



Changing Pattern of Forest Resources and Manmade Implications towards Declining Biodiversity

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Abstract: *Forest resources play intrinsic role to maintain global ecosystem and biodiversity balancing ecological and environmental systems. Depletion of Global forest resources over the years due to natural disasters and human intervention grows up forest cover changes declining biodiversity comes threats and challenges for sustainability of forest ecosystem and environmental protection. Reviewed and assessment of forest cover change in global, regional and national scales together with implications on biodiversity this paper evaluated through monitoring results of global scale comprising as a case study of Nepal. Since 1990 global forest area changed in 31.6% accounting 3999 million ha in 2015 whereas in Nepal forest area was changed annually by 2.1% with annual changing rate of -1.1% in 2015. As tropics biodiversity covers 78% flora and fauna decline rate of forest area, deforestation and fragmentation of forest habitat, degradation and loss of ecosystems challenging by the manmade anthropogenic changes. Since earth's life existence, over-exploitation of the natural resource base changing biological diversity continuously due to human kind interventions or induced direct impacts in ecosystems with triggering loss of biodiversity and interrupt to recover the natural ecosystem. However, improving national policies, plan and programs, implementing legislative measures and instruments together with research and innovation as well as promoting renewable energy can be the useful for sustainable management of forest and biodiversity. Natural forests and woodlands play vital role to protect environment and balancing ecosystem together with havens for wildlife and protection of endangered species or critical flora and fauna, Nepal endowed immense biodiversity can be managed through replacing forest base dependency and by increasing green cover with sustainable development.*

Keywords: *Forest Resources, Global Ecosystem, Biodiversity, Deforestation, Manmade Implications*

1. INTRODUCTION

Global forests terrestrially dominated contributes 75% of terrestrial gross primary production accounting 80% of Earth's total plant biomass covering 4.03 billion hectares approximately 30% of Earth's total land area. (1) Statistical profile of world's forest assessment in 2015 (2) showed 3999 million ha forest area of 234 countries and territories with annual changing rate of 0.13% with declining ration of 31.6%, since 1990 from 4128 million ha to 3999 million ha in 2015. The total number of terrestrial species is estimated to be around 8.7 million while the number of oceanic species is much lower, estimated at 2.2 million (3) and estimated 220,000 vascular plants, using the species-area relation method (4).

The strategic goal of CBD 2014, forwarded key potential actions to address habitat loss and degradation, an integrated policies is essential to be developed covering positive and negative incentives; engagement with sectoral groups, indigenous and local communities, landowners, other stakeholders and the general public; effective protected area networks and other area based conservation measures; and enforcement of relevant regulations and laws (5). The Earth is home of living organisms occupying entire space a biosphere organizing discrete groups. Among the total 1,74,4000 described numbers of species globally comprises 4000 bacteria, 80,000 Protocists (algae, protozoa, etc), 13, 20, 000 animals, 70,000 fungi and 270 000 plant species. However, total estimated numbers of species globally accounts ca.14 000 000 species comprising 10, 00,000 bacteria, 6, 00,000 Protocists (algae, protozoa, etc), 10,600,000 animals, 1,500,000 fungi and 300 000 plant species (6).

Out of the total land area of the planet 40 million km² (30%) was estimated forest area as per the data recorded form 228 countries and territories in 2005. Among world regions highest percentage of

forest cover is the South American region and lowest percentage is Asia region (less than 20% of the land area) (7), (8) reported 30% forests covers Earth's land area contributing terrestrial biomass by 80% and it provides over half of the world's terrestrial habitats of plant and animal species (9), (10).

To maintain and balances global ecosystem, forests play vital role securing thousand million of inhabitants of the Earth. Around 1.7 million species of living beings, 29% biodiversity globally resembles with plant species. Since human growth and their development actions global forests are declining from the ration of 3.1% over past 25 years. The global natural forest area accounts 93% which was decreased from some 10.6 million ha in the 1990s to 6.5 million ha between 2010 and 2015. The global biodiversity provides ecosystem services interacting among species ranging forest and agro ecosystem (11) availing goods and services, water and food, pollination protecting together with soil erosion, pollution, climate change, disease vectors and local ecosystem resilience and stability. (12) The loss of biodiversity and vegetation leads to the changing pattern of natural environmental conditions occurring from numerous fundamental systems (13), (14), (15) and decreasing number of species biodiversity due to modified environment and increased pressure on forest and vegetation (16).

Human growth and development are closely associated with the loss of forest due to fragmentation decreasing habitat and declining biodiversity with changes in land use, atmospheric CO₂ concentrations, nitrogen cycle and acid rain, climate alterations, exotic species and pollution. Global change of land use, forests and biodiversity has been studied through routine monitoring by the numbers of international programs to manage ecosystems sustainably towards consequent mitigation of rates, causes and consequences of such changes. All reviewed, analysis and evaluation of such available data generated by the global forestry programs and other case studies, this paper has illustrated consequences of land use changes in terms of forest cover and biodiversity allied with manmade impacts and implications.

2. MATERIAL AND METHODS

Required data were collected from different secondary sources such as Global Forest Resources Assessment 2015 to understand changes in forest resources over 25 years comparing variables of years from 1990 to 2015. Assessment and changes in forest cover and land use dynamics quantified through satellite data and global forest cover monitoring using Landsat TM, Landsat ETM+, DMC; RS/GIS were the main tools for review and all evaluated to understand modern scenarios or changing pattern of global, regional and national forest resources. Similarly, data from Forest Resource Assessment (FRA) Nepal Project (2010-2014) generated from Department of Forest Research and Survey (DFRS) were reviewed and evaluated. Forest related legal instruments of Nepal such as Forest Policy, 2015; National Biodiversity Strategy and Action Plan (NBSAP) 2014-2020, Forestry Sector Strategy, Forest Act, 1993 and 1995 were reviewed and identified major gaps and implications in the forest sector policies.

As Nepal is signatory of about 30 different international agreements on biodiversity and environment conservation such as UN Convention on Biological Diversity (CBD), 1992, the UN Convention on Combating Desertification (UNCCD), 1994 and UN Framework Convention on Climate Change (UNFCCC), 1992 and the Kyoto Protocol, 1997 etc. all integrated for review including environmental policy and conservation strategies. The main Acts, Regulations, Directives, Guidelines promulgated by the Government of Nepal were reviewed and documented. Some of the reviewed documents are: Forest Act, 1993, Nepal Trust for Nature Conservation Act, 1982, Soil and Water Conservation Act, 1982, Environment Protection Act and its Regulation 1997, Wildlife Reserve Conservation Regulation, 1973, Various Regulations of the Specific Protected Areas of Nepal (e.g. Chitwan NP Rules, 1974; Khaptad NP Rules, 1987; Bardiya NP Rules, 1995), Forest Regulation, 1995, Buffer Zone Management Rules, 1996, Community Forestry Inventory Guidelines, 2004, Forest Fire Management Strategy, 2010, District Forestry Sector Coordination Committee Guidelines, 2011, Private Forestry Development Guidelines, 2011, Forest Encroachment Control Strategy, 2012, Scientific Forest Management Procedures, 2014, Wildlife Damage Relief Guidelines, 2014 and Community Forestry Guidelines 2015. Global biodiversity and variability of life forms as 99%

extinct species of the Earth were reviewed through Global Biodiversity Outlook, Biodiversity Convention, Global Biodiversity Information Facility as well as other several research and literatures.

3. RESULT AND DISCUSSION

3.1. Global Forest Cover Changes

The complicated issue of Global deforestation converting forest land to other land use and rate of plantation increment accounted annual loss of 7.6 million ha and an annual gain of 4.3 million ha per year resulting in a net annual decrease in forest area of 3.3 million ha between 2010 and 2015. Global forest area decreased by a net 6.5 million ha per year from 2010-2015 which is net forest loss from 10.6 million ha per year period of 1990 to 2000 whereas since 1990 planted forest has increased over 105 million hector. According to FAO’s Global Forest Resources Assessment 2015 (FRA 2015), global forest area of 234 countries and territories accounted 3999 million ha in 2015 with annual change rate of -0.13% that change from 31.6% of global land area in 1990 to 30.6% in 2015. Similarly, natural forest, planted forest, conservation of biodiversity and protected areas in 2015 accounted 3695 million ha, 291 million ha, 524 million ha and 651 million ha with annual changing rate of -0.24%, 1.84%, 1.54% and 1.98% respectively. The highest forest cover of 50 European countries and territories has increased rate of forest cover as it was accounted 989 million ha in 1990, 998 million ha in 2000, 1005 million ha in 2010 and 1015 million ha forest area in 2015 with annual change of 0.08%. Whereas, along the Asia 48 countries and territories total forest area, natural forests, planted forests in 2015 represents 593, 462, 129 million ha with changing rate of 0.17% , -0.24% and 2.17% respectively (Table 1).

Table1. Global Forest Cover Change from 1990 to 2015

Region	Total Forest Cover (Million Hector)				Annual Change (%)
	1990	2000	2010	2015	
Europe	989	998	1,005	1015	0.08
South America	946	904	864	842	-0.40
Africa	749	709	674	624	-0.49
North and Central America	708	705	705	751	-0.01
Asia	576	570	563	593	0.17
Oceania	199	198	191	174	-0.08

Global forest loss is also attributed to use of forest products like timber and fuel wood as 50% around 1.86 billion cubic meters wood extracted from forests annually for use of energy such as fuel, cooking and heating use in households, small industrial industries. According to FAO report around 40%, 36%, 17% and 8% of the world’s wood fuel is consumed in Asia, Africa, America and Europe respectively (17).

As the goals of Convention of Biological Diversity is to conserve biodiversity with sustainable use sharing equitable benefit of genetic resources, the Bonn Challenge attempt to bring 150 million hectares of degraded and deforested land into restoration by 2020 and 350 million by 2030 including Target 15 of Aichi calls for restoring 15% of world’s degraded ecosystems by 2020. Pursuant these efforts to conserve biodiversity 76% mountainous areas were covered by green cover in 2017 and 50% of the world’s species hosts in the tropical forests (18).

3.2. Case Study

3.2.1. Location and Physiographic Zones

Nepal a landlocked southern Asian country located between 26° 20' 53" N to 30° 26' 51" N latitude and 80° 03' 30" E to 88° 12' 05" E longitude, bordered between north in China and south in India with its total area of 147,181 sq. km. Physiographically, Nepal divided into five major physiographic zones (19), namely the High Himal, High Mountains, Middle Mountains (or Middle Hills), Siwalik (or Chure), and the Tarai Plains with the lowest elevation ranges of 60m to the highest 8,848 meters (Mt. Everest) above sea level (Figure 1).

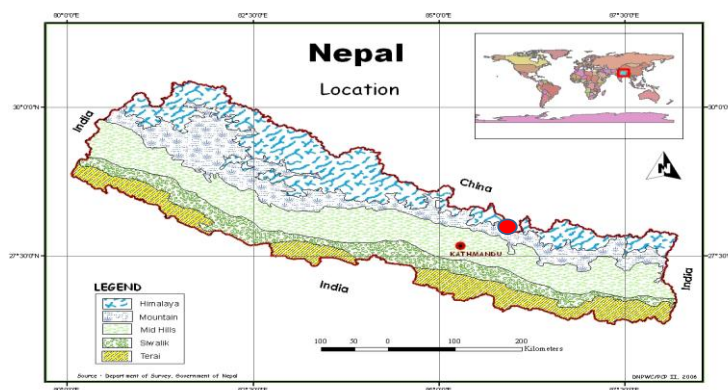


Figure1. Physiographic Zones of Nepal

3.2.2. Protected and Conservation Areas of Ecological Importance

Among the 20 Protected Areas managing under government of Nepal, Department of National Parks and Wildlife Conservation (DNPWC), 12 includes National Parks, 3 Wildlife Reserves, 6 Conservation Areas, 1 Hunting Reserve and 12 Buffer Zones as *in-situ* conservation (20). The total estimated 5,962,038 ha forest area of the country resembles 4,929,436ha (82.68%) from outside of the protected area, and 1032604 ha (17.32%) protected area which includes 792,506 ha core area and 240,098ha buffer zone area (21). The total 40.36% forests about 5.96 million ha of the country, physiographically divided with the highest 37.80% area covered by the middle mountains and the lowest 6.90% area of Terai or low lands whereas 32.25% area covered by the High mountain and High Himal and 23.04% area from the Churia of Siwalik range. Out of the total land area of the country the Churia range with elevation range from 93 to 1,955 masl occupied 12.8 % land area covering parts of 36 Districts of Nepal (22). The Churiya or Siwalik Range bordered with Mahabharat range in the north and duns or inner Terai in south represents rich forest cover and biodiversity but due to its vulnerability the range has high risk of landslides, erosion, and flooding. Moreover, excessive excavation of sand and gravel, forest encroachment and deforestation makes it risk for the lowland areas. Showing the risk and uncontrolled manmade exploitation of resource impacting landscape ecology, Government of Nepal has declared Chure range as an Environmental Protection Area in 2014 (2071/03/02 B.S.) provisioning under Article 10, Sub Article (1) of the Environment Protection Act 1997. The range has identified 666 floras of different species which includes 240 trees, 144 shrubs, 187 herbs, 70 climbers, 22 ferns and three epiphytes including 305 species of medicinal plants (23).

3.3. Forest and Biodiversity

Forest sector of Nepal is legally binding by the Forest Act 1993; defining forest area covered by tress with full and partial crown coverage. With this provision inventory conducted by DFRS using satellite image from 1994 to 1997 identified total 5.83 million hectares (39.6%) forest area comprising 4.27 million hectares (29%) forest area and 1.56 million hectares (10.6%) shrub land area (24). Furthermore, Forest Policy, 2015 endorsed by the Government of Nepal replacing previous forest policy, 2000 has envisioned contributing in the local and national development through sustainable management of forests, biodiversity and watersheds. The policy aims further improving the livelihoods of poor communities by increasing the employment and income opportunities through wiser conservation, management and utilization of forests and forestry resources; maintain ecosystem balances. Forest Policy 2015 has incorporated seven policies, 33 strategies and 107 working level strategies.

Similarly, National Biodiversity Strategy and Action Plan (NBSAP), 2014-2020 reported that Nepal represents immense biodiversity consists 284 species of angiosperms and 160 species of animals only found in Nepal (25), (26) representing 3.2% and 1.1% of the known species of world flora and fauna. The NBSAP adopted by MFSC updating Nepal Biodiversity Strategy 2002 and Nepal Biodiversity Strategy Implementation Plan 2006 provisioning of long term vision of 'conserving biodiversity for sound and resilient ecosystems and national prosperity' for next 35 years which are divided into short term strategies and priorities action to be accomplished by 2020. The plan has aimed to achieve goal

with ecological systems integrity identifying various threats to biodiversity including loss, degradation and alteration of natural habitats of the wildlife, over grazing, rampant forest fire, widespread presence of invasive alien species, poaching, illegal trade and human-wildlife conflicts and climate change.

Nepal is divided by five physiographic zone (Fig. 1) consisting 35 forest types (27), (28), 75 vegetation units and 118 ecosystems (29). Globally, 0.1% area occupied by Nepal harboring over 3% of the world's known flora consisting 284 endemic flowering plants, 6,073 angiosperms; 26 gymnosperms; 534 pteridophytes; 1,150 bryophytes; 365 lichens; 1,822 fungi and 1,001 algae (30). Among them, following plant species are legally protected in Nepal under the Forest act 1993 (Table 2).

Table2. Legally Protected Plants of Nepal

Banned for Collection, Transportation and Trade	Banned for export outside the country without processing	Banned for felling, transportation and export	Banned for Export without identification & certification
1. <i>Dactyloriza hatagirea</i> (D.Don) Soo 2. Bark of <i>Juglans regia</i> Linn.	1. <i>Abies spectabilis</i> (D. Don) Mirb 2. <i>Cinnamomum glaucescens</i> (Nees) Hand.-Mazz. 3. Lichens 4. <i>Nardostachys grandiflora</i> DC. 5. <i>Rauvolfia serpentina</i> (L.) Benth.ex Kurz 6. <i>Taxus wallichiana</i> Zucc. 7. <i>Valeriana jatamansii</i> Jones 8. Rock exudates	1. <i>Dalbergia latifolia</i> Roxb. 2. <i>Juglans regia</i> Linn. 3. <i>Pterocarpus marsupium</i> Roxb. 4. <i>Shorea robusta</i> Gaertn.	1. <i>Neopicrorhiza scrophulariiflora</i> (Pennell) D.Y. Hong Endemic plants : a) Flowering: 282 Species (31) b) Non flowering:248 Species (32)

The management of the protected areas binding legally with National Parks and Wildlife Conservation Act (NPWCA), 1973 to provide protection of valuable floral and faunal species with complete protection to 27 species of mammals, nine species of birds, and three species of reptiles of the country (Table 3).

Table3. List of Protected Mammal species under the NPWC Act 1973

Scientific Name	English Name	Scientific Name	English Name
A. Mammals		B. Bird Species	
1. <i>Macaca assamensis</i>	Assam Macaque	1. <i>Buceros bicornis</i>	Hornbill
2. <i>Manis pentadactyla</i>	Chinese Pangolin	2. <i>Sypheotides indicus</i>	Lesser Florican
3. <i>Manis crassicaudata</i>	Indian Pangolin	3. <i>Tragopan satyra</i>	Satyr Tragopan
4. <i>Caprolagus hispidus</i>	Hispid Hare	4. <i>Lophophorus impejanus</i>	Impeyan Pheasant
5. <i>Canis lupus</i>	Grey Wolf	5. <i>Catreus wallichii</i>	Cheer Pheasant
6. <i>Ursus arctos</i>	Brown Bear	6. <i>Grus antigone</i>	Sarus Crane
7. <i>Ailurus fulgens</i>	Red Panda	7. <i>Ciconia ciconia</i>	White Stork
8. <i>Prionodon pardicolor</i>	Spotted Linsang	8. <i>Ciconia nigra</i>	Black Stork
9. <i>Felis bengalensis</i>	Leopard Cat	9. <i>Houbaropsis bengalensis</i>	Bengal Florican
10. <i>Felis lynx</i>	Lynx	C. Reptiles	
11. <i>Neofelis nebulosa</i>	Clouded Leopard	1. <i>Gavialis gangeticus</i>	3. <i>Varanus flavescens</i>
12. <i>Ovis ammon</i>	Great Tibetan Sheep	2. <i>Pythos molurus</i>	
13. <i>Pantholops hodgsoni</i>	Tibetan Antelope	D. Number of Faunal Species in the CITES Appendices	
14. <i>Hyaena hyaena</i>	Striped Hyaena	Appendix I: Mammals-32	
15. <i>Platanista gangetica</i>	Ganges River Dolphin	Birds- 12	Reptiles :2
16. <i>Panthera tigris</i>	Tiger	Appendix II: Mammals:16	Birds: 95
17. <i>Panthera uncia</i>	Snow Leopard	Reptiles: 15	Insects:3
18. <i>Elephas maximus</i>	Asian Elephant	Appendix III: Mammals:4	Birds:1, Reptiles:2
19. <i>Rhinoceros unicornis</i>	Greater One-horned Rhino	Government of Nepal, Ministry of Forest and Soil Conservation has regulated International	

20. <i>Sus salvanius</i>	Pygmy Hog	Trade in Endangered Wild Fauna and Flora in April 23, 2017 to make necessary legal provisions for conservation of various species of the endangered fauna and flora in order to implement the Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973 as Nepal is a party for regulation and control of international trade. This Act was enacted by the parliament referred to in clause (1) of Article 296 of the Constitution of Nepal and referred for citation as "(the) Control of International Trade of Endangered Wild Fauna and Flora Act, 2017"
21. <i>Moschus moschiferos</i>	Musk Deer	
22. <i>Cervus duvauceli</i>	Swamp Deer	
23. <i>Bos gaurus</i>	Gaur	
24. <i>Bos grunniens</i>	Wild Yak	
25. <i>Bubalus arnee</i>	Wild Water Buffalo	
26. <i>Antelope cervicapra</i>	Blackbuck	
27. <i>Tetraceros quadricornis</i>	Four-horned Antelope	

3.4. Forest Cover Change

Forest cover change attributed to its impacts on water, energy, carbon, and other nutrient cycling together with affecting ecosystems, biodiversity and human life. However, loss of forest cover recorded in 2016 about 29.7 million hectares (73.4 million acres) attributed to forest fire is primary cause including deforestation, logging and mining (33). More than 1 billion peoples dependency on global forests for livelihoods, forest ecosystem are in threats as its intrinsic role to stabilizing climate, avail food, water, timber, NTFP, ethnobotanical products including medicine as well as role of supporting world's biodiversity. The total forest area of Nepal accounted in 2010 was 25.36% (34) however table 1 showed 25.42% approximate 3636 ha area reported in 2015 (Table 4), (2).

Table4. Forest and other wooded land of Nepal in 2015

Forest			Other wooded land			Other land	Inland water	Land area
1 000 ha	% of land area	Tier status	1 000 ha	% of land area	Tier status	1 000 ha	1 000 ha	1 000 ha
3636	25.42	2	1897	13.2	2	8802	383	14335

Since 1990 to 2000 forest area of Nepal was changed annually by 2.1% reporting it on annual changing rate of -1.1% in 2015 (Table 5).

Table5. Extent of forest 1990-2015 in Nepal

Forest area (1 000 ha)						Annual change rate							
1990	2000	2005	2010	2015	Tier trend	1990-2000		2000-2010		2010-2015		1990-2015	
						1 000 ha/yr	%	1 000 ha/yr	%	1 000 ha/yr	%	1 000 ha/yr	%
4817	3900	3636	3636	3636	1	-91.7	-2	-26.4	-1	0	0	-47.2	-1

Source: FAO 2015

The changes in forest over past 25 years Nepal's forest area has declined rate of -1.1%. The changing pattern of total forest areas with associated land uses are presented below in the Table 6.

Table6. Pattern of Forest Area, wooded land and Other Land area in Nepal Changed over time

Categories	Area (1000 ha)				
	1990	2000	2005	2010	2015
Forest	4817	3900	3636	3636	3636
Other wooded land	1180	1753	1897	1897	1897
Other Land	8303	8682	8802	8802	8802
Inland water bodies	418	383	383	383	383
Total	14718.00	14718.00	14718.00	14718.00	14718.00

Source: Global Forest Resource Assessment 2015, Country Report Nepal 2014, FAO, Rome

Since 1991 to 2002 annual change on forested, shrub and grassland area of the country were reported by -2.70%, 12.70% and 0.10% respectively (Table 7).

Table7. Land-Use Change 1991-2001 ('000 ha) Land Use

Land uses	Year	Ecological Region				Change	Annual Change %
		Himal	Hills	Terai	Total		
Forested	1991/1992	233	4,436	1,159	5,828	-1,560	-2.70%
	2001/2002	228	2,891	1,149	4,268		
Shrub land	1991/1992	138	512	39	689	872	12.70%
	2001/2002	168	1,254	138	1560		
Grass land	1991/1992	133	1,589	35	1757	9	0.10%
	2001/2002	138	1,592	36	1766		

3.5. Threats and Implication on Forest and Biodiversity

The main threats on forest and biodiversity related to the encroachment of forest area by the development activities, urbanization and infrastructure development, conversion of forest land into agriculture, increasing rate of livestock grazing and deforestation, loss of humus soil and erosion as well as changing pattern of climate and pollution increment. Forest loss and fragmentation is higher in the tropical biodiversity (35), (36), (37) as recent research showed tropics harbors 78% of floral and faunal species as tropics covers about 40% Earth's surface only. Forest cover changes effects local climate and vegetation fragmenting forest habitat, fragmentation and promote forest desiccation impacting interactions among species, ecosystem functions, including forest hydrology and also in biochemical cycles. Annual degradation of world's natural forests between 2000 and 2005 recorded about 7.3 million ha (38) which often exceeded 13 million ha/year before 2000 (39).

An anthropogenic changes in natural environment like degradation and loss of ecosystems due to changes in land uses, human impacts on the biogeochemical cycles (e.g., climate change, pollution), invasive species that displace or out compete endemic species, and poor management or over-exploitation of the natural resource base (40), (41), (42) changing biological diversity continuously since life exist in the Earth (43). Human induced direct impacts of interventions in ecosystems cause rushed changes triggering loss of biodiversity and interrupt to recover the natural ecosystem that might be irreversible (44).

Nepal signed CBD in 1992 to protect the biodiversity together with strengthening the institutional and legal frameworks. Later on Climate Change Policy has adopted in 2011 to improve livelihoods by mitigating and adapting to the adverse impacts of climate change, adopting a low-carbon emission-based socio-economic development path and supporting and collaborating in the spirit of Nepal's national and international commitments related to climate change. However, national annual deforestation rate is more than about 84,000 hectare of forest land including deforestation rate in the Terai about 2.7 % annually. To restore such degrade forest land plantation of fast growing species is crucial to jump start the regeneration of natural species as use of colonizing species to initiate natural regeneration suggested by Fimbel and Fimbel, 1996 (45) and Fisher, 1995 (46).

Similarly, degradation of wildlife habitat is attributed to the encroachment of forest land due to increasing population, urbanization and expansion of development activities converting grasslands and forests to agricultural lands, extraction and overharvesting of natural resources, overgrazing and spread of invasive alien plant species such as *Mikania micrantha* (mile-a-minute weed), *Lantana camara* and *Chromolaena odorata*. Moreover, reduction of prey base, habitat fragmentation, poaching and hunting, natural disasters played vital role extent the valuable species.

3.6. Challenges and Opportunities

Forest regulated ecological and socioeconomic functions providing water and nutrient cycling, soil and watershed conservation, species, genetic and ecosystem diversity together with regulation of greenhouse gases (47). Growing anthropogenic pressure on land use dynamics and forest cover changes, environmental degradation increasing soil, water, air and noise pollution (48), (49) as well as

loss of biodiversity due to forest fragmentation and loss of soil threats regional and global scale ecosystem productivity (50).

Forest degradation in Nepal's context intervention of developmental activities, shifting agriculture and urbanization can lead to land fragmentation and forest cover degradation as mentioned causes of deforestation in developing countries of Africa, Asia, and Latin America documented by different authors (51), (52), (53), (54), (55). Management of natural forests in the 21st century is the big deal for conservation biologists for issue related to loss of biodiversity due to micro level forest fragmentation (56), (57). The global concern about threats on biodiversity due to deforestation and degradation, increasing demand of forest products due to rapid population growth towards forest-related ecological services and rural livelihoods conservation and rehabilitation is necessary for the sustainable protection of remaining natural forest and woodlands. The forest sector represents one of the most challenging areas in terms of water supply and quality, flood protection, soil conservation, local climate and role of biodiversity on the existence of functioning forest ecosystems. There are immense opportunities for sustainable management and protection of forests and biodiversity by improving national policies, plan and programs implementing legislative measures and instruments participating local community approach of benefit sharing involving women and indigenous or marginalized people.

Similarly, enhancement roles and responsibilities of private stakeholders such as local community based organizations, nongovernmental organizations and cooperatives, INGOs and local leaders developing awareness and technical skills can harmonize extinction of forestry education, support for research mechanisms, intersectoral coordination, decentralization and responsibility building incentive systems to balance holistic approach for sustainable and environmentally sound forest management.

Forest change and monitoring is major challenge for large area assessment, data accuracy and reliability to improve forest management. Specific management plans such as protected and natural forests, community forests, private and religious forests, other natural and planted forest areas, open areas, degraded sites and settlement areas, biodiversity and water catchment hotspots for sustainable management and development of the forests. These efforts can play vital role to provide habitat of life for wildlife and protection of endangered species or critical flora and fauna together with protecting environment and balancing ecosystem.

4. CONCLUSION

Forest plays intrinsic role to conserve biological diversity, habitat for plants, animals and other organisms, sustain productive values for human life, maintain ecosystems and protect the environment. An increasing threat on forest and biodiversity encompasses change in forest cover, degradation and deforestation, ecosystem loss, conversion of forest land in other purposes, soil erosion, and landslide including watershed degradation. Land use planning and management strategies can sustain forest resources as the global forest area has decreased 3.1% over the past 25 years and 6.5 million ha net loss of natural forests between 2010 and 2015.

Such forest degradation and fragmentation, deforestation, pollution and climate change a critical global issue impacting on forest biodiversity and atmospheric carbon flux. Forest biomass and carbon stocks are productive capacities of forests, energy potential and capacity to sequester carbon but threat of biodiversity loss reflects degradation or loss of primary forests, persists and continue the carbon stocks in forest decreasing biomass by almost 11.1 Gt, equivalent to a reduction of 442 million tonnes per year or about 1.6 Gt of carbon dioxide over the past 25 years. The reduction is attributed carbon stock changes due to converting forest lands to other land use and forest degradation. The Forests of Asia Pacific region contributes significantly to global biodiversity where Nepal is one of the richest biodiversity hotspot contributing about 0.1 % of the global area harboring 3.2% and 1.1% of the world's known flora and fauna respectively. Nepal covers 29% forest area excluding 10.6% shrub area out of the total area of the country where factor of forest degradation and loss of biodiversity continuing due to change in land uses, urbanization and settlement expansion, encroachment, infrastructure development and conversion of forest land to agriculture, overexploitation and overharvesting of forest products, invasion by alien species and pollution including poaching and illegal wildlife trade and human-wildlife conflict in protected areas.

Since 1990 to 2015, Nepal's forest area reported to declined annual changing rate of -1.1% however 12 national parks, 3 wildlife reserves, 1 hunting reserve, 6 conservation areas and 12 buffer zones around the park and reserves, totaling more than 3.4 million ha of country's land committed to biodiversity conservation above 23% of the land of Nepal. In spite of immense effort for biodiversity conservation, forests continue to be under great pressure due to developmental activities, population increase, implementing large scale infrastructures, logging and land use changes. To protect and manage the forest biodiversity, logging management, site specific management plans, forest rehabilitation, afforestation on degraded and open lands, agro forestry, proper land use planning, green infrastructure, integrated watershed management, protection of wildlife and protected area management as well as policy level strong plan strategies and implementation with effective monitoring is essential.

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