Deforestation causes, impact and management

Introduction

Increasing human population and needs causes increase in exploitation of natural resources mainly the forest, changing patterns of consumption and techno machinery further fuel this issue. World's annual deforestation is estimated as 13.7 million hectares, equal to the area of Greece, if this continues in the same rate the total forest cover may get completely vanished in next hundred years. However, still 30 per cent of the land cover is occupied by forests. According to DCCEE (Department of Climate Change and Energy Efficiency) 2012 report estimated current average net CO_2 emission is 27 Mt-e and it is projected to be 43 Mt-e in 2020. We are inevitably committed to involve in reconstruction of socio, economic and environmental factors to promote inclusive developmental strategy to ensure the sustainability of forest ecosystem as it leads to firm existence of life in our planet. Man has started clearing forests several thousand years ago this also mainly for agriculture and ranching purposes. In the nineteenth century transformation of Modern man in terms of industrialism, urbanism, liberal democracy and capitalism he overexploited the nature mainly the nature's forest resource. This causes various negative impacts in the entire ecosystem, the existence change in weather patterns, global warming, outbreak of epidemics, droughts, desertification and behavior, existence and distributional changes in entire biota and its diversity. However, in today's postmodern era man has well understood the importance to conserve nature and becoming eco-centric. "What we are doing to the forest of the world is but a mirror reflection of what we are doing to our self and to one another"- Mahatma Gandhi.

Importance of forest ecosystem

Forest ecosystem is essential for the existence of our planet, almost 20 per cent of worlds Oxygen is produced in Amazon forest as the forest maintains the balance between Oxygen and Carbon dioxide, maintains rainfall and gives significant contribution in water cycle, nutrient and mineral cycles are maintained, maintaining whether pattern and reduces the effect of global warming and prevent soil erosion and maintaining soil fertility, prevent the spreading of disease and pests, trapping the pollutants of air and water, sink for various mineral elements, for its services such as source biodiversity, source of gene pool, reservoir of carbon, source for shelter, food(bush meet, fruits, oils & nuts), for medicinal needs, natural fertilizer, natural pesticides, valuable timber, lumber, pulp, gum and fibers, in addition it also known for its educational, recreational, aesthetic value, and refreshing the mind and soul.

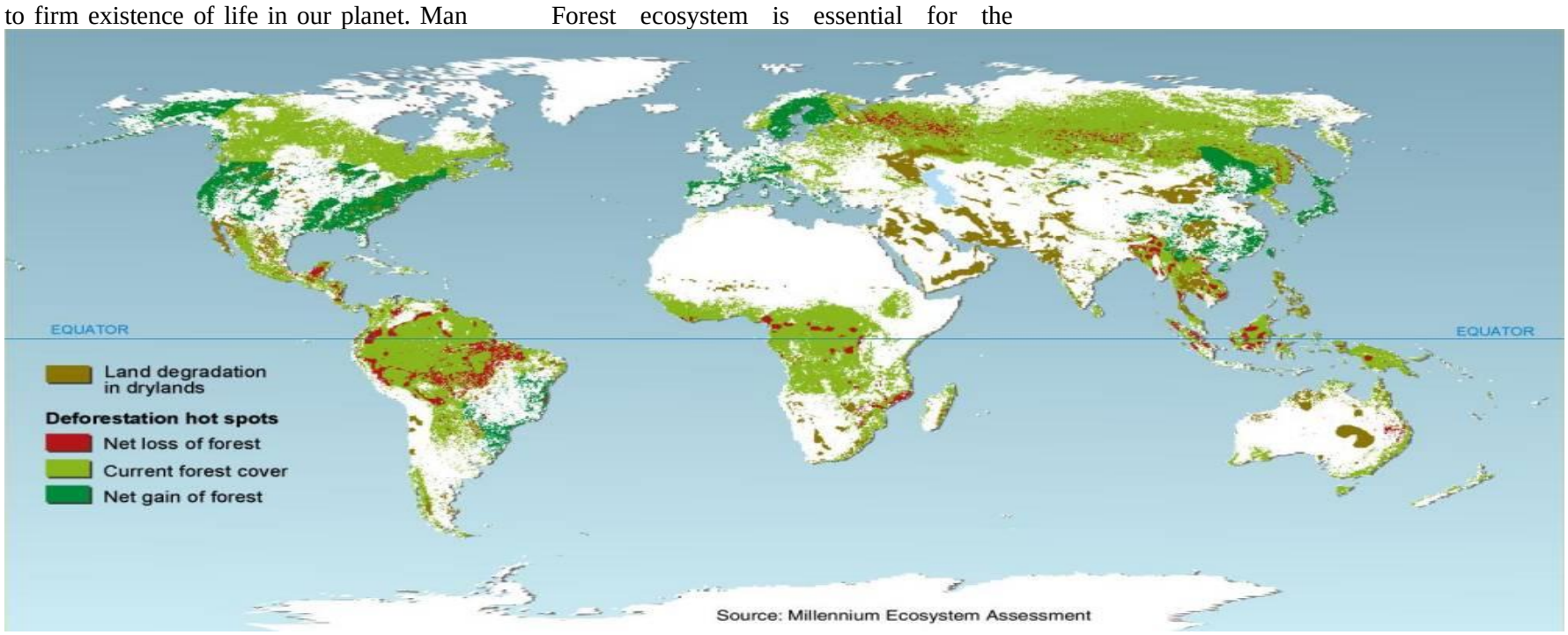

Figure 1: Deforestation, Source: Millennium Ecosystem Assessment ('Trees', n.d.).

Effects of Deforestation

Deforestation causes decline in rainfall all over the world, unusual weather pattern alter the distribution of species as it increases the effect of global warming which causes the loss of habitants of animals such as polar bear and Penguins due to melting of glaciers, increase in occurrence of landslides, forest fires and flooding. Oppression and conflicts rises in the society due to poverty, the hardships of sudden weather change, desperately poor resort and increase sex slavery (Figure 2) ('Deforestation', n.d.).

- **Loss of Biodiversity**

destruction of forest threaten both fauna and flora, indeed it leads to severe extinction of entire biota, there are several species completely become extinct due to anthropogenic means such as Tasmanian wolf, Moa, Wooly mammoth, Cape lion, Atlas bear and several wild plants, there are many other species are red listed as Critically Endangered and plenty of species are becoming vulnerable.

- **Increase in Greenhouse gases**

Forest trees absorb Carbon dioxide and releases Oxygen, reduction in forest and increased anthropogenic Carbon dioxide emission together amplifies the effect of global warming. Effects of the warming are

loss of habitants of polar bear and penguins due to the melting of glassier, rising sea level also causes small islands to be sunken permanently such as Maldivians questioned their existence in near future (a span of several hundred years). According to Australia's Emission Projections report (2012), emission from deforestation activities is 44 Mt-e and removal from reforestation activities is 26 Mt-e, resulting net emission during the Kyoto period (2008-2012) is 26 Mt-e. And this net value of emission is projected to be 43 Mt-e in 2020 where as projected deforestation emission to be 47 Mt-e.

- **Change in weather pattern**

Forests can withstand severe weather changes due to its high resilience. Increase in temperature and effect of cyclones are minimized in forest covered areas than bare. It further amplifies the effect of natural drought, which is more severe during ENSO events.

- **Desertification and soil erosion**

Destruction of forest in a huge are eventually cause degradation of soil fertility and water holding capacity. This is amplified during the slash and burn harvesting as the nutrient loss is high. Burned ash do not support for cultivation at all. Many of the today's desert lands were forest lands several million years ago, as the carbon in pre-historic trees now available in the form of fossil fuel. Deforestation directly facilitates soil erosion as open soil is easily taken by wind and flowing water this also leads to siltation of dams that reduces the water holding capacity. Loss of over 100 tons per ha. have been reported in several parts of India, China, Yemen, El Salvador, the Dominican Republic, Kenya, Madagascar and Ethiopia. (Paul, 1993)

- **Floods and Landslides**

Flooding and land slide events are rare in the forest regions which is extremely high in urban lands. However, deforestation caused several land slide events around the world resulting loss of live hood and properties. Chances of landslides are extremely high when deforestation occurs at mountain forest.

- **Spread of diseases**

Forest provides natural boundary between colonies of human population. This prevents the direct access between communities thus reduced the chances of epidemics and also filter the air and water for infectious agents. Diseases such as swine flu, Dengue, Ebola can be sealed from spreading to other regions.

- **Increase in pollutants**

Forest traps the pollutants and increases the chances of biodegradation. Deforestation declines this natural process and this meliorates particle pollution and effects of toxic gases. Particles smaller than 10 micrometers in diameter pose the greatest threat when inhaled it may even reach the blood stream. Some such particles and droplets are possibly human carcinogens.
Eg. Great smog of London in 1952.

- **Habitat loss**

According to WWF orangutan, elephants, tigers, rhinos and many other species lose their habitats in the tropical regions such as Africa, Latin America, and Asia. This also increases human animal conflict. Deforestation leads to habitat fragmentation which minimizes the chances of meeting among a group of population or between communities, it severely affects the natural balance, interrelationships and access to food and other ecological spots or resources, alter the seasonal migratory pattern and ultimately increases the stress or changes in animal behavioral patterns.

- **Human animal conflicts**

Increasing human population increase their needs, constructions such as roads, highways and irrigation schemes dams, etc. This causes habitat fragmentation which increases the chances of meetings between animals and man several road accidents with wild animals are recorded in many parts. Elephants and monkeys cause many conflict events. Elephant cause destruction of houses and agricultural farm lands even injure the ranching herds, this is very common in south Asia. Similarly, Territorial behavior of Rhinos often results in conflicts with human and other animals commonly seen in Africa and some parts of India.

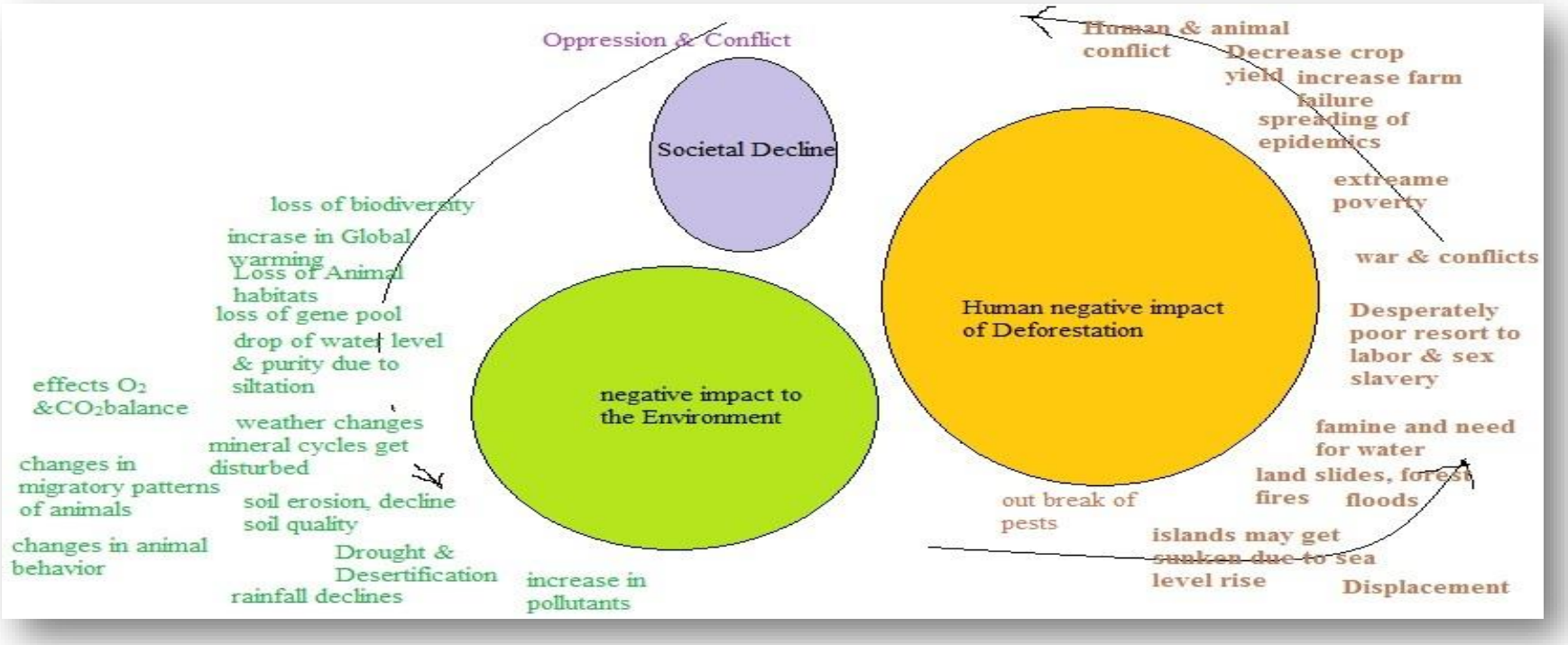

Figure 2 Effects of Deforestation Adopted from Giornalettismo (n.d.).

History

There is evidence of clearance of rain forest at least 3000 years ago in Africa. 7000 years ago in south and central America and possibly 9000 years ago in India and New Guinea. Also evidences of slash and burn technique was retrieved in Northern South America, South East Asia and Central Africa 12,000 years ago. Land hunger, increased economic needs for resources causes the destruction. Historically, English and Dutch migrants lured by a gold rush, collecting spices and mono culture plantations such as tea and rubber are the pioneer reasons for the destruction of forest cover in Brazilian Amazon, North America and South Asian regions. When considering tropical rainforests, in Bangladesh, Haiti, India and Sri Lanka almost all rainforest lost by 1988, China 50% loss in Xishuangbana province, by 1960-85 Philippines and Thailand loss 55 and 45 per cent of rain forest respectively (Chris, 1992). In the year between1990 and 2000 the world is estimated to have suffered a net loss of 8.9 million hectares of forest each year, but in the period 2000-2005 this was declined to an estimated 12.9 million hectares per year, recent deforestation rate is annually 7.3 million ha. ('IPCC' 2007: 544). Overall, world lost about 3 per cent of its forests in the period 1990 to 2005, at present we are losing about 200 square kilometers of forest each day.

Types of deforestation

1. Land clearing for the grazing of dairy cattle and other life stock
2. To obtain and expand Agricultural lands, mono culture such as tea, wheat, paddy, oil palm and vegetables.
3. Subsistence farming through slash and burn forest cuttings including unplanned 'chena'
4. Logging for commercial needs such as pulp, rubber, resins, timber harvest, charcoal and fire wood.
5. Development for expanding civilization, industrialization, irrigation, mineral mining, energy, transport and Tourism.
6. Natural catastrophic event such as hurricanes, volcanic eruptions, forest fires or El Nino and other sudden climatic change.
7. Manmade environmental problems
8. War and civil unrest.

Adopted from Hogan, 2014.

Underlying causes of Deforestation

1. Development and over consumption

Massive development programmes such as road or high way constructions, rail ways, water reservoirs, dams, grounds for athletic and sports development, air ports and industrial zones, harbors, mineral mining projects, power plants, military expansion programmes and scientific research programmes and housing and services development activities.

2. Colonialism

During colonial times forest trees logging was carried for establishing rail ways mainly for sleeper bars and for building naval boats massive mono culture programmes such as coffee, tea rubber and spices were carried out in Sri Lanka, Kenya, Togo, and India (Assam and Kumeon). Similarly, Araucaria Zone of southern Brazil, Sahelien Africa and Thailand are badly affected by colonial deforestation.

In Sri Lanka 162,700 acres of forest area was cleared for Coffee cultivation by 1867 (Sri Lanka coffee, n.d.) in Madagascar up to 7 million ha of forest were cleared in the first three decades of the colonial period (Perrier de la Bâthie, 1921) as cited in Claudia, 2010). The Transmigrasi Program, commenced 1974, caused an average annual loss of 200,000 ha. in Indonesia (Colchester & Lohmann, 1993 as cited in 'Rainforestinfo', n.d.).

3. Debt Burden and Exploitation by developed countries

Developing nations of South and South East Asian countries uses money of developed nations for their infrastructural development and they pay the loan with their natural resources including timber countries such as Japan utilize their forest resources and granting loans for various development schemes (Colchester and Lohmann, 1993 as cited in 'Rainforestinfo', n.d.).

In both least developed and developing countries factors such as cheap labor, reduction in tax or land price or subsidies by government, increase in the demand of timber or agricultural land or other forest commodities, mineral value and debt burden have accelerate the effect, changes in international trade.

4. Role of Poverty and Over population

Increasing population increases the land

needs for shelters, agriculture, industrial and other developmental needs. Poverty severely effects least developed countries as well as developing countries this increases the over consumption of forest resources without any impact assessment or analysis. Adopted from 'Rainforestinfo', (n.d.).

Causes of deforestation

1. **Land clearing for the grazing of dairy cattle and other life stock**

In Central America deforestation was carried out for cattle production, over the last four decades the forest cover has been declined by 40%, in the period of 2004-2005 about 1.2 million rainforest were destroyed for Soybean crop as cattle feed. (Charles, Robert and David, 1995). In Latin America forest lands are abducted for the cultivation of soy, most of the soy is used by poultry, pork, cattle and farm fish, in the period of 1981-1990 about 75 million hectares were destroyed most of the area was converted to pasture (David, 1996). In South America about 4 million hectares of forest are destroyed annually this includes the most precious Amazon (Figure 3), Argentina, Brazilian Cerrado, the Chacoand the Atlantic forest of South America. According to Food and Agriculture Organization (FAO) of the UN estimates as cited in Lauren Berger, Brighter Green, 30 per cent of worlds' land has been consumed for the production of milk and meets (Lauren, Brighter, n.d.). In New Zealand, according to ministry of agriculture and forestry about 455,000 hectares forest land is at risk due to pastoral expansion MAF (2006) similarly, deforestation for cattle ranching severely affects East African countries such as Ethiopia and Kenya.

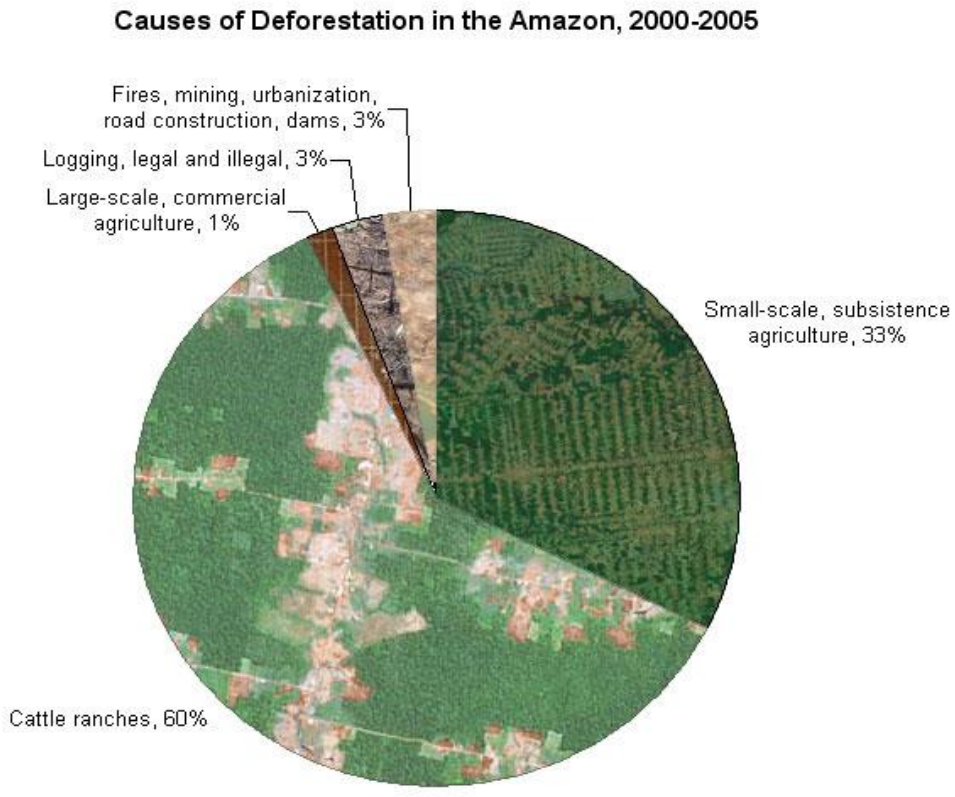

Figure 3 Causes of Deforestation in the Amazon 2000-2005, Source: The Merig (2014)

2. **To obtain and expand Agricultural lands, mono culture such as tea, wheat, paddy, oil palm and vegetables.**

According to recent studies of (Charles, Robert and David (1995) showed nearly half (49%) of the deforestation in tropic region is due to the illegal clearing for commercial agriculture. Oil palm, soy, rubber, coffee, tea, and rice plantations took much of the tropical forest area worldwide ('WWF Global', n.d.). In Malaysia more than 3.5 million ha. of forest have been cleared for rubber and palm cultivation. Annually worldwide deforestation for Tobacco plantation alone ranging 1.2 to 5.5 million ha. ('Science daily', 2014) Western Europe's forests have been removed due to ongoing population growth and agricultural expansion.

3. **Subsistence farming through slash and burn forest cuttings including unplanned 'chena'**

Slash and burn agriculture is the process of cutting down and setting fire and burn the chosen slot of forest land and then use the land for cultivation, this land is known as swidden which is rich in nutrients but this land is left after short period of cultivation, then the vegetation reappears this is also referred as shifting cultivation. However, regrown forest may not have the complexity as virgin forest and it may grow through the succession. It is always advisable to do slash and burn while keeping the large trees without cutting, downed vegetation is allowed to dry to ensure efficient burning, land is burnt to clear vegetation and drive the pest away, remaining ashes are rich in nutrients and used for plantation. This method is used for over 12,000 years, often used in grass lands and rain forest, most commonly in practice in Northern South America, Southeast Asia and central Africa. In South Asia this is most popularly known as chena cultivation.

Major adverse effect is loss of soil fertility due to erosion. As the loss of tree layers, litter and roots subsequently reduces the water holding capacity and causes close by river flows to decline and land dry off. Longer the crop higher the loss of nutrients, reduction in cation exchange capacity and increase in soil acidity. However, longer fallow period helps to retrieve the soil nutrients. Burning and land clearing causes loss of biodiversity as many species leave or die this includes the viable seeds. ('Geography', n.d.).

In 20th century, swidden crops of Europe were turnips, flax, barley, wheat, rye, oats, millet and radish, usually the duration is one year, in favourable soil this was extended to 2-3 years (Linnard 1970, 195 as cited in 'Shifting cultivation', n.d.). During 1930-1950s this technique was widely used in countries such as Bosnia, Serbia, Hungary, the Caucasus, Estonia, Poland, Switzerland, Germany and Austria. ('Shifting cultivation', n.d.).

4. **Logging for commercial needs such as pulp, rubber, resins, timber harvest, charcoal and fire wood.**

Indonesia, Sumatra, Bomeo, New Guinea, Russian Far East, Atlantic forest region in Brazil and Southern Chile pulpwood industry took much of its natural forest. About 40% of timber is harvested for paper production. Mainly in poor countries subsistence agriculture causes 48%, commercial agriculture is responsible for 32%, commercial logging 14% and charcoal and other fuel wood removal causes less than 6% of deforestation (Hogan, 2014).

Poorly designed property right system, increasing population, widespread poverty increases the need for land and to increase the per capita income many developing countries have been foraging the forest resources, lax forest management, displacement of indigenous people, loss of traditional way of food harvest, live hood and procurement methods (Hogan, 2014).

5. Development for expanding civilization, industrialization, irrigation, mineral mining, energy, transport, job creation and tourism.

Many governments increase the access of forest resources for poverty alleviation, job creation and for the expansion of civilized area such as colonization schemes and expansion of cities. Secondly, industrial needs such as implementation of industrial processing zones and storage plants. Thirdly, development activities including rail way, road and high way construction, air ports, irrigation water ways, reservoirs and dams. Most of the mineral deposits such as Gold, copper, other precious metals, diamonds and gem stones are found in forests. Amazon forest has been affected by gold mining activities due to its alluvial gold deposits; clearing also involved the use of heavy machinery.

Tourism and hotel construction also affects the forest ecosystem such as Cape Tribulation in Australia affected by excessive tourist's interference (Rainforestinfo, n.d.). Projects of energy such as hydroelectric power, windmills, nuclear reactor plants are constructed in cleared forest lands, in Brazil about 1750 km^2 of forest area was flooded for the Tucurui dam, the estimated electricity production is 7.6 megawatts (Wolfe and Prance, 1998).

6. Natural catastrophic event such as hurricanes, earthquakes, volcanic eruptions, acid rain, forest fires or El Nino and other climatic changes.

Hurricane of Katrina in 2005 affected 5 million acres of forest across Mississippi, Louisiana and Alabama the estimated damage in Mississippi alone is $ 1.25 billion, the speed of the wind was at 140 mph which toppled the trees and debris soil was taken as airborne sandpaper, according to the study of NASA in 2007 depicted, an estimate of 320 million trees were damaged in both Mississippi and Louisiana (Carrie, 2012). In 1980 hurricane in Mount St. Helens wiped out a forest area of 150,000 acres (Thomas H. M and Karen K., n.d.). 2005 earthquake in magnitude of 7.6 Richter in Pakistan severely affected the Himalayan region 3% of conifer forest was lost (2009). Wenchuan earth quack of China in 2008 caused a loss of 330,000 acres of forest area including the habitats of Panda. (Lu *et al.*, 2012). In volcanic eruptions subsequent ass fall affects the trees, deposits thicker than 100 mm affect young trees, however, larger deposits greater than 500 mm can break the branches, even re-plantation on silicic ash such as rhyolite is difficult due to the deficiency of N and Ca (Neild *et al.,* 1998). 1995 eruption of Ruapehu, New Zealand destroyed 20 km^2 of beach forest (Cronin and others, 2003), rain fall with the volcanic emissions causes acid rain due to its acidic contents, in Costa Rica acid rain affects the vegetation as the downwind of Poàs volcano flows over (Peterson and Tilling, 2000). In 2010, volcanic eruption of Merapi mount Indonesia caused a loss of 1.12 million trees in 2,800 ha. of forest area net value of destructed trees is approximately 222.2 dollars ('Volcano eruption', 2010). 1980s Mount St. Helens volcanic eruption caused loss of timber worth $114 million at the Gifford Pinchot national forest said by forest supervisor Robert D. Tokarczyk (Foxworthy & Mary Hill, 1982). In 2007, fires in Southeast Amazonia burned 10 times more forest than in an average weather, area is equivalent to million soccer fields said Douglas Morton, NASA. ('Science daily', 2014)

Severe drought in 2005 caused a dieback of canopy across an area the size of California, covers 30 % of the Amazon. The 2010 study cites well documented recent forest die offs in Spain, Greece, Russia, Australia, and North America, During 2010 drought 57 % of Amazonia had low rainfall.(Simon, 2011; Caroline, 2013).

According to Derek Eamus, in Southern Europe crop loss and mortality of forests were high, Crop losses and forest mortality, during the drought in 2003, causes more than 500,000 ha. of forest lost in southern Europe alone (University World News, 2014).

El Nino of 1997-98 caused severe forest fire which burned the forest vegetation in Kalimantan, Sumatra, Sulawesi, Iran, Java, Papua New Guinea, Bali, Lombock and Sarawak, Malaysia the total area had reached up to 5 million ha. (Rhett, 2013), 1982-83 ENSO caused depletion of moisture in both vegetation and soil and resulted in forest fire causing loss of 3.7 million ha. in Kalimantan alone, this ENSO (called "Ash Wednesday") also caused many public health implications. 1997 forest fires in Kalimantan and Sumatra had a devastating effect. Forest fires are more frequent in Australia, Indonesia, Brazil, Russia, Canada and Southern United States during the El Nino events.

7. Manmade environmental problems

Emission of greenhouse gases caused global warming this intensifies the natural drought event or droughts during El Nino events further.

Acid rain and acid deposition due to air pollution causes severe loss to natural forest; in China Sichuan basin among 275,600 ha of forest about 15,000 ha of forest have been died due to acid precipitation (Feng, 1993).

A Survey in 1983 in West Germany showed 34% of countries forest has been damaged by acid rain; this is 14% in Switzerland (Ophardt, 2003). Southeastern Canada, Northeastern United States and most of Europe including portions of Sweden, Poland, Norway, and Germany are facing more intense acidification occurrences. In addition, some amount of acid deposition is found in parts of South Asia, South Africa, Sri Lanka and Southern India. ('conserve-energy-future', n.d.). According to China's Environmental Protection Agency (SEPA) annual loss in both forestry and agriculture in China due to acid rain is $13.25 billion.

8. War and civil unrest.

In some countries government and terrorism factors are dominant factors; war also another reason, Vietnam War causes massive sprayed defoliation, burning and destruction of forest trees. Destruction of forest cover by US forces during the war alone was estimated as 4.9 million hectares. (Brian Hill, n.d.) Warfare in central Africa also causes displacement of communities and farm lands, this cause deforestation on a massive scale.

Nuclear explosion of Hiroshima and Nagasaki in Japan 1945, destroyed nearby forests including a large forest with Cryptomeria trees. (Horoshima, n.d.)

Afforestation and Reforestation

Planting a tree is generally for establishing wind breaks, shelter belts, timber, fuel wood, flowers, nuts, vegetables, medicinal plants and wildlife. Maintaining or protection against forest degradation can be successful by planting, site preparation, tree improvement, fertilization, uneven aged stand management, thinning, pruning, weeding, cleaning, liberation cutting or other appropriate silviculture techniques, maintaining or increasing the landscape level carbon density using forest conservation strategies, longer forest rotations, fire management and protecting against insect pests. (IPCC, 2007)

Ethnobiology (Indigenous knowledge)

It is essential to get access to indigenous community in every forest management programmes as they are considered as part of the forest ecosystem. They are well aware of native plant species, plant animal relationships, and locations of species richness, animal behaviors and exploitable resources such as medicinal plants, structural stratification of the area, soil type, weather pattern, etc. They also know the traditional methods of conservation of forest. Agro forestry has been managed by American Indian people for thousands of year s they utilized natural animal behaviors for their own benefits Eg. American Indians cultivate nectar flowers in order to attract predatory ants as it gives protection and techniques for culturing honey bees.

Silviculture techniques

Silviculture techniques are not so innovative in modern science instead there are adapted or ameliorated practices and methods of our ancient cultivars. However, using advanced techniques not always result in best result it also require proper analysis and assessments prior to the implementation and it is also important to select the right species at the right habitat for example, in Sri Lanka, Pine and Eucalyptus(nonnative plants) trees are introduced as a substitute to natural mountain forest, hence, other trees cannot grow in degraded soil without undergoing succession (it takes long time)and aiming to collect pulp for paper industry, but unlike indigenous varieties Pines absorb much moisture required by their huge accumulation of biomass and pine litter also reduces the infiltration of rain water through soil as it is not readily decomposed like ordinary mulch due to its oiliness. This causes soil layers to dry up, and resulted in depletion of perennial river flow (which directly affects the countries hydro power generation). In addition dry soil layers tend to move apart, this resulted in landslides in many areas during rainy season said Prof. Sarath Kotagama, University of Colombo, Sri Lanka. Furthermore, they also cause forest fires during dry weather. So it is important to study the possible impacts before implementing invasive species or any advanced techniques weather it suits or not. In silviculture selecting the right variety is initially considered as a key element, rather than working on ecological parameters and harvesting methods. Selection is depending on the purpose; for what reason the forest to be generated mainly for.

I. Intermediate cuttings

This includes commercial thinning of trees that have attained sufficient growth and to be used for timber, pulp, fuel wood or saw. In thinning by reducing the number of trees and given independence to the most desired tree from competition, smaller and malformed trees are cut and give space, sun light and other resource to the desired ones. E.g. Low thinning, crown thinning (increases light penetration), selection thinning, mechanical thinning, free thinning, loose thinning and Ecological thinning(aims to the development of wild life).

II. Regeneration cuts

This occurs on mature older stands that are ready for harvest, these also occur on young stands which are identified as poor in quality. This is usually done either seed tree method or shelter wood method, in seed tree method widely spaced residual trees are kept to facilitate dispersal of their seedlings in order to regenerate the forest, in shelter wood method trees are partially cut periodically for several years which is eventually culminates the final cut and gives way to new generation even aged strand. Coppicing also a regeneration method and it dose depend on the sprouting of cut trees, trees such as pines that sprout from stumps are managed this way. Variable retention is a kind of harvesting and regeneration method which keeps the understory layer and forest floor undisturbed in order to preserve the structural complexity. Clear cutting and patch clearing, here all unwanted tall trees are cut to facilitate the availability full sun light for saplings E.g. Walnut, red oak, yellow poplar, yellow pine etc.

III. Even aged and uneven aged

Usually stands that developed after pasture or heavy cutting events are generally even in age. In uneven aged strands generally there is an over story above, so it ultimately favours the shade tolerant crops such as sugar maple, beech and hemlock. However shade intolerant species also can be grown if thinning and harvesting are done frequently.

IV. Group selection

Where small tree groups are removed leaving large varieties (opposite to clear cut) this method promotes uneven aged strands for the entire forest.

Only shade tolerant varieties can be cultivated such as sugar maple (on better sites) and oak (on poor sites).

V. Crop tree management

Here a manager identifies good trees and species on better sites, then frees them to grow independently by clearing the rest unwanted vegetation.

VI. But log forestry

It resembles the crop tree management, in this method veneer logs are produced in relatively short time. When crowns begin to close week trees are removed branches of the crops are trimmed at 17 feet.

VII. High grading diameter limit cutting

Where marketable trees over certain diameter (14" DBH for pine & 10" DBH for hard wood) are cut and more suppressed and less vigorous varieties are left.

(Adapted from 'Silvicultural Methods', n.d.; Silvicultural Systems, n.d.; Silviculture, 2014.)

Most popular Afforestation and Reforestation programs

Forest plantation in a land which does not have any forest in last 50 years of history is Afforestation, if it has an occurrence of forest within last five decades then it is Reforestation.

- China annually increased its forest cover by 11,500 square miles, an area the size of Massachusetts, according to a report from the United Nations in 2011. China's Great Green Wall was designed to plant nearly 90 million acres of new forest.

(Jon, 2012).

- Reforestation in Korea: Between 1961 and 1995, stocked forest land went up from 4 million ha. to 6.3 million ha. Total timber rose from 30.8 million cubic meters in 1954 to over 164.4 million cubic meters in 1984. By 2008, 11 billion trees had been planted about two-thirds of South Korea is now clothed with forest.

- Reforestation in Tanzania: the Kwimba Reforestation Project: During the nine year period of the project's run, over 6.4 million trees were planted.

- Reforestation in Mexico: the Mixteca Region: Center for Integral Small Farmer Development in the Mixteca reforested with 1 million trees covers more than 1000 ha.

- Reforestation in the United States: the Appalachian Regional Reforestation Initiative: 60 million trees have been planted on about 87,000 acres of active mine sites in Appalachia under ARRI's guidance.

- Reforestation in Colombia: Gaviotas: Villagers have successfully reforested about 20,000 acres as a result rainfall has increased by 10%. ('Sustainablog', 2011).

- Japan after World War II, have done intensive reforestation from 1950-1970, during that period professional silviculture spread out in every Japanese village. (Gerry, 2005)

Forestry projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol.

General features of this mechanism are reforestation of native forests, plantations for timber, agro forest or multipurpose tree plantations and healing barren lands. Kyoto Protocol governs Land use, land use, change and forestry (LULUCF) and modalities and procedures for CDM. Organizations such as International Tropical Timber Organization (ITTO) carried out the task according to the discussed strategies.

Role of International Tropical Timber Organization (ITTO)

International organizations such as ITTO, encourages conservation, sustainable development, use and trade of forest resources. It has 59 members represent about 80% of tropical forests and 90% tropical timber trade worldwide. ITTO collects analyses and circulates data on production and trade of timber and allocates funds since 1987. It has funded more than 750 reforestation and afforestation projects valued US$290 million. Donors are mostly Japan, Switzerland and the USA.

CDM projects

- Pearl River Watershed Management, China: This project proposes to alleviate local poverty and reduce threats to forests by afforesting 4,000 hectares in the Guangxi Zhuang. Project also includes half of the Pearl River basin.

- Pico Bonito Forest Restoration, Honduras: This is a pilot project on agroforestry to support small scale farmers of 20 villages with in the Pico Bonito National park buffer zone of 2,600 ha. Main roles of the project are introducing agroforestry for small scale farmers, reforestation to promote conservation, establishment of sustainable commercial grade plantation.

- San Nicolás Afforestation project: This project includes both forest and agroforest plantation in an abandoned pasture land of 8,730 ha. in San Nicolás, Colombia.

(Timothy, Sarah and Sandra, 2006).

International Conventions related to forest ecosystem and conservation

1. United Nations Framework Convention on Climate Change (UNFCCC) or Kyoto convention.

This was made due to the increased concern on global warming due to anthropogenic means and mainly aiming to limit the emission of greenhouse gases protocol was adopted in Kyoto, Japan, on 11 December 1997. It also discussed various forestry practices including techniques of agro forestry such as tilling use of natural fertilizers which could enhance the release of greenhouse gases. Discussions such as Land use, land use, change and forestry (LULUCF) and modalities and procedures for Clean Development Mechanism (CDM) are major breakthrough in forest conservation.

2. Convention on Biological Diversity (CDB).

Treaty aims following three aspects conservation of biological diversity, sustainable use of components of biodiversity and fair and equitable sharing of benefits arising from the use of genetic resources. It covers levels of biodiversity such as ecosystem, species and genetic diversity. It covers biotechnology by Cartagena Protocol on Biosafety. In 2010 a ten year strategic action plan (2011-2020) was adopted by relevant parties to ensure the safe guard of natural biodiversity.

3. United Nations Convention to Combat Desertification (UNCCD).

UNCCD targets those countries experiencing serious drought and/or desertification, mainly in Africa. It provides strategic plan to combat desertification, mitigating the effects of droughts, sustainable development, improving productivity of the land, living condition and expansion of the forest.

4. International Tropical Timber Agreement (ITTA).

Its main objective is to promote the international timber trade from tropical sources. However, it is adopted in 1992 in order to achieve sustainable management of tropical forest as “Year 2000 objective” by International Tropical Timber Organization.

5. Other conventions related to forest.

Ramsar convention on wet land (which aims to protect all kinds of wet land ecosystem), Convention on protecting World Cultural and Natural Heritage (this aims to protect heritage of outstanding universal value, forest can be considered as natural heritage), CITES(Convention on International Trade on Endangered Species of Wild Fauna and Flora: aims to restrict the overexploitation of wild plant and animal species via international trade), Convention concerning Indigenous and Tribal People in Independent Countries (aims to protect social, cultural and economic rights of indigenous people, it also includes protecting their habitats as they are mostly related to forest).

(Adopted from Ruis, n.d.).

Conclusion

To conclude, the causes of deforestation are mostly anthropogenic except natural disaster events. Effects of the deforestation take comparatively longer period to get cured. It is believed well studied deforestation, afforestation and reforestation activities with a clear cut impact analysis.

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