitat destruction a pervasive threat contributing to extinctions. In many tropical regions poverty and subsistence lifestyles are contributing to habitat loss. As such, improving environmental outcomes often requires social and economic issues to be addressed.

As available funds for conservation activities are limited, the concept of biodiversity hotspots assists decision makers to allocate funds to maximise environmental benefits. The concept of biodiversity hotspots is also useful in mobilising public interest in biodiversity and conservation issues.

Source: *Conservation International Foundation*

Notes

1. A two stage process was undertaken to assess which nations are classified as being in the tropics for reporting purposes – a population-based stage and a data availability stage. For large nations that straddle the tropics analysis and reporting is for subnational provinces primarily in the tropics. These nations are Australia, Bangladesh, Brazil, China, India, Mexico, Saudi Arabia and the United States. The reporting covers 109 of the 144 nations fully or partially in the tropics. More information on the nations and regions included in the report is available at: www.stateofthetropics.org
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3. The system is based on the concept that native vegetation is the best expression of climate. Climate zone boundaries reflect vegetation distribution, and are defined with reference to a combination of average annual and monthly temperatures and precipitation, and the seasonality of precipitation. The five main climate groups are Equatorial, Arid, Warm Temperate, Snow and Polar.
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13. The Russian Federation is excluded from the trend analysis as the irregular trend in the area of primary forest is the result of a change in the classification system introduced in 1995.
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