



An Introduction to Forests and Indian Forest Societies

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This document introduces the forest as an ecosystem and its importance to different species including humans. It describes the relation between forests and humans over history, benefits derived from them and how they are affected by actions such as deforestation. The current deterioration of the forest's health and related issues, such as climate change and dangers to the overall biodiversity around the world, are presented to the reader. These are explained in relation to historical developments such as colonization and industrialization, with a focus on India. In this context, issues faced by forest-based tribals in India over the last two centuries and their struggle for their traditional rights culminating in the Forest Rights Act of 2006 have been presented. It is hoped that this document enables the reader to follow ongoing discussions on climate change, environmental crisis and tribal rights, and encourages them to participate in finding solutions as needed.

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1 Introduction

The term *forest* often conjures up an image of a tree-filled landscape with abundant wildlife, but little human influence. In reality, while they are important, forests are much more than trees and wildlife – they are quite complex systems and have surprisingly strong interactions with human societies. They directly and indirectly affect nearly all life on Earth including all human societies'. Given their critical role in Earth's ecology, climate and overall influence on us, it is important to understand them in some detail. In particular it is worth examining the crucial roles forests play in maintaining a delicate balance between various ecosystems and moderating climate to facilitate human habitation.

A better understanding of forests in particular and ecosystems in general also enables us to appreciate the significance of and participate in ongoing efforts combating issues such as deforestation, climate change, tribal displacements and environmental degradation. It behooves us to understand these critical developmental issues in greater detail and to present it to the AID community in an objective manner. We hope this document serves that purpose in a meaningful way.

1.1 How should we define forests?

A combination of the diversity of forest ecosystems across the world and human perceptions have led to numerous definitions of forests. Lund has documented around 1600 different ways in which forests are defined [1]. These can be classified predominantly under two headings:

Land-Cover referring to the total area of land that is under vegetation and hence can be thought of as describing the actual physical appearance of the land and

Land-Use referring to whether or not an area of land is being used for human activities.

These definitions can sometimes lead to confusion: for example, from a land use perspective if there is a piece of land devoid of any vegetation but is not intended for human activity in the near future, it can be classified as a forest. However, this land will not qualify as a forest based on land-cover.

Yet other definitions of forests also take into account criteria such as canopy density (i.e. proportion of forest floor covered by the vertical projection of trees), tree height, and whether a piece of land currently devoid of vegetation will be reforested in near future. This diversity in the definitions induces us to consider a comprehensive definition of forests that will include several of these criteria, and also one well accepted by the majority of researchers in this field. One such definition is given by the Food and Agricultural Organization (FAO) of the United Nations Organization [2]:

"Forests are defined as land spanning more than 0.5 hectares, with a minimum canopy cover of more than 10 percent and trees which are higher than 5 meters or are able to reach such thresholds in-situ (i.e. in their natural state). It does not include land which is under agricultural or urban use". Going forward, we will use this description to define forests and distinguish them from other landscape features.

1.2 Types of forests

Forests may further be sub-classified as:

Primary Forests: Also known as virgin forests or primeval forests, these are old growth forests that contain trees of native species and have no indication of human activity whatsoever.

Secondary Forests: These are naturally regenerated forests which bear clear indications of human activity.

Plantation Forests: Forests comprising of trees directly planted by humans or through deliberate seeding.

Besides forests, FAO also defines:

Other wooded lands: These are lands not classified as forests, but still spanning an area of 0.5 hectares, with trees reaching a height of more than 5 meters but with either a total canopy cover of 5-10% or a combined cover of over 10 percent of shrubs, bushes and trees.

Other lands: All area not classified as forests or wooded lands. We should take note that this category includes area under agricultural and urban use. More importantly, it also includes a sub-category of "other land with tree cover" that is defined as land primarily intended for agricultural or urban use. It contains patches of trees that may cover a total area of 0.5 ha with a combined canopy cover of 10% and may include trees of both native or non-native species.

These descriptions lead us to arrive at the following principle: Tree cover should not be equated with an area under forest. They are not the same.

Climatic conditions are one of the main determinants of the type of forest and different regions across the Earth yield different forest types. These may be thought of as:

Tropical found in regions that are warm throughout the year. Examples of these would those found in equatorial regions in Africa, Asia, Latin and Central America and also in certain parts of India.

Temperate found in regions that have well defined seasons such as sub-freezing winters and warm/hot summers. Trees in these forests usually shed their leaves during winter and regrow them in spring summer. These forests are usually found across Europe, large parts of N America and some parts of Asia.

Boreal found in places that do not see warm weather at any time of the year. These are usually close to Arctic and in high elevations such as parts of the Himalayas and other mountain ranges

The forest types have significant influence on the soil. Temperate forests usually have the most fertile soil, caused by the shed leaves which decompose and release their nutrients back to the soil. Tropical forests do not have very fertile soil, but the equitable climate provides a steady home to several species of plants and animals. Boreal forests are characterized by evergreen trees which also do not shed periodically and thus have poorer soil.

Tropical and subtropical forests have the most influence on climate. Temperate forests and boreal forests, also affect the climate, but not as much as tropical forests.

1.3 Parts of a forest

While seen as a single entity from the outside, forests are made of different segments. Beyond common demarcations such as by species or terrain, a forest may be thought of as two parts:

Edge: This represents the exterior part of the forest as it transition to surrounding landscapes. It is normally defined as being within 300 feet of the forest's end [3]. These areas are more open, providing access for greater light to reach the ground. It results in these areas being warmer and drier with fewer water bodies. The openness also enables greater access for non-forest species and these areas see birds and animals from other landscapes [4] that are not seen elsewhere in the forest.

Interior: This represents areas within the forest more than 300 feet away from the edge. These have a greater density of trees. Their climate does not change as rapidly as the edge as the greater tree cover protects them from heat and wind. This makes the interior more humid and it is more likely for water sources to be found here. The more equitable climate enables certain species of plants to grow here, which might not be possible in the forest edge [4]. The greater density of trees also prevents mobility of animals and birds and these regions are some of the more secure areas within a forest [3, 5, 6]. This makes it the home of many nesting forest species, which avoid forest edges.

Healthy forests have large size interiors, and one of the main reasons for decline in a forest's health is fragmentation i.e. breaking up a larger forest into several smaller non-continuous ones resulting in more forests, but with smaller interior areas.

Another way demarcate areas within the forest is through height. By this classification, there are three main layers to a forest:

Floor which represents the bottom part of the forest. This is the place where all the organic matter of the forest eventually collect. In dense forests, very little light reaches the ground and thus, this area is usually dark. The conditions give rise to a home for scavengers. Other terrestrial animals, such as large cats, flightless insects and birds, also inhabit this space.

Understory representing the middle part of the forest elevation. This layer usually hosts plants and young trees. It receives some filtered light and collects most of the moisture from the canopy, making this the wettest part of the forest. The combination of some light and high moisture makes it a home to moisture loving species such as ferns, mosses and fungi.

Canopy represents the topmost layer of the forest. These are usually dominated by the tallest trees of the forest. They trap most of the light from the sun which makes it the most productive layer of the forest.

Each layer of the forest has its own ecosystem. The micro-climate of each is substantially different resulting in species unique to that layer. Numerous species of birds, insects and even animals often live their entire lives within a single layer. Together they all form the forest ecosystem and determine the overall behavior of the forest.

1.4 Facets of a forest

Different dimensions of a forest affect species living within and without, in different ways. It is important to note that they are interrelated and worth understanding in some detail, particularly those dimensions that affect humans. There are three primary dimensions to a forest that are of interest to us i.e., ways in which forests impact our societies –

1. as a home to numerous species, evaluated through biodiversity, which directly and indirectly affect several facets of human life such as food sources, agricultural productivity, diseases, pests and their natural control,
2. as a socioeconomic benefactor to several forest-based societies, and others that live close to them and depend on them for food and livelihood and,
3. as an influence on climates – both local and global, affecting life well away from forests

Of these, the first and third directly affect several species including humans, whereas the second is exclusively human related. When a forest is affected, its impact on all three facets will be felt. We examine them in the next few sections starting the relationship between forests and humans over time.

2 Forests and humans

Throughout history, human beings have had a complex relation with forests. For a section of people, forests represent home and a source of livelihood. But for another large section, forests have served more as an energy resource and at times, potential land for other human activities such as farming and living space. As human societies grew and became more complex, their effects were felt on forests (and on all other parts of Earth). These were usually damaging to forests and species within them, the most severe being deforestation i.e., removal of a part of or the whole forest. It started as exploitation of forest for resources and clearing it for land, but today deforestation has reached a critical level that endangers all life on Earth.

2.1 Historical relation with forests

It is well known that like most terrestrial life, humans as a species evolved in and around forests. For the earliest humans, forests and surrounding landscapes such as grasslands provided sources of food. As human societies evolved, they slowly expanded outside of forests and into more open land. Over time, developments such as tool making and farming led us to form settlements.

Deforestation and landscape alteration have been seen since humans formed settled societies. The earliest humans cleared sections of forests for agriculture and habitation. Low population and primitive tools minimized the need and degree of deforestation to where the forests could revive quickly once the human settlement was no longer present.

The rate of deforestation increased as human population became larger, developed better tools and larger urban centers sprung up [7]. The deforestation in ancient and medieval Europe starting from the Bronze Age, has been well researched [8, 9]. The Epic of Gilgamesh, written around 2100 B.C mentions the complete destruction of an ancient cedar forest in the Middle East by the king of Mesopotamia [10].

Up until the 20th century, much of the world, particularly Europe, relied on wood as the primary source of energy [11]. It resulted in large scale deforestation across the entire continent, and continued even where undesirable effects in the environment such as changes in rainfall and lower fertility of soil were noticed and tied to destruction of local forests, since there were no other solutions available for generating energy. By the late 19th century much of Europe had run out of forests to cut down [12, 13]. Wood became very scarce and valuable, and Europeans set out to find newer sources of wood and other energy materials. Colonization of newer lands resulted in a fresh supply of wood which resulted in damage to forests in the colonized countries.

2.2 The industrial age

Industrialization starting in mid 19th century A.D. changed the dynamics of deforestation significantly. As production rates increased, so did population growth rates and newer urban centers formed around production centers. New deforestation was undertaken to clear land for factories and the growing population, particularly in newly colonized countries and the New World. For instance, by the 19th century nearly 177 million square miles of forests had been removed for timber and land in USA alone [14]. While the principal energy source changed from wood to coal and other fossil fuels, charcoal obtained from wood was still an important energy source. The railroad industry, which began in mid 19th century also depended on timber for its lines resulting in significant deforestation. As newer forest areas were accessed, it started to encroach on lands traditionally used by forest societies. The resultant conflict was often catastrophic to these societies, especially as the encroachment policies were often supported or even initiated by the government which was immensely more powerful.

With increased population came a demand for more food. Also, as agricultural techniques became better and synthetic fertilizers became available, farming as a commercial venture became more widespread. This became more popular in the later part of 20th century, particularly in tropical developing countries. Whereas traditional farming was primarily seen as an occupation to feed local population, commercial farming was linked with trade (revenue generation) and large-scale processed food production. These required larger farms (sometimes called industrial farms) which were created by clearing forests [15, 16, 17, 18, 19]. While small farms were seen as a cause of deforestation, it was observed that larger farms required significantly more deforestation even by scale [17]. Commercial farming of soy, palm oil, beef (cattle ranching) and even tobacco were now the primary contributors to tropical deforestation [17, 20, 21, 22, 23].

Towards the second half of the 20th century, adverse effects of large-scale environmental degradation were noticed around the world. Pollution, desertification, health issues, changing climate and a decrease in biodiversity beneficial to humans were all observed and tied to the damage caused to our environment [24]. The awareness resulted in efforts to improve knowledge of our environments and newer movements that sought to decrease and eliminate deforestation. Nevertheless, deforestation has continued to occur, particularly in

developing societies as they strove to catch up with already industrialized societies.

2.3 Deforestation in the 21st century

An extensive study on global deforestation carried out between 2000 and 2012 by M.C. Hansen and his team at the University of Maryland observed the following [25]:

1. During this period 2.3 million square kilometers of forest were lost and 0.8 million square kilometers of forests were gained, for a net loss in forest cover of 1.5 million square kilometers. To put those numbers in perspective, the total area of India is 3.287 million square kilometers, hence in a 12 year period the world lost forest cover equal to almost half the size of India.
2. Among the four different climate types identified in the study, viz. tropical, sub-tropical, temperate and boreal, tropical regions exhibited significant deforestation dynamics. In the tropical region, the ratio of forest loss to forest gain came out to be 3.6. Moreover, *tropical rain-forest regions alone amounted to 32% of the total global forest loss.*
3. Even though Brazil experienced the second highest forest cover loss in absolute terms, yet it's rate of deforestation has significantly reduced. *The slowing down of the pace of deforestation can be directly attributed to its dramatic policy intervention, e.g. formalizing and administering forest land right acts for the forest dwelling communities during the said period.*
4. The report also questions the statistics reported by countries such as China and India, which in their report to FAO mention significant forest gains. Landsat imagery used in this study does not corroborate the claims made by these countries.

Some other interesting trends have been brought forth in the report on "State of the World's Forests (2016)" published by FAO [26]. We list some of the more important ones below:

1. Agriculture, more than anything, continues to be the most significant driver of deforestation. In the tropical countries, roughly 7 million square kilometers. of forest was lost in the period 2000-2010, whereas, in the same period there was a net gain of 6 million square kilometers. of agricultural land. Moreover, the most significant net loss of forest cover and net gain of agricultural land was seen in the low-income countries. However, a word of caution is warranted here in interpreting this data. The report also points out that commercial and large scale farms account for more deforestation when compared to subsistence agriculture. In fact, in the tropics and the subtropics, 40% of the deforestation is due to commercial agriculture, 33% due to subsistence agriculture, infrastructure accounts for 10%, urban expansion another 10% and finally mining accounts for 7% of deforestation. However, from the Indian perspective, things look different. Even though this does not find mention in the FAO report, according to data released by the Govt. of India, since 1980 15000 square kilometers of forest lands have been diverted. Of these, the largest chunk (nearly a third) has been diverted for mining and related activities, followed by defense and hydroelectric projects.

2. To understand the effect of forest policy on rates of deforestation, a deeper analysis of data from seven countries showed significant decrease in forest cover, while at the same time showing significant increase in agricultural land usage. The drivers of deforestation were classified into three categories: agriculture related, forest products related and social/governance related. Among agriculture related drivers of deforestation, shifting agriculture and land encroachment constituted the highest percentage of factors causing deforestation. Among the wood and forest related drivers, the need for forest products and insecure tenure of forest lands seem to cause deforestation the most. Finally, among the social/governance related drivers of deforestation, population growth, industries and increasing poverty seems to be the main reasons behind deforestation.

In trying to explain the relationship between investment in agriculture, change in forest area and poverty, the FAO makes the following observation: *“For many developing countries, particularly low-income, food-deficit countries, agriculture is the largest sector in terms of both employment and share of gross domestic product (GDP), which can be as high as 30%. In such countries, public spending on agriculture is an important policy instrument for promoting agriculture growth and food security. According to the FAO Agriculture Orientation Index, however, agricultural expenditure as a proportion of its contribution to GDP is declining in many of these countries. Poverty and hunger, perpetuated by a lack of economic opportunity, force poor people to exploit the natural resources around them. Forest loss, therefore, is a chronic feature in many low-income, food-deficit countries where government investment in agriculture is low. [...] the loss of forest cover is greatest in countries with a low Agriculture Orientation Index and these are also low-income countries”*.

In light of the above, it is clear that to tackle the scourge of deforestation comprehensive policies need to be formulated. These should cover multiple areas such forest rights, agriculture, poverty alleviation, food and income security, rural development, sustainable industrial development and soil and water use. We will address some of these issues in the subsequent sections. At this time however, we would like to note that the FAO report [26] also makes several recommendations in this regard such as:

1. effective market reforms to incentivize the development of tools and technologies to achieve more productivity in agriculture,
2. sensible land use policies that recognize not just the value of forests in preserving our environment but also understand their role in delivering wider economic development, especially to those communities that depend on them
3. effective and inclusive legal and institutional frameworks provide predictable and secure land and forest tenure, with rights to trees, tree products and services to the traditional forest dwellers and
4. collaborative forest management in which the government partners with local communities to preserve forests and manage its produce.

3 Ecosystems and biodiversity

Ecosystems are self-regulating communities of plants and animals interacting with each other and with their nonliving environment - forests, wetlands, mountains, lakes, rivers, deserts and agricultural landscapes. Biodiversity is a feature of the ecosystem that measures the variety of life within it. According to the Millennium Ecosystem Assessment, “biodiversity is the variability among living organisms from all sources, including terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part” [27]. Sometimes biodiversity is incorrectly presumed to be a relevant feature of only unmanaged ecosystems, such as wildlands, nature preserves, or national parks. But managed systems like plantations, farms, croplands, aquaculture sites, rangelands, or even urban parks and urban ecosystems, also have their own biodiversity.

The forest as an ecosystem is home to several different types of species. These include small and large animals including humans, birds, reptiles, insects, trees, plants and even microorganisms such as bacteria. They have complex relationships with each other which may be as part of the food chain or as support to each other for shelter, protection or even as pollinators. Some of these relationships (sometimes referred to as *webs*) may involve just a few species while others involve many different species. Scientists are still discovering the different types of relationships that occur in the forest environments and how these affect other ecosystems.

A critical consideration is that for species within, ecosystems are not interchangeable. The ecosystems that exist in forests can not be replaced by a plantation or any other ecosystem. The biodiversity that exists in one ecosystem is dependent on that ecosystem and will collapse if changes are made to it. Just as all ecosystems are connected, so is biodiversity across these systems. A decrease in biodiversity in one ecosystem ripples through others eventually affecting all other ecosystems including ones involving humans.

3.1 Why are ecosystems and biodiversity important to us?

Humans obtain several benefits from ecosystems including provisioning services such as food and water; regulating services such as flood and disease control; cultural services such as spiritual, recreational, and cultural benefits; and supporting services such as nutrient cycling that maintain the conditions for life on Earth. Some examples are obvious: without plants there would be no oxygen and without bees to pollinate there would be no fruit or nuts. Without the actions of pollinators, agricultural economies, our food supply, and surrounding landscapes would collapse. Birds, bats, bees, butterflies, beetles, and other small mammals that pollinate plants are responsible for bringing us one out of every three bites of food.

Others are less obvious - coral reefs and mangrove swamps provide protection from cyclones and tsunamis for those living on coasts, while trees can absorb air pollution in urban areas. If money is a measure, the services provided by ecosystems are estimated to be worth trillions of dollars. Biodiversity loss in Europe alone costs the continent about 3% of its GDP, or €450 millions a year [28].

This biodiversity is essential for forests, too - without a diverse set of species to support them, trees cannot sustain for very long and the forest system collapses. The species within, rely on tree cover and on each

other for their survival making this an ecosystem of its own. Every forest is unique in that its ecosystem is different from others. There are special species found in every forest that are not found in others. A forest is damaged not just by removal of trees, but also by removal of species within. Furthermore, the destruction of forests is felt globally, not just locally. For instance, the destruction in the Amazon forest affects the oxygen supply of the entire world.

3.2 Why should we be concerned?

Ecosystems are vulnerable to interference as pressure on one component can upset the whole balance. They are also very vulnerable to pollution. Today many ecosystems have already been damaged – some beyond repair, while many others are at risk. The world's forests house about half of global biodiversity. But they are disappearing at a rate of 0.8% per year. Tropical forests, which are among the most bio-diverse ecosystems, are vanishing at an annual rate of 4% [29].

The loss of biological diversity is one of the most severe human-caused global environmental problems. Hundreds of species and myriad populations are being driven to extinction every year. The sixth mass extinction in geological history has already begun, according to some scientists [30]. In the last few decades, habitat loss, over-exploitation, invasive organisms, pollution, toxification, and more recently climate disruption, as well as the interactions among these factors, have led to the catastrophic declines in both the numbers and sizes of populations of both common and rare vertebrate species. For example, several species of mammals that were relatively safe one or two decades ago are now endangered. Even marine life is in danger—seafood is the critical source of protein for more than 2.5 billion people but rampant over-fishing has caused catches to fall steadily since their peak in 1996 and now more than half the ocean is industrially fished [31].

It has been estimated that there are at least a million species of insect and another 300,000 species of spiders, molluscs and crustaceans. Several of them depend directly or indirectly on multiple ecosystems including forests for survival. Today, many of these insects are critically endangered. A recent study in Germany shows that 75% of flying insects were lost in the last 25 years and the same situation prevails elsewhere, too [32]. And insects really matter, not just as pollinators but as predators of pests, decomposers of waste and, crucially, as the base of the many wild food chains that support ecosystems. When insect populations change, it affects the entire food chain, including humans. Changes to the climate are reversible, even if that takes centuries or millennia. But once a species becomes extinct, particularly those unknown to science, there's no going back.

To assess if this damage to biodiversity will cause widespread ecological collapse, one approach gaining popularity is called “planetary boundaries” within which humanity can continue to develop and thrive for generations to come. Crossing these boundaries increases the risk of generating large-scale abrupt or irreversible environmental changes. Further research is underway to improve the availability of reliable data to further examine these thresholds. *Of the nine planetary boundaries, biodiversity loss and nitrogen pollution are estimated to have been already crossed* [33].

3.3 Biodiversity in India

India possesses a tremendous biodiversity both in genetics as well as of species and ecosystems. It contains over 7% of the world's biodiversity on only 2.5% of the Earth's surface. This diversity can be attributed to the vast variety of land-forms and climates resulting in habitats ranging from tropical to temperate, and from alpine to desert.

Within India lie some of the world's most biodiverse regions. A biodiversity hotspot is a bio-geographic region with significant levels of biodiversity that are threatened with destruction. Myers [34], terms a region as a biodiversity hotspot based on two criteria: it must contain at least 0.5% or 1,500 species of vascular plants as endemics (i.e., found only in that region), and it has to have lost at least 70% of its primary vegetation. Around the world, 36 areas qualify under this definition. There are 36 biodiversity hotspots around the world. These are home to around 2 billion people, including some of the world's poorest, many of whom rely directly on healthy ecosystems for their livelihood and well-being. These sites support nearly 60% of the world's plant, bird, mammal, reptile, and amphibian species, with a very high share of those species as endemics. The hotspots provide crucial ecosystem services for human life, such as provision of clean water, pollination and climate regulation. India hosts 4 biodiversity hotspots: the Himalayas, the Western Ghats, the Indo-Burma region and the Sundaland (includes Nicobar group of Islands).

India is home to several well-known large mammals, including the Asian elephant, Bengal tiger, Asiatic lion, leopard and Indian rhinoceros. Some of these animals are ingrained in culture, often being associated with deities. The popularity of these charismatic animals have helped greatly in conservation efforts in India. The tiger has been particularly important, and Project Tiger, started in 1972, was a major effort to conserve the tiger and its habitats. Project Elephant, though less known, was started in 1992 and works for elephant protection. Most of India's rhinos today survive in the Kaziranga National Park. The Western Ghats are a chain of hills that run along the western edge of peninsular India. These regions have moist deciduous forest and rain forest. Nearly 77% of the amphibians and 62% of the reptile species found here are found nowhere else. Much of Indian biodiversity is intricately related to the socio-cultural practices of the land.

Over the last few centuries, due to a combination of population explosion, environmental damage, climate change and lax implementation of environmental policies, several species are facing the threat of extinction. Not only does this affect the food chain, but also the livelihood and the culture of millions of Indians who depend on local biodiversity.

4 Forests: bulwark against climate change

It is now universally understood that human activities, especially over the last two hundred years, have caused the global climate to change and become warmer overall. In 2009, 18 scientific associations came together to issue the following statement, "*Observations throughout the world make it clear that climate change is occurring, and rigorous scientific research demonstrates that the greenhouse gases emitted by human activities are the primary driver*" [35]. Besides, several major research institutions working on the issue of climate change worldwide agree with the above assessment that this human induced climate change

will have catastrophic consequences for much of humanity as we know it. More recently, the scientific community in the USA came together to reaffirm the conclusion that the worldwide scientific community reached decades ago and issued a “National Climate Assessment” report which highlighted the fact that, “*Global climate is changing. Most of the warming of the past half-century is due to human activities. Some types of extreme weather are increasing, ice is melting on land and sea, and sea level is rising*” [36]. In face of all this evidence, as animals on top of the food chain, it is our responsibility to reverse this trend as soon as possible and save ourselves and other life forms from the impending doom. Forests can be our ally in this fight to reverse the effects of climate change. Indeed, the importance of forests in mitigating the effects of climate change can not be overstated and we will now examine the various ways in which preserving forests can equate to preserving life on this planet.

Forests and rainfall: The positive local effects of forests in retaining moisture and inducing rainfall was shown in the work of an early American environmentalist, J.M. Anders [37]. On the other hand, cutting down forests can lead to reduced rainfall. In fact, the impact of degradation of the forests can be felt far and wide. Recent studies carried by Dominic Spracklen at the University of Leeds in the Amazon rain-forests suggest that at the current pace of forest degradation, by 2050, rainfall in the entire region could be reduced by 12% during wet season and by as much as 21% during the dry season [38].

Several such studies have been carried out in the Indian context as well by scientists at premier research organizations like IISc and IITs. A team led by Prof. Ghosh showed that the Indian Summer Monsoon Rainfall (ISMR), which accounts for 80% of the total annual precipitation in India has weakened significantly since 1980 and this weakening of the ISMR is explained by the change in land use/land cover over most of India that has resulted in destruction of wooded land as more and more of it has been converted to cropland or has been subsumed in burgeoning cities [39]. Deforestation in the Western Ghats affects the southwest monsoon over six South Indian states [40, 41]. Over time, it affects climate on other parts of the country and even neighboring countries. In light of increasing water scarcity in India, the importance of preserving forests to prevent instances of major drought is obvious.

The importance of forests in regular rainfall is also well known to societies associated with forests, such as those that live in or farm around forests. Their knowledge, while not always scientifically recognized, is critical as it provides a model of environmental conservation as an integral part of social cultural i.e., preservation of forests is integrated into their daily lives. By observing and absorbing this aspect into our own lifestyles, we can incorporate forest preservation and growth into the culture of the larger society.

Forest as sinks for greenhouse gases: Much of the climate change that we see today is caused by indiscriminate emission of greenhouse gases into the atmosphere. This has resulted in what is called “global warming” which refers to the *average rise in temperature of the Earth’s climate system*. By some estimates, the global average temperature may rise by as much as 4.5°C in this century [42]. This will lead to large scale destruction of life forms all across the planet. By current estimates, the forests of the world absorb 40% of all CO₂ emitted due to human activities. Destruction of forests causes a two fold harm: (a) it reduces the overall CO₂ absorption as more forests are destroyed and more alarmingly (b) the destruction of forests contributes to more CO₂ emission as the biomass stored in forests is dispensed with.

Increased instances of devastating forest fires: As global average temperatures rise and severe drought like conditions prevail, it makes degraded forests (which can not hold moisture in both the soil and atmosphere effectively) very susceptible to forest fires. This adds to the ever increasing greenhouse gases being put in the earth's atmosphere.

Loss of water: It is now well understood that trees by themselves and forests in particular capture and hold an enormous amount of water that is recirculated locally [43, 44]. It is estimated that all vegetation on Earth recycle about 48 cubic miles of water every day – for instance about 40% of rainfall in sub Saharan regions is estimated to be recycled by vegetation [45]. Forests, in particular are an integral part of global water cycle, regulating the transfer of ground water to the atmosphere through evapotranspiration, storing and releasing them at different times of the day and year [43, 45]. They are able to trap moisture present in fog and mist during dry seasons and transfer it to land [43]. They are an integral part of watersheds, often providing the cleanest water [46]. Even urban environments benefit from having local forests (“urban forests”) [44] When forests are cut down, the water is lost with no mechanisms available for recapture and adds to desertification.

Soil degradation and erosion: The mechanism of soil degradation as a result of deforestation around the world is well established [47, 48, 49]. As the forest cover is removed, the soil loses its primary source of nutrients, namely organic matter from trees and plants. It also loses its rain cover, which protects the fragile top soil structure from direct impact of rainfall. Without tree roots and vegetation to bind the soil together against runoff, the top soil is carried off by resulting floods. This is greater in mountainous and hilly regions which often see landslides as a result of deforestation [50, 51]. The most affected areas are those in the immediate vicinity of the forest whose nutrition was replenished by organic matter from the forest, and where the danger of flooding was mitigated by the forest. A World Bank cited research shows that deforestation can increase the danger of surface erosion by more than a factor of 170 (17000%) [49].

5 Preserving forests: A social argument

The forest as a home or source of livelihood for a significant part of humans in the world is something that often overlooked by conservationists and environmental policy makers. In a report published in 1999, the World Commission on Forests and Sustainable Development said, “... *350 million of the world's poorest people depend almost entirely for their subsistence and survival on forests. A further 1 billion poor people - about 20% of the world's population - depend on remnant woodlands, on homestead tree gardens, and on agroforestry systems for their essential fuel wood, food and fodder needs*” [52]. These sections are found mainly in developing societies in Asia, Africa, Central and Latin America. Let us understand these numbers in the Indian context, with the following definitions:

Indigenous people: They can be understood as descendants of those who inhabited a country or a geographical region at the time when peoples of different cultures or ethnic origins arrived.

Forest people: Forest people may be described as people who live in and have customary rights to their forests, and have developed ways of life and traditional knowledge that are attuned to their forest environ-

ments. Forest people depend primarily and directly on the forest both for subsistence and trade in the form of fishing, hunting, shifting agriculture, the gathering of wild forest products and other activities.

It should be noted that **not all forest people have indigenous roots and not all indigenous people live in forests.**

According to the IWGIA report of 2011, indigenous people in India number 84.3M while roughly 275M can be identified as forest people as described above. Furthermore, P.K. Biswas of the Indian Institute of Forest Management (IIFM) writes, *“forest sector is the second largest land use after agriculture. In remote forest fringe villages about 300 million tribal and other local people depend on forest for their subsistence and livelihood and about 70% of India’s rural population depends on fuel-wood to meet its domestic energy needs. For about 100 million of them, forests are main source for livelihood and cash income from fuel-wood, non-timber forest products (NTFP) or construction materials. More than half of India’s 70 million tribal people, the most disadvantaged section of society, subsist from forests”* [53]. Given the affected population size, it is important to understand the impact of forest degradation on those whose lives are closely intertwined with the health of forests.

Deforestation impacts the lives of forest-dependent people both directly and indirectly. Examples of direct effect include:

1. **Deteriorating health condition:** In areas where forests have been cleared to set up industries, research by AID partner organizations such as Jan Swasthya Sahyog (JSS) and Community Environmental Monitoring (CEM) in Chhatisgarh and Jharkhand has shown an increased prevalence of musculoskeletal disease in youth, increase in respiratory diseases among the population living in areas where new industries have been set up. Their research also shows increase in food and water borne diseases because of increase in soil and water toxicity due to the uncontrolled discharge of toxic materials by the industries, see e.g [54, 55].
2. **Decrease in agricultural productivity:** As forests are being cut and their ecosystems are being disturbed, the natural ability of the soil to replenish itself with the dead and decaying flora and fauna is lost. Furthermore, in areas where forests are being replaced by industrial and mining activity, the soil and water quality deteriorates due to the dumping of harmful chemicals in the surrounding environment. As a result, agricultural productivity comes down severely creating famine-like situation in these areas.
3. **Drought like situations:** We have already seen that deforestation disrupts the rainfall cycle. Indigenous and forest dependent population in India are most affected by it as they rarely have access to any centralized water supply and depend almost exclusively on seasonal rivers and streams for their water needs. We would like to remark here that AID has tried to tackle this growing problem by helping the indigenous people in Jharkhand and Chhatisgarh build water-sheds and bunds in order to encourage water storage for lean months.

The greatest indirect consequence of deforestation arises is from population displacement due to industrialization. Increasingly, forests are being cut down to satisfy the ever growing demands of a burgeoning

population and the indigenous population of our country is being forcefully displaced. According to the Internal Displacement Monitoring Center (IDMC), roughly 65 million Indians were displaced between 1950-2015 on account of “development projects” that were undertaken in the said time period [56]. Further analysis of this data showed “90 percent of the displaced people were forced from their home by state-run projects” [56]. According to Dayamani Barla, a prominent journalist from Jharkhand and tribal-rights activist, 8 million people from Jharkhand alone have been displaced. This includes indigenous tribes as well as other people depending upon forests.

We will briefly describe the historical structural reasons that facilitated such massive displacement in the next section. In this section we will rather focus on the effect that displacing whole communities from the lands of their ancestors has on the social and economic fabric of India.

Disintegration of communities: Rarely are the displaced people given the benefit of rehabilitation packages. Even when the government attempts to rehabilitate and resettle them, they rarely rehabilitate entire communities together. This has resulted in the disintegration of tribal communities and often cultures, languages and art-forms of the indigenous people, which relies on the dynamics of the entire community, are lost.

Deteriorating living conditions: Data suggest that resettlement and rehabilitation packages that are offered to these communities are grossly insufficient on account of severe under-valuation of resources that these communities are forced to give up. R.B. Mallavarapu notes that [57], “Rehabilitation and Resettlement (R&R) policies at the National and State Levels, though are expected to safeguard the interests of the displaced persons, they are not practiced in the right spirit. Absence of rehabilitation Act at National level and violation of protective laws, regulations, legislations, and court orders are causing deprivation of tribal and weaker sections.” As Dayamani Barla describes in her book, “..As adequate compensation in terms of money and jobs were not given to the displaced people, removed from their forests that provided for them and fulfilled their needs, they have completely lost their economic independence”. More often than not, the displaced indigenous people are left to populate the slums of the cities and towns in which they are rehabilitated and resettled.

Increase in poverty and vulnerability: An internal world bank review for the period 1986-1993 [58] shows that, “... declines in post-relocation incomes were as high as 40 per cent for people who were poor before their displacement”. Both forced displacement and resettlement cumulatively hurt the capacity of indigenous people to work for a living. On the one hand, they are forced to give up their traditional forms of livelihood, and on the other, due to lack of training, they are ill-equipped to take up skilled professions in the regions where they are forcibly resettled. Poverty leads to food insecurity and hence, chronic malnutrition in the displaced population is rising very fast.

The displaced children do not have access to good educational facilities and drop out of schools to help their families earn a living. Besides, the psychological trauma of forced eviction affects adults and the young people alike. This has also led to severe alcoholism in the displaced population. All these combined create a severe public health issue in the displaced population.

Disproportionate suffering of Women: Among the displaced, it is found that women suffer the most [59]. As they perform almost all the domestic chores, they have to travel farther and longer after resettlement to get access to food, fuel, water etc. When displaced women farmers can't find jobs, they are forced to take up menial jobs in the city and often fall prey to sexual abuse.

6 Indian forest societies

6.1 Pre-colonial era

Historically, Indian forest societies and forest dependent population have had varied interactions with rulers and other Indian societies. It is noted that in ancient times, the forests were accessible to all sections of society and forest tribes (or *adivasis* as they are more commonly referred to, *adi* = ancient, *vasi* = resident) were considered an integral part of India's mainstream societies. Their roles in ancient Indian religious texts and literature portray them as functionally interacting with rest of society. Their rights have traditionally been respected and Indian rulers ensured they did not interfere with their way of life. Religious texts also mention forests as a haven for members that sought spiritual development.

The forest societies have in their turn, developed an extraordinary knowledge about the forests they live in. Having lived in the same forests for hundreds, if not thousands of years, they have learnt about the dynamics of the forest and its inhabitants. Just as each forest is different, so is each forest society. Some are nomadic, while others are settled. Many of them farm small plots of land within the forest or on its edges, which they rotate every few years. They collect firewood and water, harvest produces such as fruits, vegetables and plants for food and medicine, some of which they sell outside. They may also rear animals such as cattle or goats using forest land for grazing, and may also hunt animals occasionally for food. That they were able to live in the same forest for several centuries is a testament to their ability to source it without causing any long-term damage. Being dependent on the forest, they have a strong interest in protecting it as they have shown on many occasions (elaborated in section 6.4).

Over time, as population grew, sections of the forests were cut down and converted to farm land or for habitation. Special incentives were provided to people that took up the task of this conversion as it resulted in greater revenue for kings. Nevertheless, much of the original forests were still around when the British colonized India.

6.2 Colonial era

The policies experienced a change under the British colonial rulers, who viewed Indian forests as reservoirs of timber and other natural resources. They created the first forest policies in India in the modern era and a dedicated Forest Department tasked with commercialization of the forest for revenue generation. The policies took the form of various Forest and Land Acquisition Acts, and were progressively instituted between 1865 and 1927 [60]. They gradually transferred the ownership of forests from communal to the colonial

government. The acts separated forests into “reserved” areas where valuable timber wood such as teak, *sal* and *deodhar* were available and “wasteland” where these were scarce or not available. Reserved areas were strictly controlled with access permitted only to Forest Department employees for the purpose of generating revenue for the government. Any entry into them by the average citizen, including societies that traditionally lived on forest land, was barred. Deforestation of wasteland forests was initially encouraged so that it could be converted into revenue generating farmlands, but was discouraged from 1894 (resulting from the Voelcker Resolution named after the author, German agriculturalist Dr. J. Augustus Voelcker) when it was determined as causing environmental degradation which resulted in lower agricultural production [60].

The restriction on using parts of the forest that were traditionally open to the forest tribes created several issues resulting in protests from them. The government reacted with a heavy hand and through capital punishments. Dayamani Barla writes “..*The Britishers carried out a policy of reckless exploitation of natural resources like water, land and forests, brutal oppression of women and children, forced dispossession and displacement of the tribal population from the lands that they had called home for centuries, and coercive collection of revenues from a population already reduced to abject poverty*”.

The protesting tribes were termed “criminal” which opened them up to governmental prosecution - even for indulging in activities for their sustenance. Laws were passed that enabled the government to imprison members of these tribes with little oversight. These acts brought the tribes into open conflict with the government’s forest department resulting in revolts and rebellions [60].

6.3 Independent India’s policies and The Forest Rights Act

The situation of the *adivasis* changed little after independence. The newly independent country’s priorities were industrialization and revenue generation, and the existing colonial laws provided the government a framework to address these more effectively.

The National Forest Policy adopted in 1952 stated that “*Village communities in the neighborhood of a forest will naturally make greater use of its products for the satisfaction of their domestic and agricultural needs. Such use, however, should in no event be permitted at the cost of national interests. The accident of a village being situated close to a forest does not prejudice the right of the country as a whole to receive the benefits of a national asset*” [61]. It gave the Central Government the right to declare any area as a “forest” without ever actually carrying out a physical survey of the land. By some estimates, 80% of the “reserved forest” land in Madhya Pradesh and 40% of such land in Odisha has never been surveyed [62]. The result was that the tribals were still condemned as criminals for following their age old practice of living on forest resources.

The Wildlife Protection Act passed by the parliament in 1972 [63] followed the same model of deciding the fate of forest dwelling communities of India without taking any input from them. This act, which was ostensibly written to protect the wildlife of India, was actually used to provide a legal basis for displacing *adivasi* communities from the lands that they had always lived in with complete harmony with nature.

In 1988, changes were made to India’s forest and environmental policies, which recognized the rights of forest tribes to access forest land and join in the conservation efforts (section 4.6 of National Forest Policy, 1988 [64]). The Circular Concerning Joint Forest Management [65] recognized tribal and village community

as stakeholders (and also NGOs as interested parties) in the preservation of forests allowing them more access and a role in conservation efforts, while the Forest Department maintained the right to the final decision. Nevertheless, these acts only restored part of their original rights, and these were not transferred to state government policies [66].

In 2006, the government, with inputs from affected tribals, created The Forest Rights Act [67] to undo the “historical injustice” perpetrated since the colonial times on forest dwelling communities. Unlike past acts, this was written with the help of the Ministry of Tribal Affairs (and opposed by the Ministry of Environment and Forest) [68] and provided a framework which legally recognizes their traditional rights over the forests that they call home. This latest act while still not perfect, is a substantial step in correcting these historical wrongs.

6.4 What does the FRA do?

At a top level, the Act essentially does two things:

1. This act legally recognizes the traditional rights of the forest dwelling communities over the forests.
2. It gives the forest dwelling communities a voice in forest and wildlife conservation.

The traditional rights of the forest-dwelling communities can be classified as either land-rights or use-rights. The land rights provision of the act ensures that the land which the adivasi communities have cultivated for generations can be legally registered in their names, provided appropriate documents are submitted. For scheduled tribes, this effectively translates to showing that an individual or a family has been cultivating that piece of land for over a generation i.e. roughly, 25 years (the cut-off year for this calculation is 2005). On the other hand, individuals or families termed as OTFD (other traditional forest dwellers) need to show that the land which they claim as their own should have been cultivated by them for at least three generations, i.e. roughly 75 years.

The use-rights provisions of the act give legal rights to the forest dwelling communities over minor forest produce such as *tendu* leaves, various herbs and medicinal plants, with the exception of timber. Besides, they are also allowed free use of pastoral lands and water bodies for their needs. The act is quite revolutionary in giving the right to protect and conserve wildlife and forests to the forest dwelling communities. Before this act, conservation and protection of forests and wildlife used to be the sole preserve of the forest department. If a forest department classified an area as protected, it had the authority to remove the people inhabiting those lands overnight. On the other hand, if the forest department wanted to destroy a forest or hand it over to some private or government entity which sought to destroy it, it was illegal to stop the forest department from doing so. FRA, 2006 (especially when seen in conjunction with the Land Acquisition Act of 2013) seeks to empower people by giving them the final say in what shall happen to the forest lands that they inhabit.

This provision of the act was put to good use by the Dongria Kondh community of tribals living in the foothills of Niyamgiri to prevent Vedanta Resources from conducting harmful bauxite mining operations in that ecologically sensitive region [69, 70, 71].

In light of the recent Supreme Court order to evict the tribals (as of this writing, a stay has been put on that order), we also need to address the objections that some conservationist organizations such as Wildlife First have to FRA, 2006. In their view, granting Forest Rights Act to indigenous communities of India will result in severe degradation of wildlife and natural resources. This contention has been successfully disproven by several studies carried worldwide.

- A widely cited white paper on, “Indigenous People and Conservation” written by a team led by Janis Alcorn and published by the Macarthur Foundation states that, “*Indigenous Peoples agendas go far beyond conservation. Their concerns aim toward a state of integrated well-being that includes a healthy ecosystem. As one indigenous interviewee said: ‘conservation production, production conservation’. Without conservation and ecosystem management, production will fail; and ecologically-sustainable production is necessary to maintain the people and society that care for the ecosystem and its well-being. This concern is a cultural dimension that has been honed over centuries of survival depending on their own societies and local resources while threatened by colonial repression*” [72].
- Another study from Papua, Indonesia, by scientists at the Center for International Forestry Research (CIFOR) [73] showed how local communities effectively protected extensive areas of land – falsifying assumptions that such communities overuse or damage natural resources. The researchers say that, “*In each village we found evidence that local monitoring contributes to effective protection and deters unregulated exploitation*”.
- According to an extensive report published by the Rights and Resources Initiative, where they compared and contrasted the two models of conservation in 28 different countries, it was found that the rate of deforestation on customary (tribal) lands was half of what it is elsewhere. Furthermore, in areas where the rights of the indigenous people have been formalized (e.g., by an act of the parliament), the rates of deforestation is far less than in the areas where these rights have not been given the sanctity of the law. In the Brazilian Amazon, for example, the rate of deforestation in tribal lands was less than 1% while elsewhere it was more than 7% [74].
- Similarly, there are other reports that establish the very significant role of indigenous communities in protecting biodiversity as well [75].
- Within India, it is shown that “*over 60% of the country’s forest cover exists in 187 tribal districts inhabited by tribals (who make up less than 8% of national population)*” [68], while much of the forests in non-tribal areas have been destroyed.

The heroism of the Dongria Kondh community in protecting the forests around Niyamgiri has already been mentioned above. All these studies belie the assertion made by organizations that tribal communities rather than protecting forests are instead dangers to them.

7 Potential solutions

To help achieve sustainable development, it is crucial that the important role of forests is recognized by policy makers sitting in governments worldwide. Forests support the livelihoods of more than a billion people living in extreme poverty worldwide and provide paid employment for over 100 million people. They are home to more than 80% of the world's terrestrial biodiversity and help protect watersheds that are critical for the supply of clean water to most of humanity. Climate change, however, poses enormous challenges for forests and people. Adaptation and mitigation are the two main responses to climate change, mitigation seeking to address its causes and adaptation aiming to reduce its impacts.

It is also important to note that the degradation of forests affects men and women differently specially in countries like India. In rural areas, a woman's life is fundamentally dependent on nature, since she has to maintain her family by managing and using natural resources (e.g. women are primary providers of household food, fuel and water for cooking, heating, drinking and washing). Climate and biodiversity alterations caused by forest degradation largely hinder women's livelihoods. When assessing forest conditions and planning a reverse degradation project, forest managers must consider women's needs, as well as the role they play as mitigating agents. If trained and empowered, women can lead the fight against degradation. They have a very close relationship with forests and trees and can recognize the undesirable effects of forest degradation such as soil depletion, reduced productivity and regeneration, and the presence of pests.

Solutions to these should be thought of at multiple levels.

7.1 Policy Level

Citizens should demand policies at local, state or central government levels that reverse deforestation and unplanned urbanization. There should be greater transparency in urban planning with adequate spaces for green areas. It is well understood that while individual trees bring some changes, the real benefits occur when trees are present large contiguous areas (>0.5 Ha).

Similarly, policies should be demanded and adopted to preserve existing forests, reforest denuded areas where forests were present in the past. The location of the forest is as important as the forest itself. Having forests in the path of monsoon winds, in areas of high flood risk, montane terrains etc. provide substantial benefits.

The expertise and motivation of India's forest-based societies should be taken advantage of in these efforts. These societies have been heavily victimized over the past two centuries due to the government's policies. The FRA is a good framework to remedy this error, provide them an important role in India's development and make them custodians of forests, and these should be implemented without gaps. The effects of the new policies should be studied by independent groups to identify faults which should be addressed as needed.

7.2 Organization Level

Organizations such as AID should adopt a strong policy of environmental protection and tribal rights in their efforts. Projects that tackle tribal, agricultural, pollution, water access and other related issues should include clauses to empower the affected population through scientific and legal education on the environment, biodiversity, climate change and people's rights/responsibilities, introduce monitoring by citizens as appropriate and funding for such efforts. Where possible indices should be developed and monitored as part of the program. The organizations should also develop expertise in designing afforestation and environmental awareness programs in cooperation with affected people.

In parallel, the organizations should embark on large-scale education programs focusing on local ecology, climate change, pollution, and people's rights and responsibilities. These should highlight issues at both local and global levels, and provide community based solutions.

7.3 Individual

Industrialization is inherently linked with consumerism - they grow with each other. Reducing our own consumption will eventually lead to a reduction in the need for industrialization and thus, deforestation. Most wildlife is destroyed by land being cleared for cattle, soy, palm oil, timber and leather. On a more personal level, most of us consume these products every day, with palm oil being found in many foods and toiletries. Choosing only sustainable options helps, as does eating less meat, can help reduce carbon footprint. Sustainable waste management practices like recycling and composting could also help in reducing the amount of solid waste entering landfills and incinerators thus helping prevent greenhouse gas emissions. Other actions that we can take ourselves are:

1. Join nature clubs that help us know more about our natural environment and understand its other inhabitants like animals, plants and other living beings.
2. Get to know the communities that live in close proximity with the forests and try to understand their lifestyles and appreciate their contribution to preserving our natural resources.
3. Support conservation groups by engaging and volunteering in activities like reforestation, cleanliness drives and provide monetary contributions to people/ groups working in these areas.

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