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Research Article

Anthropocene-Bio-geography need reverse Gearing in India: Beyond Domestication and Farming

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Abstract

The plate boundaries are the limits of the faunal biodiversity. The species can be endemic, converging or invasive. International Union for Conservation of Nature and Zoological Survey of India are the agencies record and make an action plan to preserve extant/extinct and endangered species. India has 2.4% of the landmass of the globe but accommodating about 7-8% of the total species of the world so a rich biodiversity nation. The country lies at the confluence of the Central zone of Africa, Europe and Malaya region, the biota therefore includes African, European, Eurasian and Mediterranean geographical areas, India has a unique assemblage of flora, fauna, avifauna and aqua-fauna along with some endemic species, that contributes to the richness of the nation. India's biodiversity population changes are influenced by climate, temperature, altitude, invasive alien species, topography, moisture, CO2, light, nutrients, water quality, ambient air, habitation, and above all the anthropogenic activities for their growth, survival, or reproduction. Present study envisages preparation of an updated bio-geographical status of the species, statistical analysis of the biota those are endangered and threatened and causes for such defaunation and defloration. Though preservation action plans have been enhanced in India through biodiversity reserves yet it is observed that the largely under-explored sector is algae, protists, fungi, microbes. The biodiversity in the marine sector is given less importance for conservation in India.

Keywords: *Biodiversity, sanctuaries, species, geo-biography, Anthropocene, bio-reserves*

1. Introduction

The assortment of life in all systems, levels, is a consolidation of adjoining genetic species and ecosystem diversity called the bio-diversity. Biogeography is the study of the extensive distribution of species that investigates the changes in dispersal patterns occurred geospatially along with the reasons for evolution and natural selection of flora and fauna. The biodiversity hubs were natural and found the hilly areas, deserts, coasts, islands, and deep seas during the Holocene epoch. The Homosapiens disturbed the natural distribution and settled in the river deltas after domesticating wild animals and utilizing them for agriculture during the Holocene epoch. The geology, topography, climatology, geomorphology, and meteorology of an area govern its geo-biography and ecology.

The study aims at evaluating the present status of various species inclusive endemic, endangered, vulnerable species with their biodiversity, significance and migratory activities in India and across the globe. The study focuses on the geospatial design of biodiversity and the species under threat and the actions initiated for their conservations. The study also aims at identifying the invasive species and their probable impact on aboriginal flora and fauna in India.

Fig 1: The Biodiversity releams in/around India (Google)

2. Literature review

The earth's terrestrial zoogeographical realms were initially delineated by Sclater (1858), further by

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Wallace (1876). Wegener 1915 & 1929 reported that the climate along the same latitude is roughly identical and same types of species occupy similar regions along a continent, During LGM period the land mass Beringia became ice-free during the last glacial epoch (little ice age), 15000 - 6000 years BP there was shift towards hot climate and hence the biodiversity https://www2.usgs.gov/climate_landuse/glaciers/glaciers_sea_level.asp. A large number of species became extinct and the migration of many vertebrates especially mammals occurred between North America and Eurasia. Out of 300 ethnic people's community Teledo (2017) of the globe, 150 million live in Asia whereas 68millions in India. India has 227 ethnic groups including 573 tribal groups. They are derived from six racial stocks namely - Negroid, Proto-Australoid, Mongoloid, Mediterranean, West Breachy and Nordic exists in different part of the country (Pushpgandhan) Rai *et al*, (2003). The population size of vertebrates (amphibians) are an indicator of ecosystem health as they are sensitive to variations in their environment Welsh et. al., (1998); Malhotra et. al,, (1999). Sheridan *et al*., (2003); MOEF Report (2010) has reported that the biodiversity of WGB hills is under endemism which contains about one-third of floral species and a hotspot for flora and fauna. The species of WGB hills comprises of 8000 plant class (4780 and endemic 45%), Vertebrates (1073 and endemic 33%), Aves species (528 and 7.5% endemic), reptiles (259 and 62% endemic), amphibians (116 and 80% endemic) and mammals (140 and 27% endemic) as per Envis letter -21/2010 MOEF. Vivero et. al., 2005 reported that Ethiopia had 8000 plant species (24% endemic). There are four biodiversity amphitheaters such as Peninsular (endemic biodiversity), Indo-Malayan, Palearctic and Ethiopian-Mediterranean amphitheater Mani *et al* 1974. Animals have a particular distribution in a definite area having specific geographic, ecologic and climatic distinction. The plate boundaries are the limits of the faunal biodiversity (Wallace line). The agreed recent catalog of land masses into different bio-geographic regions and biodiversity are based on Darlington (1957), L. Sclater (1858), Wallace (1876).

3. Methods and methodology

Literature Studies reveal that about 5 million to 10 million species live in the globe but 1.73 million species are recorded and the rest needs to be explored and recorded to get a clear picture of Biodiversity and to conduct any realistic studies. India has a land mass of area 3,287,469 Km2 (World 510,065,284.km2) consisting of southern tropical forests and western deserts, northern snow areas, islands and coastline of 7,516.6 km. India has 94500 plants and 100693 animals with 320 types of domesticated wild crops have been cataloged. It is very less compared to available species. The more scientific study is needed in this regard (IUCN 2018). Mishra S. P. 2018. India has 4 mega centers and 26 micrometers but some micro centers and geo-biological networks are yet to be explored and recorded.

The largely under-explored sector is algae, protists, fungi, microbes. The ocean biologists have cataloged only 15042 marine taxa's in Indian marine ecosystem, much less than the world's marine species strata. (~2.2 million), Mora *et al* (2011)[15]The biodiversity is important for its consumptive, productive, social, ethical, aesthetic, and health values. The numerical values of species statistics are increasing year to year. All estimated 1737248 species are not cataloged. Only 93577 numbers of species have been evaluated by IUCN until 2018. So any speculation about defaunation and defloration activities of the all the taxa shall be misleading.

The updated statistics of domesticated animals used for food generation, geo-biography, zoo-geography and plant biodiversity conservation are reported in the present text. The IUCN red list 2018 forms the basis for reporting the rate of defloration and defaunation of species. The increased protective measures taken by the Government for the conservation of the species through bio-reserves, sanctuaries, marine ecosystem reserves is updated from different sources like browsing, visiting sites and old literature.

3.1 Biodiversity Levels and indices

Biodiversity has three levels of hierarchy such as *genetic, species and community& ecosystem..* Genetic diversity is the variation of genes within species, species diversity is the variation of species within a zone and the community of ecosystem biodiversity is the level of community and ecosystem. The community diversity has three prospective α diversity, β diversity and γ diversity. α diversity is the biodiversity within a particular area, community and ecosystem usually measured by species richness and evenness by counting the distinct group of organisms, β diversity is a measure of inter-community biodiversity representing the rate of species turn over per unit change in habitat. γ diversity measures the overall diversity for the different ecosystem and represents the total species richness over a large area. The relation between **γ (biodiversity indices) = α + β + Q** where, Q = Total number of habitats or communities, α = Average value of α diversities and β = Average value of β diversities **OR $\gamma = S_1 + S_2 - C$** where S_1 is the total numbers of species recorded in the first community, S_2 is the total number of species in the 2nd community and C is the common species in the 1st and the 2nd community https://www.slideshare.net/arzoosahni/eves-biodiversity-notes. However ***Simpsons's diversity index*** **(D** $=\sum(\frac{n}{N})^2$ or $D = \sum\frac{n(n-1)}{N(N-!)}$here n = the population of individuals like individual species, N = the population of organisms of all species Where D ranges from 0 to 1. ***Shannon diversity index (H_s)*** = $-\sum_{i=1}^{S} P_i * (lnP_i)$ *where* P_i is the proportion of individuals found in the ith species in comparison between the the the two sites and the fit value should

lie between 1.5 to 3.5. The ***Brillouin index*** which emphasizes the richness of species population is given by $H_s = \left(\frac{\ln N! - \sum \ln n!}{N}\right) where$ n = the population of individuals like individual species, N = the population of organisms of all species n = the population of individuals like individual species, N = the population of organisms of all species. The bio-geographic zones of India is ironic due to the abundance in species of flora and fauna and being ranked 8th and biodiversity Simpsons index is 0.46 (MONGABAY).

3.1.1 Uses of the Biodiversity

The Holocene taught us domestication of wild animals/plants and dogged agriculture for human services. About 90% of foodstuffs obtained from the bio-system. The biodiversity gives us protection from Water Resources, other carnivores, Invasive alien species (IAS), soil toxicity, erosion, nutrient storage and cycling, degradation of waste, pollution regulation, climate combat, biological productivity, carbon sequestration, pest, disease-causing species, and maintain soil fertility. The biodiversity of the ecosystem provides the food, drugs, fiber, fossil fuel and firewood and above all oxygen to breath. Modern studies on genes have helped us to develop healthier medicines, cosmetics, and many industrial products. About 80000 plants are used as food globally and 70-80% of the people used as medicine of the world.

The drugs in Ayurveda, allopathic, Yunani or homeopathic are the plants or plant extracts, used by about. The lifesaving drugs like Penicillin, Tetracycline are the bright examples. In spite of that activities are leading to the changes in nature and unbalancing carbon footprints in the present epoch.

3.1.2 Bio-geographical realms

Holt *et al*., 2013 have specified the faunal geographical regions of the globe into 11 mega biogeographic zones & 20 zoogeographical regions. The zoogeographic zones are Nearctic (North America north of Mexico) Panamanian (Central America), Neotropical (South America), Palearctic (Eurasia), Sahara-Arabian (Africa (N) & Asia (W)), Afro-tropical (Africa, South of Sahara), Madagascan (Madagascar), Oriental (South & SE Asia), Sino-Japanese(China (part) including Tibet ,& Japan), Australian (Australia & New Zealand), and Oceania (Islands (west) & central Pacific Ocean). However the transition zones are the significant bridging zone for species world. Five such transition zones identified are Mexican, Sahara-Arabian, Chinese; Indo-Malayan, and South American. Bio-geographers have added two micro bio-geographical regions with fewer species are Andean (Engler, 1882) and the Antarctic. The bio-geography spread is classified into six regions. The status is given in Table 1.

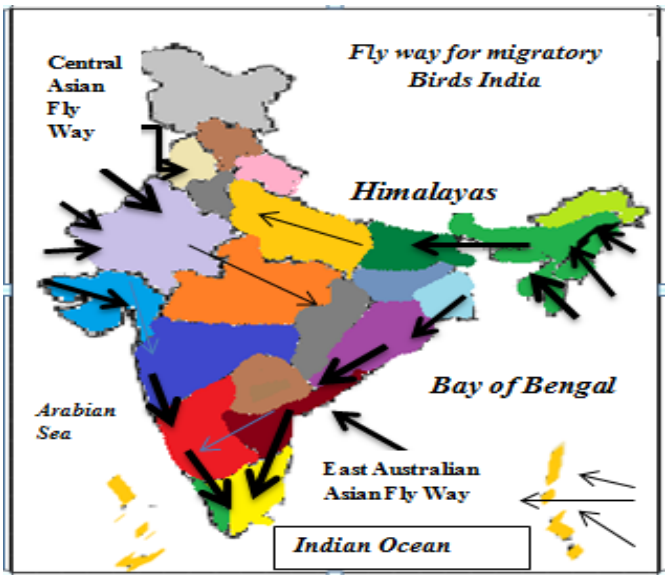


Fig 2: Flyway for migratory birds, India, (source Google)

The mega bio-diversity nations identified in Afro-Eurasia are India, Brazil, Colombia, Ecuador, Peru, Mexico, Madagascar, Zaire, Australia, China, Indonesia and Malaysia. India has 7-8% of the total species of the globe and designated as a megadiversity country that is one among the fourth Asian states. India is neighbor to Africa, Europe and Indo-Malaysia region. Unique Ethiopia's (Africa) biodiversity comprises of species more than 6,000 plants, 277 mammals, and above 800 species of Aves congruent to India which is also influenced by its neighboring biodiversity realms (Ethiopian, Paleo-arctic and Indo Malayan).

The migration of flora and fauna is a continuous cyclic process and geospatial. The Himalayan region is a part to the Palearctic region whereas NE Himalayas is a part to the Oriental realm and the deserts of Gujarat are part of Ethiopian realm.

Table 1: Global Zoogeography, classification, continental distribution and faunal specialty

#	Realm/ landmass	Realm name/ faunal region	Continent	Areas/Countries	Faunal forte
1	Holarctic (MEGAGEA) Sclater 1858, or Arctogaea Shukla *et al* 2006	Palearctic Families-42 Endemic-0	Temp. Eurasia (except South & SE Asia)	Europe, Russia, Mediterranean	Rodents, ox's, sheep, goat, deer, antelope, bear, Necturus & Siren
2		Nearctic Families-37 Endemic-2	N. America north of Mexico	North America, Mexico,	American opossum, raccoons, rodents, iguanas & rattlesnakes
3	Holarctic (NEOGEA) Rapoport, 1968	Neotropic Families-50 Endemic-19	Central & South America	South America, tropical Mexico and Caribbean Islands	Rheas, alligators tapirs, sloth, prehensile-tailed monkey, vampire bats,
4	Ethiopian (MEGAGEA) Sclater 1858,	Ethiopian Families-52 Endemic-18	Sub-Saharan Africa & SW Arabia	Africa south of Sahara	giraffe, lion, hippopotamus, elephant, rhinoceros,
5	Oriental (MEGAGEA) Wallace 1876	Oriental Families-50 Endemic-4	South & South-east Asia	Tropical Asia (S), Pakistan, India Myanmar, S. China, SE Asia, Indonesian archipelago (W)	Tarsiers, orangutan, Indian elephant, rhinoceros, flying fox. Peacock, Crocodiles
6	Australian (Oceania) (NOTOGEA) Engler, 1899	Australian Families-28 Endemic-17	Australia	Australia, Fiji, Tuvalu Kiribati, New Zealand, Tasmania, New Guinea and	Monotreme spiny anteaters, marsupials, Sphenodon lungfish,

3.1.3 AVES & Ticks Migration (Afro Eurasia)

As per the Agreement on the Conservation of African-Eurasian Migratory Waterbirds (AEWA), there are 254 species of aves and ticks in Afro-Eurasia.. They cross international barriers by migrations to suitable sites to support their food, climate, reproduction, hatching, breeding, and for better quality habitation. The CMS MOU on the Conservation of Migratory Birds of Prey in Africa and Eurasia (Raptors MOU) has reported 93 species of birds of prey and owls found to migrate within 132 states of Africa, Europe and Asia. The migration may be seasonal, partial, reverse, moult, irruptive, dispersion and cold weather. India falls under the central Asia migration zone of AfroEurasia, East Asia-Australasia Flyway, and one among the eight water birds flyways. But epoch of Anthropocene claims migratory birds do not know and obey any border **Fig 2.**

4. Biogeography of India

India is rich in biodiversity due to its biogeographic location at the triple point of Palaearctic, Afro-Tropical and Oriental region. Biodiversity starts from the genetic level such as genetic variability of species to the biota in a definite expanse of its ecosystem of the neighboring region. Species diversity can be sensed in a biodiversity hotspot area whereas ecosystem diversity is the level of organization in an ecosystem. India stands as the 10th position among floral rich nations of the globe. India, part of the Oriental realm, is small in area and comprises of mammals (20 families) common to Palearctic, Ethiopian region but different from Australian. About 120 families of angiosperms are common to Neotropical and Australian indicating India is a country having diverse biodiversity https://pdfs.semantic scholar.org /presentation /ab10/435. India belongs to three regions of the geo-biogeographic system. About ≈90% of the subcontinent belongs to the Oriental region.

Table 2: The area, Bio-geography of the mega/micro centers in India (http://www. indiaenvironment portal.org.in/files/file, http://www.Cpreec .org/pub book-ecozone.htm, https://www.cbd.int/doc/world/in/in-nr-05-en.& http://www.indiaenvironmentportal.org.in

#	Biogeographic zone	Geographical areas	Area	climate	Hills	Threat to Bio-diversity
		Mega Centers	Km^2		Mountains	Causes
1	Trans-Himalayas	Ladakh, Tibetan Plat. Siachin, Leh, Srinagar, Lahul-Spiti H.P.)	174225	Cold/ Sub-Alpine/Alpine Forest	Zaskar, Ladakh, the Kailas,, the Karakoram	Anthropogenic, climate change(CC) tourism, , deforesting, NTFS,, human-animal fight,
2	Eastern Himalayas	Assam & Aru nachalPr. Sikkim, Cherrapunji, Imphal, Shillong	83000	Cold/moist, heavy r/f, Moist Temp, Subgroup- Pine Forest	The Patkai-Bum Hill, Garo-Khasi-Jaintia Hills, (Mizo Hill)	CC, deforestation, IAS, NTFPs, fire, LU urbanization, mining, tourism. (CC), NTFPs,
3	Western ghat Hills	Malabar plains, Western Ghats	99300	Tropical/monsoon climate, Tropical Wet Evergreen Forest	Agasthyamalai, Palini, Nilgiri hills	IAS, exotic mining, disease plantations, intrusion, exploitation NTFPs, co-extinction poaching, fire, , CC.
4	Deserts	Thar, Great Rann of Kutch, & Snow deserts	213672& 7770	Dry, Tropical Thorn Forest, cold climate	Aravalli hills, Pin Valley, Chandratal	IAS, LU change, livestock killing, grassland degradation,

		Micro Centers				
1	NW Himalaya	Himachal Pradesh, J&K, Uttarakhand	69033	Himalayan Moist Temperate Forest	Aravali, Himadri, Himachal, Siwalik Hills	CC, deforestation, fire, invasive species, NTFPs, tourism. LU change, urbanization,
2	Western Himalaya	Karakoram, Zanskar, Pirpanjal, Siwalik Hills, Kumaon Himalaya	720000	Himalayan Dry Temp. Forest	Tarai, Riparian Forests, Grasslands	CC, deforestation, LU/LC change, IAS NTFPs, Poaching, fire, sprawl, mining, tourism.
3	Cent. Himalayas	Uttarakhand, Sikkim & Nepal Himalaya	83000	subtropical broadleaf/mixed conifer/conifer forests alpine meadows	Kathmandu, Pokhara valleys, Tarai, Siwalik range, Nanaga/Namcha	CC, deforestation, LU change, tourism mining IAS, fire, Exploiting NTFPs, urbanization
4	Gangetic Plains, (20^0 N Lat)	Uttarakhand, UP, Bihar, Assam(W)	107600	Moderate temperature / rainfall	Floodplains, Aravalli-Bindhya & Satpura hills	CC, mining, Deforestation, loss of grassland IAS, anthropogenic act, LU/L change, pollution
5	Islands arcs of India	Andaman Islands	6575	Tropical/moderated by sea breezes	Sunda Lands	Habitat loss/ Hunting, fragmentation, Species Exploitation Exotic species, Poaching Pollution, Pests, &Predators, Global warming, Extreme, CC
6		Great Nicobar group of Islands	3287	Tropical/moderated by sea breezes	Sunda lands	
7		Lakshadweep islands,	3110	Tropical/moderated by sea breezes	Coastal Lands	
8	Semi-Arid Zone:	Punjab plains, Gujarat Rajput Ana,	287000	Rainshadow of WGB, grasslands	Satpura, Throny& deciduous Forest	Habitat loss/ fragmenting, IAS, exploitation of species, CC, and pollution, LU change. IAS,
9	Deccan Peninsula Zone	Cent. high lands, Chhotnagpur Hills, Deccan South	378000	Tropical uneven climate/ dry evergreen deciduous	Nallamalai, Sunki, Deomali, Sukma, hill ranges	
10	Coastal Zones	East coast	6500	Tropical, deciduous forest, & mangroves	Estuarine biota EGB hills, lagoon Chilika	Habitat loss, Hunting, Exploitation Species, Fragmentation, IAS, Exotic Species, Pollution, Pests, Predators, Calamities, CC, Global warming
11	(Marine influenced-10440Km)	West coast	6500	WGB Hills, Harishchandra and Satmala range	lagoons, Malabar, Konkani	

The Thar Desert is included recently in mega-biospheres of India which is populous (17.44 million) and has vast livestock (23.33 million) in comparison to other deserts of the world Khan *et al*, (2003). http://www.bsienvis.nic.in/Database/Biodiversity-Hotspots-in-India_20500.aspx

A part of the west of J&K to Rajasthan is lying in the border of the Sahara-Arabian biodiversity region. The major part of Himalayan ranges belongs to the Sino-Japanese region i.e. Palearctic region. The major and micro biodiversity centers are in **Table 2.**

4.1.1 Geological Evolution behind Geo-biodiversity India

Evidence of the geological evolution of species is ascertained from paleontology (fossil records), Phylogeny (systematics) and biotic interchange of the area. The geologic backgrounds on the diverse biodiversity of India are interrelated to the chronological geological phenomena's (a)Rift, break up and shifting of Gondwana land of Indian plate in pre-Cambrian age (b) Drifting and shifting of the Indian plate from Antarctica (c) Prolonged volcanic eruption Deccan and Chhotanagpur plateau (d) Protracted collision of the Indian plate with the Asian landmass (e) 22Mounting of the Himalayas ranges from west to east with Tibetan plateau (f) WGB hills formation due to down-warping of Konkani low lands into Arabian Sea (g) Meteorological extremes, Tsunamis and climatic anomalies (h) Estuarine, lagoon and island biodiversity (k) Pleistocene warm periods and Ice ages (l) Present Anthropogenic pressure in the Anthropocene epoch (m) Disjunct distribution species in India. The major three biogeographic distribution of species (small or large) can be cosmopolitan (globally distributed), endemic (aboriginal locally disseminated) and Holarctic disjunct (Geospatially and geographically spread). Biogeographic realms created by Wallace A R. (1876) based upon, identical or congruent characteristic within the endemic species of an area those are convergent under similar adaptations. Different theories were put forth by different authors regarding the distribution of species based on dispersal, and vicariance (splitting). The distribution of species in India mostly fall under the disjunctive distribution of species Darwin C. (1859), Ali (1949), Hora (1949, Ripley 1949, Karanth 2003, Mani, 1974,.Different theories were framed for the distribution of flora and fauna and their migrations Shukla R. P., 2006 are Deccan Traps Theory (North-South intermix through barriers Satpura hills Hora *et al* 1949, Himalayan glaciation theory Medlicott *et al* 1849, late Pleistocene glaciation compelled species to migrate to tropics), Continental-drift theory (Discontinuity of migration due to climate changes,

Alfred Wegener 1966, The equilibrium theory of island biogeography Mac-Arthur and Wilson 1963, 1967, island species migration depends on population and proximity to land mass) and land breeze theory. The pertaining dispersal and migration routes are Satpura Hills range or EGB Hills range to WG Hills range and then to Srilanka. The hypothesis of migration of species has occurred from Australia to India through oceanic paths. Barriers to the migration of the flora and faunal biome are climate, topography, physiography, edaphic, biotic, genetic, reproductive and anthropogenic. The other routes of migration from one biodiversity hotspot area to other are Aravalli hills Abdulali, H. 1949[29], Mani, M.S.,1976, Satpura-Vindhya hills range Hora S. L.,1949, Govardhan Hill in Braj Digler 1952, in Karanth K. P., 2003[32], and EGB Hills range. Beyond the main routes, the secondary intra migration paths are through Aravali Hills range for passage of NW Himalayan species, Darjeeling hills and Garo– Rajmahal (Bindhya) hills range for mid-Himalayan species, Darjeeling- Chittagong hills for east Himalayan species and Mizo Hills to Gandhamardan via Chittagong Hills, Sundarbans. The aqua fauna of India are also migratory and travels thousands of kilometers to reach the Coasts of India and breed and swim away to their native habitation. Kartik Shanker had shown the path migratory turtles in Indian ocean http://www.fao.org /docrep 007/y5750e/y5750 Fig 3. Similarly the the fishes and aqua faune takes some predetermined path and traves through the Indian ocean and bay of Bengal then through Arbian coast and swim to Coasts of Africa Fig 4.

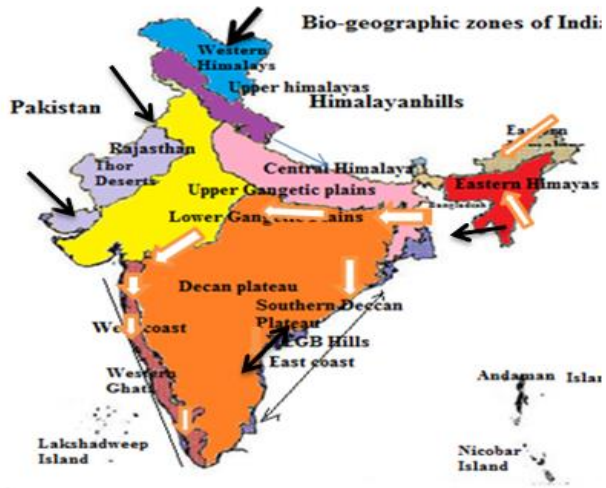


Fig 3: The major migration paths of animals in biogeography map of India, (Source Google)

The exodus act of species can be biotic or abiotic. The biotic factors are genetic homogeneity, mobility, seed dispersal, food scarcity, search for a better partner whereas the abiotic factors are meteorological, geomorphologic, geologic, climatic vagaries, soil-type, floods and topography. The migrant species must have grown genetically under appropriate geomorphological, physiological, biomechanical, behavioral, and life-history characters under suitable climatic condition Fuller et. al., 2005; Hobson, 2008, Holland et. al.,2009. The geographical isolation of species stimulates the evolution of new species through variation, crossbreeding and mutation.

Fig 4: Migratory path of aqua fauna in marine area, India

4.1.2 Forest India

Total Land Area of Earth is 510,065,284 sq.km with a forest Cover of 38.7 million sq.km (26%). About 40% of global forest land is in South America, Africa, and South Asia. India is in South Asia. There were 16 main types of forest types with 221 subtypes spread in 4.1 MHA of lacustrine areas not including paddy fields and mangroves in India. The ranking of India in the global diversity is 8th against mammals and birds, 5th for reptiles and 15th to 20th for amphibians and angiosperms IUCN – 2018. The country has about 6700 km2 mangroves area (7% of the world). The list of land area under forest and tree cover placed India as 10th rank in the world. India has forest cover of 24.4%, even though it accounts for 2.4 % of the land mass of the globe focusing on India, biodiversity enriched. India has 708273 Km2 of forest which is 21.53% of the total geographical area of the country FSI, 2011. Considering ISFR data 2009, there were 83471 km2 of thickly dense forests (crown density >70%), 320736 km2 (crown density of 40 to 70%) of moderately thick forests exists in India. The remaining 287820 Km2 are open forest having crown density 10 to 40%, existed in India.

India State of Forest Report of MOEFCC (ISFR 2017), reported that overall forest and vegetation spread in the country has added by 8021 km2 (6778 km2 and tree cover as 1243 km2), which is 1% increase from 2015. The CO2 absorbing sources, very dense forests have increased by 1%. The present increase in forest cover was in the eastern Himalayan states such as Nagaland, Arunachal Pradesh, Tripura and Meghalaya's having 531 Km2, 450 Km2, 190 Km2, 164 Km2 and 116 Km2 rises respectively. http://mospi.nic.in/statistical-year-book-india/2017/202

Table 3: Statistics of the Protected Areas in Indian subcontinent updated 2018

#	Specialties	unit	India	% of world	Source
1	Land area	Km^2	3287469	2.21	Govt. of India[46]
2	Population 2018	Million	1355.3	17.74	Worldometer
3	Forest cover 2/2018	Km^2	708273	21.54% Ind, 2.4% world	ISFR-17, W. Bank.-2015
4	Forest/tree cover	Km^2	802088	24.39% of India	ISFR 2017
5	Mangrove	Km^2	4921	0.15% of India	FSI 2017 as per H Times
6	National parks NP's	Nos Km^2	104 40501	1.23% of India	http://www.wiienvis.nic.in/Database
7	WLS's, 2018	Nos Km^2	544 118932	3.62% of India	http://www.teriin.org/opinion/ protected-area-network-India
8	PA's 2018	Nos Km^2	770 162099	4.93% of India	http://www.wiienvis.nic.in
9	Conservation Reserves (CRs)	Nos Km^2	77 2594	0.08% of India	http://knowindia.gov.in
10	Community Reserves	Nos Km^2	46 72.6	0.002% of India	http://www.teriin.org/opinion /protected-area-network -India
11	Herbarium	Nos	79	NA	http://www.bsienvis.nic.in/Database/Floral_Statistics_of_India_
11	Costal (MPA's)	Nos Km^2	25 8231.5	0.0025% of India	http://natureconservation.in/list-of-marine-protected-areas-in-india-updated
12	Island MPA's	Nos Km^2	106 1570	0.0005% of India	

4.1.3 Biodiversity Protected Areas India

Global statistics by Deguignet M. *et al*., 2014 UN reported about 209,429 protected areas (PA's), distributed in 193 countries of the world covering 32,868,673km2 and spread in 11 regions such as Africa, Asia, America, Caribbean, Central, Europe, Middle East, North America, Oceania, South America and Southern Oceans. It was 9,214 PA's in 1962 and the area under the PA's were 2,400,000Km2. The largest being the Marine area, the Oceania, Natural Park of the Coral Sea (France) spread over 1,292,967Km2 followed by Southern Oceans South Georgia and South Sandwich Islands PA's (UK) 1,070,000Km2.

According to UNEP-WCMC (2018), India reports 672 units of protected terrestrial areas covering 182647 km2 out of 3061193 km2 of the total land area of India. The protected marine areas of India consisting of 0.17% cover (3928 km2) is out of 2301226 km2 total marine area. https://protectedplanet.net/ country/ IN. There are three protected areas as biosphere reserves such as Nanda Devi, Gulf of Mannar and Nicobar islands as the area has recognition, dedication and management, through legal or other operative means, to accomplish the long-term protection of nature with associated ecosystem services and cultural values, IUCN 2008. The details of the protected areas in the Indian subcontinent updated is given Table-3

4.1.4 Wildlife sanctuaries

In the Anthropocene epoch, the conservation of wildlife species like flora, fauna, avifauna and aquafauna became the need of the hour. Hence 498 numbers of sanctuaries have been created to date after the date of commencement of the new epoch from 1945 onwards.

Table 4: Status of major WLS's/ some Biodiversity reserve sites, India (UNEP-WCMC (2018)

#	Category	No.	Biodiversity zone (Name)	State	Famous Fauna	IUCN Type	Area Km^2	Year
1	Sanctuaries	498	Wild Ass	Gujarat	Wild ass	III	4954	1974
			Ranthambore	Gujarat	Tiger	II	392	1957
			Periyar	Kerala	Elephant	IV	427	1950
			Desert NP	Rajasthan	Camel	II	3162	1980
	http://www.wiienvis.nic.in/Data		Nagarjunsagar-SrisailamT.R.	AP	Tiger	IV	3568	1978
			Nelapattu Bird Sanctuary	AP	Flamingo Palearctic bird	Threatened	3568	1976
			Campbell Bay	Nicobar	bravura orchids, ferns ,crabs, turtles,	IV	426.2	1992
			Gr. Indian Bustard Sanctuary	Maharastra	Indian Bustard	IV	8496	1979
			Sathyamangalam	TN	Tiger	IV	1412	2008
			Kutch Desert WLS	Gujarat			7506	1986
2	Biosphere reserve	3	Nandadevi Gulf of Mannar Great Nicobar	UP TN A.&N.	Orchid Asteraceae, Dugong, Crab eater monkey	NR VI VI	6407 10500, 885,	198819 89 1989
3	Birds reserve	1	Nilgiri	Karnataka		NR	5520	1986
4	Closed Area	1	Doli	Rajasthan	Black Buck,	NR	706	

Besides the Bio-geo-graphical reserves there are 50 Tiger Reserves (TR) covering 71,027.10 km2, 16 Elephant Reserves, 26 Ramsar Wetland Sites (12,119.03 km2) for saving the wild large animals. www.environment.gov.au Apart from the above biosphere reserves, India has a number of notable avifauna reserve sites such as Bharatpur Bird Sanctuary (Rajasthan), Nal Sarovar Bird Sanctuary (Gujarat), Ranganthittu Bird Sanctuary, (Karnataka), Nalabana Sanctuary,Chilka Lake (Odisha), Mayani Bird Sanctuary, (Maharashtra), Salim Ali Bird Sanctuary, (Goa), Sultanpur Bird Sanctuary, (Haryana), Kumarakom Bird Sanctuary, (Kerala) and many others. The status of major sanctuaries is in **Table 4.**

4.1.5 Biodiversity hot spots

Biodiversity hotspots are the areas that sustain natural ecosystems those are largely intact and where endemic species linked with the bionetworks are well represented. A biodiversity hotspot area must fulfill the criterion of minimum 1500 vascular endemic plants or (>0.5% of the globe) and lost minimum 70% of its original habitat. According to Conservation International (CI), there are 35 bio-diversity hot spots in the globe including 4 from India. The listed 35 hotspots comprise of Asia Pacific (12 nos), African subcontinent (8 nos), Europe and central Asia (6 nos), South America has (5 nos), and North and Central America (4 nos). The prominent biodiversity hotspots of India are Himalayan belt. The Indo-Burma biodiversity hotspot areas including North-east India (except Assam and Andaman group) and the Sundaland consisting of Nicobar group of Islands. The smallest among biodiversity hotspots is the Western Ghats. At present biodiversity hotspots are susceptible for to threat due to deforestation, habitat loss and fragmentation.

4.1.6 Biodiversity heritage sites (BHS), India

BHS sites are distinctive ecologically fragile ecosystems (terrestrial, coastal and inland and marine lacustrine systems) possessing iconic biodiversity involving any one or more of the components such as: rich in wild/domesticated species, high endemism, possessing rare and threatened species, species of evolutionary significance, wild descendants of domestic/cultivated species, possessing historical pre-eminence of fossil beds and significant cultural, ethical or of aesthetic values of cultural diversity having a long history of hominid association with them.

To preserve biodiversity the Indians Authority have listed 23 heritage centers out of which few important conservation spots are Kaziranga National Park & Manas Wildlife Sanctuary (Assam) Keoladeo National Park (Rajasthan) Sunder bans National Park (West Bengal) Glory of Allapalli, Gadchiroli, Tonglu BHS, Dhotrey BHS under the Darjeeling Forest Division, Darjeeling, Dialong Village, Tamenglong and Nanda Devi National Park, Uttaranchal and many others. In March 2017, The Sustainable Action for Climate Resilient Development (SACRED) has designated Majuli, Assam, Indiaas the largest river island of the globe, as a carbon neutral site to fight against climate change and depletion of GHG's and to maintain its ecological culture and legacy.

4.1.7 Biosphere Reserves in India

'Man & Biosphere' (MAB) programme by UNESCO in 1971 has initiated reserving areas of terrestrial, lacustrine and coastal ecosystems to encourage and safeguard the biodiversity along with its support system and ethno-botanical uses. The MAB need immediate preservation, protection and nurturing of its endangered flora and fauna. MAB had identified the first biosphere reserve in 1979 and at present more than 651biosphere reserves and 15 trans-boundary reserves in 120 countries around the globe. Presently, there are 18 biosphere reserves are existing in India comprising area 91272 Km^2. Convention on Biological Diversity (CBD) had focused on the zoning of core areas of biodiversity, buffer zones for sustainable biodiversity and transition zones. The primary criteria are effective protection and habitat area loss for extension and conservation of nature and the core area should be biogeographically extended to accommodate all trophic levels of the sustainable ecosystem. The other norm is that the core area should have rare and endangered species in various types of soil, differing soil, aboriginal varieties of flora and fauna. India has declared 18 numbers of biodiversity reserves (MOEF) and 10 numbers out of them are included as part to world network programme (UNESCO) http:// natureconservation.in/ list-of-biosphere-reserves-in-india-updated. Status of Biosphere reserves is in **Table 5.**

The biospheres where the ancient culture preserved by implementation of national policies are Nilgiri (2000), Gulf of Mannar (2001), Sunder bans (2001), Nanda Devi (2004), Nokrek (2009), Pachmarhi (2009), Similipal (2009), Achanakmar-Amarkantak (2012) , Great Nicobar (2013) and Against- yamala (2016).

4.1.8 Biodiversity and aboriginal Indians

Aboriginal people spread over India in a land mass area of 329MHa, which harbors 306.686 million species (2809 indigenous groups) and these inhabitants are the architects of their jungle land. The traditional /indigenous groups cover 22% of total land whose lifestyle sustained with the major biodiversity of the area. Similar indigenous/ethnic tribes are now found in South and North Americas, Africa and Asia. As the son of the soil and as an aboriginal community tapping on ancestral knowledge, they are erudite about conservation of the biodiversity in significant areas and primitive territories. The ethnic community must be protected to survive in their pristine environment rather than modernizing them.

Table 5: Status of Biosphere reserves under geo-climatic conditions of India

#	Name of MAB	Biogeographic zone,	Year declaration	States of India	Area Km^2	Places (parts of districts and places)	Major Biota (Endemic species)
1	Nilgiris	Western Ghats	1.1.1986	TN, Kerala, Karnataka	5520	Wayanad, Nagarhole Bandipur, Udumalai, Milambur, Silent, valley, Siruvani hills,	Nilgiri Tahr, Lion-tailed macaque
2	Nanda Devi	Western Himalayas (MAB)	18.1.1988	Uttarakhand	5860	Chamoli, Pithoragarh and Almora districts, Ladak and Nepal	Himalayan Snow Leopard
3	Nokrek	East Himalayas	1.9.1988	Meghalaya	820	East, West and South Garo Hill	Red Panda
4	Gulf of Mannar	Coastal(MAB)	18.2.1989	TN	10500	Ram swarm,	Dugong, Corals, mangroves
5	Sundarbans	Coastal (MAB)	29.3.1989	West Bengal	9630	Ganga-Brahmaputra delta	Royal Bengal Tiger
6	Nicobar Islands	Coastal (Island)	6.1.1989	Carnicobar Islands	885	Campbell Bay, Chingen Kakana, Banaga, Indira Pt.	Marine crocodiles
7	Manas	Eastern Himalayas	14.3.1989	Assam		Kokrajhar, Kamrup, Nalbari, Barpeta, Darang	Golden langur, red panda
8	Similpal	Deccan peninsula (MAB)	21.6.1994	Odisha	4374	Mayurbhanja	Gaur, Royal Ben gal Tiger, Wild elephant
9	Dibru Saikhowa	Eastern Himalayas	28.7.1997	Assam	765	Debrugarh & Tinsukia	Golden langur
10	Dihang-Dibango	Eastern Himalayas	02.9.1998	Arunachal Pradesh	5112	Siang (upper/west), Upper Dibang valleys	various Leopards/ red panda, Pine Jungles
11	Panchmarhi	Semi-arid (MAB)	3.03.1999	M.P.	4981	Betul, Hosangabad, Chhindwara,Shimoga	Squirrels flying or giant
12	Kanchenzonga	Eastern Himalayas	7.2.2000	Sikkim	2931	North & west Sikkim	Snow leopard /red panda
13	Agasthyamalai Hills	Western Ghats	12.11.2001	T.N., Kerala	3500	Thiruneveli, Kanya kumari, Kollam, Patha namthita, Thiruan	Nilgiri Tahr, Elephants
14	Achanakamar to Amarkantak	Semi-Arid (Maikela Hills)	30.5.2005	M.P. & Chhattisgarh	3835	Annupur, Dindori Chh-garh & Bilaspur in MP	Leopard, Chital, Gaur
15	Rann of Kutch	Western Himalayas,	29.1.2008	Gujarat, GRK/LR	12454	Kachchh, Rajkot, Surendranagar	Wild ,asses, nilgai, desert fox
16	Cold desert Trans-Himalayan)	Western Himalayas	28.8.2009	J&K, H. P.	7770	Kargil in J&K and Sipti in H.P. Kinnaur (Chandratal, Sarchu)	Snow leopards
17	Sheshachalam Hills	Eastern Ghats	20.9.2010	Andhra Pradesh, Odisha	4756	Chittoor, Cudappa, Nallamalai, Tirupati, Sunki, Deomalli hills. Jeypore hill, Odisha,	Mouse Deer, 4-Horned antelope, giant Squirrel, Indian Civet
18	Panna	River Valley	25.8.2011	M.P.	2998	Panna, Raigarh & Chhattarpur	Tiger, Chital, Sloth bear, Sambhar

4.2. Marine protected area (MPA's)

The water cover of earth can be divided into 31% national water and 61% high seas. At present MPA's of national waters cover 23684818 Km^2 (16.77%) of the oceans but only 2618153 Km^2 (1.18%) of high seas are protected. In 2000, MPAs covered was about 2 Mkm^2 (0.7% of the Ocean) which has been increased to about 23 MKm^2 (7.26%) of the ocean at present. Development in MPA area in high seas is negligible https://www.protected planet.net/marine. Only one percent of India's vast coastline is well protected.

India has 7516.6 km of coastline (5422.6km along the coast, 2094km along island periphery). The coastal stretch has 372.42Km^2 economic zone, continental shelf 2.02x 10^6 Km^2 and a territorial water area of 193834 Km^2 spread over nine (9) coastal states and two (2) Union Territories (UTs). The coastal stretch consists of 43% sand, 36% muddy, 11% rocky, and 10% marshy lands https:/ / www. geographyandyou.com/ climate-change/environment/ coastal - marine -ecosystems. India.

4.2.1 Coral reefs India

A ridge of rock in the sea formed by the growth and deposit of coral susceptible to coastal development, agriculture, pollution, and other human activities resulting in sedimentation are the coral reefs. There is 600000 Km^2 area in the globe (Smith 1978) including 60% of the Indian Ocean region in SE Asia. The coral reef areas in India waters territory are estimated as 2375 Km Wafar 1990[18], DOD and SAC, 1997[19],. The coral reef zones of India has species biotic algae

(180types), seaweeds (20 types), seagrasses (20 types), Poriferans (115species), Crustaceans (5 varieties), Echinoderms (110types), and bony fishes varieties of 600 species Jyoti S. *et al*., 2016. The Coral reef Ecosystem of Andaman and Nicobar has the most biodiverse reefs comprising 235 Species of corals, 111 Species of soft corals, 112 Species of sponges, 411 Species of crustaceans, 1422 Species of molluscs, 430 Species of echinoderms, 750 Species of fishes, 4 Species of mammals, 14 Species of reptiles, 50 species of Marine birds, and 64 species of Algae including rare varieties of Coconut crabs Rajan *et al*., 2011 and Jay Prakash *et al* 2014. Coral reefs prevent sediments from washing up the shoreline and protect coastline habitats, sequester for CO_2, augments tourism and used for medicine. The threats to reef kingdom are sediment dredging and logging, san mining, trans-boundary poaching, careless tourism, and bleaching. Details of coral reefs in India is given in Table 4.

For protection of reef kingdom the federal initiatives are establishment of Indian Coral Reef Monitoring Network (ICRMN), Database Network and Website on Coral Reefs, Establishment of National Coral Reef Research Centre at Port Blair, Inclusion of Corals in Schedule I of the Wild Life Protection Act, 1972,National Focal Points of Global Coral Reef Monitoring Network (GCRMN), International Coral Reef Initiative (ICRI) and Coral Reef Degradation in Indian Ocean (CORDIO), Implementation of UNDP-PDF-B Project on Management of Coral Reefs in A&N islands and Implementation of India-Australia Training and Capacity Building (IATCB) Proj. on Coral Reefs **Table 6.**

Table 6: The status of coral reefs and their location in Oceans and Bays around India till 2016

#	Coral reefs(Ind)	Islands	Area	species	Reef forms	Location/Protection	References
	Name of coast	No	Km^2	No	Forms		
1	Goa coast (Arabian Sea)	3	≈. 30	29	Patchy	Ratnagiri Redi,, Malvan & Bombay (S) Grande, Bat Islands, St. George Island	Pillai,1996 Dey *et al*., 2015 http://eprints.cmfri.org.in/9874/1/Philipose_11.pdf Pillai1996, http://www.fao.org/docrep/X5627E/x5627e06.htm, Jyoti S. *et al*., 2016 Krishnamurthy, 1987[25], DOD & SAC, 1997 Pillai & Jasmine1989, SAC, 2010, http://niobioinformatics.in/corals/corals, Pillai,G.,1996
2	Kerala coast	6	≈. 05	29	Fringing reef	Artificial	
3	Palk Bay(9 °17'N and 79° 15') (BOB, Indian Ocean) TN	2	≈.600	>60	flat reef and sandy beaches, fringing reef	Rameswaram, soft corals, octocorals and other sessile benthos	
4	Gulf of Kutch 22 º 15' - 23º 40' N 6 8º 20'- 70 º 40' E, Gujarat, Arabian Sea	40	352.5	37	Platform reefs and fringing reefs (patchy)	All corals, Acro- pora, Pocillopora, Stylophor	
5	Gulf of Manner (78° 12' E and 79° 14'E) the Indian Ocean	21	94.3	96	Fringing reef, Shore platform, patch,	coral pinnacles & atolls Tuticorin- Rameswaram Biosphere reserve).	
6	Lakshadweep islands 19-12 ºN 72-74 ºE, Arabian Sea	36	933.7	105	Atolls (12) 3 reefs, 5 submerged banks)	Acropora, Porites, Diploastrea, Helio pora, Goniastreareti formis & Lobo phyllia. *Restricted area*	
7	Andaman & Nicobar island (A&N),10º 30' - 14º N 92 - 93º E & 6º 30' - 9º 30' N 93 - 94º E, BOB	572	1021	82(An) 103, (Ni)	Barrier reefs & Fringing reefs	M. G. MNP Park at Wan door, fringing reefs	

4.2.2 Marine Species coverage India

ISFR 2017 reported that the total mangrove cover in India is 4921 km2 (has enlarged by 181 Km2 in 7 out of 12 mangrove states). Mangroves have a unique biome instituted in the estuaries, creeks, lagoons, marshlands and mudflats. These mangroves have enriched flora and fauna that provides numerous eco-utilities. Table 9: The marine biodiversity of and species in India http:// iced.cag.gov.in/wp-content/uploads/2016-17/) & Wafar et. al. (2011) Venkstratnm K., 2005 had reported that the coastal marine system of India had 844 species of seaweeds (highest Palk bay: 302species), Sponges of 65 families 169 genera, and 451 species (highest 275 in Palk bay), hard Corals of 15 families 60 genera, and 218 species (highest in 180 species in Nicobar islands) UNEP-WCMC and IUCN (2018). Status of marine species in and around Indian territory is given in Table 7.

4.2.3 Marine Ecosystem services

The utilities provided by the mangroves are fisheries, recreation, coast stabilization, storm protection, and carbon sequestration. The other contributions are water and air purification, waste assimilation, nutrient retention, and bio-diversity reservation. The widespread mangroves along the east coast are Godavari – Krishna (A.P.), Sundarbans (WB), Bhitarkanika, Chilika (Odisha), A&N islands and Pichavaram mangroves along the east coast of India. In west coast of India, the mangroves are found from Bombay to Panaji and in the Lakshadweep islands of India. Indian coastline is home to 25 families, 63 genera and 69 species. The Floral and faunal species were 420 and 1862,

Table 7: Marine species population coverage in marine areas India

Marine Species	Population	Species	Populn	Species	Populn.	Species	Populn
Protista	1064+	Brachiopoda	3	Echinodermata	765	**Marine Plants**	
Animalia		**Arthropoda**		Hemichordata	12	Diatoms	200+
Porifera	486+	Crustacea	3498	**Chordata**		Dinoflagelates	90+
Cnidaria	842+	Pycnogonida	16	Protochordata	119+	Macro algae	844
Ctenophora	12	Merostomata	2	Pisces	2546	Sea grasses	14
Platyhelminthes	350	Sipunculida	35	Amphibia	3	Mangroves	39
Gastrotricha	75	Echiura	33	Aves	145		
Kinorhyncha	99	Tardigrada	3310+	Mammals	29		
Annelida	338	Chaetognatha	30+	Reptiles	35		
Mollusca	3370	Entoprocta	8	Aves	145+		
Bryozoa	200+	Phoronida	3	Mammalia	25		

4.2.4 Key issues with Marine ecosystem

It is forecasted that Global marine ecosystem shall be unsustainable and degraded by 60% by the year 2100. About 35000 Km^2 of mangroves has been removed globally from great acceleration period of the Anthropocene epoch (1980 to 2010). World's Ocean area (1%) and land mass (12%) only have been protected from biodiversity losses and rest are left for human exploitation. The phytoplankton in marine climate provides about half the oxygen of the globe. The Sea shall be an inhospitable area for marine flora and fauna in future. It is estimated that mangroves, salt marshes and meadows of seagrass can absorb, or retrieve carbon from CO_2 @ 50 times in comparison to the identical area of tropical forests Mishra S. P. 2017[51]. Ocean acidification has invited catastrophe for the vast aqua fauna ecosystem, which derives ≈15% of present food from the sea. The concentration of CO_2 which was almost constant (≈ 250PPT) during pre-Anthropocene epoch has crossed 400ppm at present. Hence the biodiversity of the marine ecosystem is under apocalyptic jeopardy which needs immediate attention. Direct and indirect disposal of all liquid wastes, excess use of pesticides and nitrogen-rich fertilizers are the main drivers of the threat. When the rivers discharge to sea, pollute the marine water hypoxic and form dead zones in the offshore region http://www.unesco.org/ new/en/natural-sciences/ ioc-oceans/ focus-areas/rio-20-ocean.

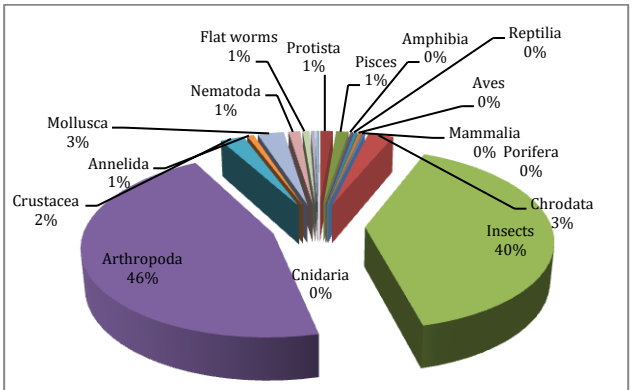
5. Endemic species in India

Endemic species grows naturally in an isolated/single geographic area of small or large size depending upon their geographic range, population size, and habitat demands. About 6850 species of Indian flora were estimated endemic (60% of flowering plants). The endemic species in major biogeographic areas are Eastern Himalaya and North-eastern region (2500), Western Ghats and Peninsular India (2600), North-Western Himalaya (800) and Andaman & Nicobar Islands (200) https://www.ukessays.com/ dissertation/examples/biology. The endemic species are concentrated in Himalayas, A&N Islands and WG Hills. About 3169 species grow in the Himalayas and 2045 species in Peninsular India including Nepal and Bhutan Chatterjee (1962)[52]. Balakrishnan (1996)[53] estimated > 6100 endemic species out of total 17500 species of flowering plants (more than 36%) in India.

Nayar (1996) mentioned 147 genera and 5725 species of flowering plants as endemic to the Indian region. The threat to endemism occurs due to habitat loss, overhunting, invasive species, non-active predators, disease-causing species, competitors, fragmentation and above all anthropogenic interventions due to draining and filling of freshwater wetlands. http://mjcet envsci.blogspot .com/2013/11. About 55 species of birds are endemic to India found mostly in the Western Ghats, eastern India along the mountain chains and the Andaman and Nicobar Islands.

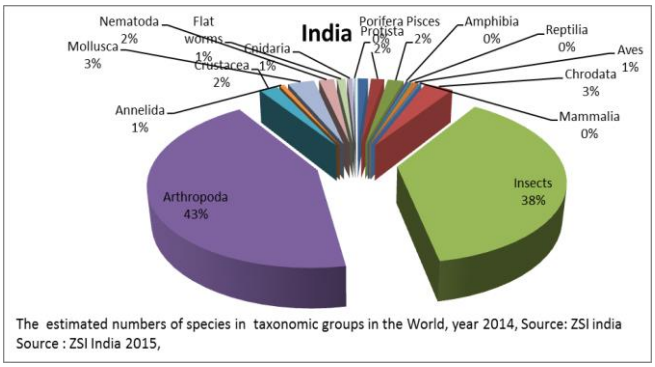
5.1.1 Species/taxa listing

The (IUCN), reported 1,737,248 numbers species out of which 26197 numbers of species are threatened (2018) **(Fig 4).** IUCN has identified 973, 988 and 1067 threatened species in the years 2014, 2015 and 2018 respectively with an increased trend in India. It is found that the highest numbers of taxa are Arthropods (43%), followed by Insects (38%) of the total taxonomy and mammals are 4629 in numbers.



The estimated species (%) in taxonomic groups in the World, year 2014, Source : ZSI India 2015

Fig 5: Different major species exists throughout the world (Source: Zoological Survey of India)



The estimated numbers of species in taxonomic groups in the World, year 2014, Source: ZSI india
Source : ZSI India 2015,

Fig 6: Status of flora and faunal species changes in of India (Source: ZSI – 2015)

Table 8: Biodiversity changes of India and the globe inclusive Indian marine Biodiversity, IUCN 2018, Arisdason et. al.,2017, .http://www.bsienvis.nic.in/Database/Floral_Statistics_of_India_2017,http://www.envfor. nic.in /soer /2001 /ind_bio.pdf & http:/ /cdn. Intech open. com/pdfs/46541

VERTEBRATES	Species MOEF 1999	Species Population 2018	Threatened species (2007)	Threatened (2018)	Species Population (1998)	ZSI species 2017	Endemic Species 2018	Endemic Threatened IUCN (2018)
	THE GLOBE				**INDIA**			
	No	No	No	No	No	No	No	No
Mammals	4629	5677	1094	1210	390	427	46	28
Birds	9026	11122	1217	1469	1232	1340	74	23
Reptiles	5817	10711	422	1236	456	572	0	0
Amphibians	5150	7866	1808	2100	350	388	167	70
Fishes	21723	33900	1201	2385	2546	3324	7	1
INVERTEBRATES								
Insects	987989	1000000	623	1478	53400	65047	NA	NA
Molluscs	66535	85000	978	2195	5070	5189	5	0
Crustaceans	31259	47000	460	730	2934	3796	60	3
Velvet Worms	119	165	9	9	1	1	0	0
Others	87121	68658	24	146	20752	20609	0	0
PLANTS	BSI 2009				BSI 2009			
Mosses	14500	16236	80	76	2500	2478	NA	NA
Ferns and Allies	10000	12000	139	246	1200	1289	0	0
Gymnosperms	650	1052	321	401	67	79	4	3
Flowering Plants	250000	268000	7899	12049	17527	18386	4	3
Algae	40000	13154	9	9	7175	7357	NA	NA
Lichens	13500	17000	2	10	2223	2511	NA	NA
Virus/Bacterias	8050	11813			850	986		
Mushrooms	1200	31496	1	33	10000	15115	NA	NA
Brown Algae	NA	3784	6	6	0	0	NA	NA
TOTAL	NA	1737248	16308	26197	NA		NA-Not available	

But in the case of arthropods the numbers of species were 46%, the insects are 40% and corresponding Mammalia in India were 423 in the year 2014. From the distribution of species it is inferred that the arthropods and insects are large in number whereas the amphibians, reptiles and mammals are the least in number in the globe and so also in India **Table 8.**

5.1.2 Statistics of Domesticated Farm animals

There are evolutionary interactions of mammalian (family Bovines) species used for agricultural activities and food production by domesticating wild animals since the Holocene epoch. India has 12 primary aboriginal cultivated plants centers and domesticated animals https:// www.omicsonline.org/blog/ 2015/ 08/27/19447. It has the homeland of 167 endemic plant species of cereals, fiber crops millets, fruits, condiments, vegetables, pulses, and oilseeds, and 169 breeds of domesticated animals. Global enumeration of the livestock's was done during the current Anthropocene epoch from mid-20th century only. ICAR-National Bureau of Animal Genetic Resources, Karnal (NBAGR) have recorded in 2017 that nine new classes of livestock and poultry *i.e* goat (2 breeds), and cattle, pig, horse, chicken, and indigenous geese, yak, duck one breed each. Present enumeration of indigenous breeds of India is 169, including cattle (41nos), Buffalo (13 nos), goat (28 nos), sheep (42 nos), horses & ponies (7 nos), came (l9 nos), pig (7 nos) , one (1no) each for r donkey, yak, duck and geese and for chicken (18 nos). So also there are evolutionary relationships

between aqua fauna and avifauna used for nutrition and agriculture production. Such birds are an emu, nandu, ostrich, turkey, ducks, goose, chicken and many more Table 9. Studies reveals that the growth rate of the chicken has the highest increase in comparison to any other birds and animals Mishra *et al*, 2018.

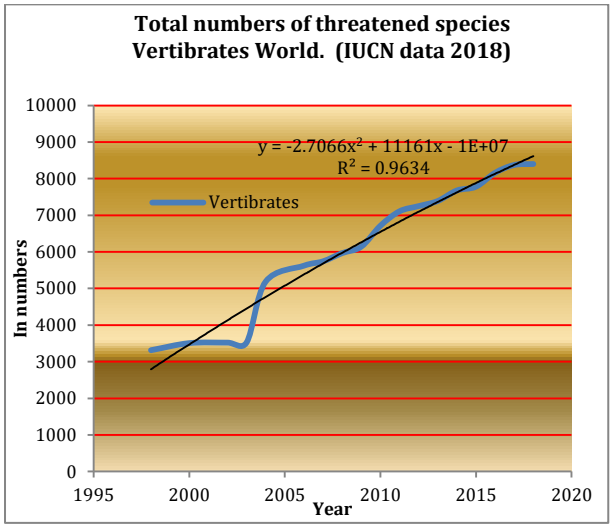
Table 9: Status of Domesticated Bovines species of the world, Asia, India and Odisha during 2017

Bovine	World	Asia	India	India	Odisha	New reports	Species (Odisha)
Species	FAO-2000	FAO00	ICAR2016	NBAGR 2017	Das -16	NBAGR	Das *et al*., 16
Cattle	787	190	30	41	5	1, Laxmi, Assam	Chilika, Birnjharpuri, Motu, Ghoomsoori & Kharial
Buffalo	72	57	10	13	7	No addition	Chilika, Manda, Arani, Kujanga, Jirangi, Kalahandi, parala khe mundi
Sheep	910	226	42	28	9	Nil	Kendrapada, Ganjam, Kuzi, Bolan gir, Machhakund, Erka, Kathargada, Dharmgada, Chhotanagpuri
Goat	351	126	22	42	7	2, Salem black TN & Sumine Nagaland	Malkanagiri, Black Bengal, Gan jam (plains, & Hills), Raighar, Koraput and Narayanpatna
Pig	353	157	3	7	4	Zovawak, Mizoram	Burudi (KPT), Golla (Ganjam),Jhinga, and Wild
Ass/Yak	77	17	3	2	1	1, Yak,Arunachali	Nil
horse/ponies	384	72	6	7	Nil	Kachchhi-Sindhi West India	Nil
Camel	56	14	8	9	0	nil	Nil
Poultry	606	72	18	18	6	1, Hansli, Odisha	Phulbani, Dhinki, Aseel, Vezaguda, Hansli, Hazara, Kalahandi
Ghoose/Duck					3	2, Kashmir Anz (J&K), Pati (Assam)	Rajhansa, Muskovy, Koraput,

(Source: http://www. nbagr.res.in/registeredbreed.html and finding

5.2. Red Listed Biodiversity

Polynomial model indicating the number of threatened species is increasing gradually and the globe may be heading towards mass extinction. The IUCN Red-listed data 2018[43] of the total numbers of threatened species of the globe and their trend is exhibited in **Fig 10 (A)** for vertebrates and the data indicate that the plant Taxas are becoming more endangered in India followed by fishes **Fig (10B)** for invertebrates.



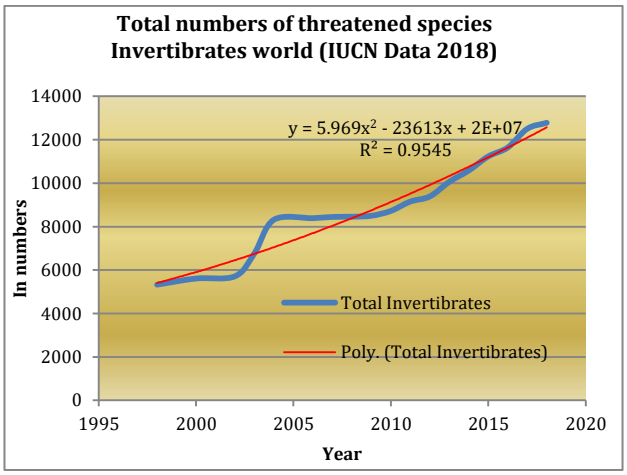


Fig 10: The Global trend of threatened species Vertebrates (A) & Invertebrates (B) (source: IUCN 2018)

The present time series data can be statistically analyzed as the coefficient of regression is 0.9634 (Fig 6A) for vertebrates and 0.9534 (Fig 6B) for invertebrates. The regression model of the series of data follows an increasing Enumeration of the major threatened species in the global scenario enlisted by IUCN in its major category has been published in the current year 2018. The annual changes in the numbers of species though could not picture the trend profile as

new threats impinge but the main threats for the change remain persistent. However knowing the time series of the number of threatened species, some concept of the trend could be derived in the status of biodiversity. The interrupted time series from 1996 to 2006 and continuous time series onwards till 2018 have been considered. R^2 is considered as a statistical measure of how close the data are to the fitted regression line.

The IUCN has listed classification of existing, extant and extinct species for future biodiversity enumeration, conservation and management used by the environmentalists. The existing extant species assessed by IUCN and reported as EW - Extinct in the Wild, CR - Critically Endangered, EN - Endangered, VU - Vulnerable, NT – Near, Threatened, DD - Data Deficient, LC - Least Concern.

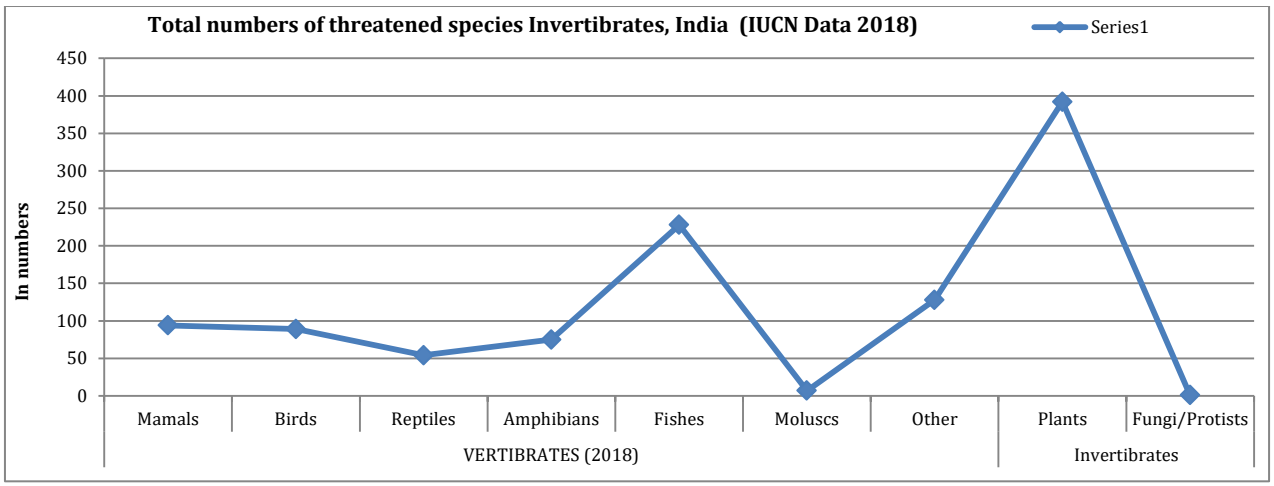


Fig 11: Total numbers of threatened species (animals & plants) India, (Source IUCN 2018)

As per IUCN report 2018[43], the accepted percentage of threatened species cycads plants (63%), amphibians (41%), reptiles (35%), dicots (35%), conifers 34%, corals 33%; sharks & rays 31%, crustaceans 27%, mammals 25%, birds 13%, fishes 7.5%, gastropods (snails) 7.5%. The discontinuous time series data for the period 1996 to 2018 of the critically endangered faunal species of the vertebrates and invertebrates were studied and are in **Fig 11**

5.2.1 IUCN Statistics and Classifications

The features that contribute to the variant biodiversity of the globe are topography, elevation, wetlands, forests, ocean, grassland, deserts, position on the earth, coastal, marine biome and the anthropogenic pressure. Different species harboring earth surface and their changes in 21st century indicate that species like amphibians have suffered more than other species from 2003 onwards. Reptiles and the fishes are also becoming critically endangered (CR) from 2012 onwards in the world **Fig 12 and Fig 13**

The data series of IUCN 2018 depicts the mammalian population inclusive the Homosapiens are changing erratically. The coefficient of regression values (R^2 values) obtained as 0.797 and the best fit statistical model is a polynomial function. There is a rise in the trend line of threatening of mammalian species in the 21st century. In overall there is an increase in the number of endangered species and the sixth extinction is inching forward in the 21st century of the Anthropocene epoch **Fig -10.**

The barriers and the limiting factors that change in the population of any species that makes difficult for its growth, survival, or reproduction are climates, temperature, altitude, invasive alien species, topography, moisture, CO_2, light, nutrients, water quality, ambient air, habitation, and above all the anthropogenic activities. The invasive alien species (IAS) is the species that has anthropogenic intrusion to a native bio-system from outside of its usual past or present dispersal and whose invasion (become 5-20%) threaten or have a negative impact and problematic to the existing biological diversity. All IAS are not problematic in nature. The time series status of mammals is in **Fig 14 (a) & 14 (b).**

Species invasion is geospatial and dynamic but generally slow and complicated. It is influenced by the geologic, geomorphic and meteorology of the area. Invasion and extinction may disrupt or change the ecosystem partly or completely. Presence of IAS may split and gradually vanish. India has 1,599 species of alien plants of 841 genera and 161 families. The invasive and alien species shall tend to reduce the population size of other species by reducing their birth rate and immigration of other species. The causes of invasion of species occur due to the land breeze, by climatically and ecological paths or by sweepstake paths such as crossing mountain ranges or large water bodies. Generally the species have complex dynamic distribution with geospatial dawdling changes which may be permanent or temporal. IAS can alter the structure and composition of an ecosystem or even detrimental to the Eco services. For example the ipomeas and hyacinth (the aquatic plants) which is aboriginal species growing in water surface of South

America has become IAS to continents of Africa, Asia and North America. The profuse invasion of species has badly affected the eco-health of water bodies by blocking and choking drainage system, navigation channels and canals so that the hydropower capacity, yield of crops, aqua catches, faunal diversity and accelerating the vector-borne diseases.

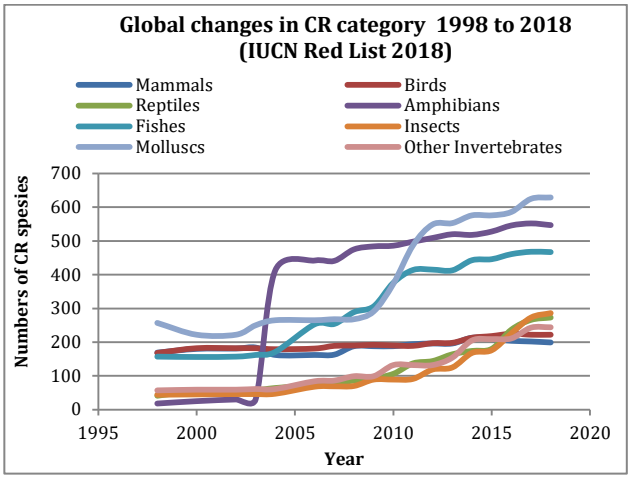


Fig 12: Global changes in the number of CR species 1996-2018; IUCN Red List 2018

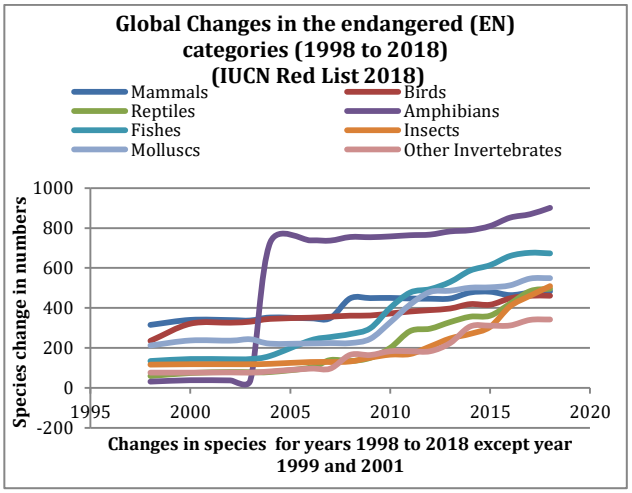
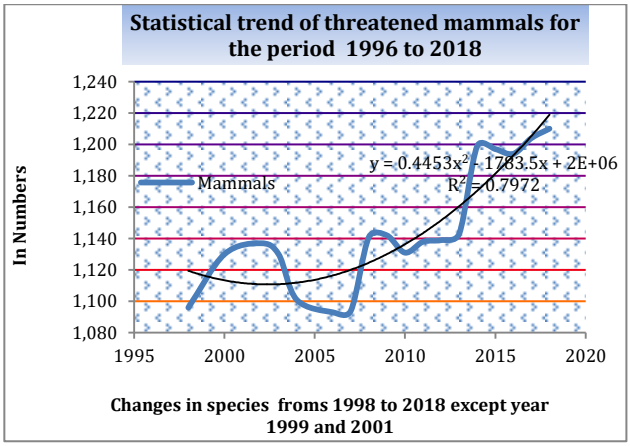


Fig 13: Global changes in the number of endangered species 1996-2018; IUCN Red List 2018



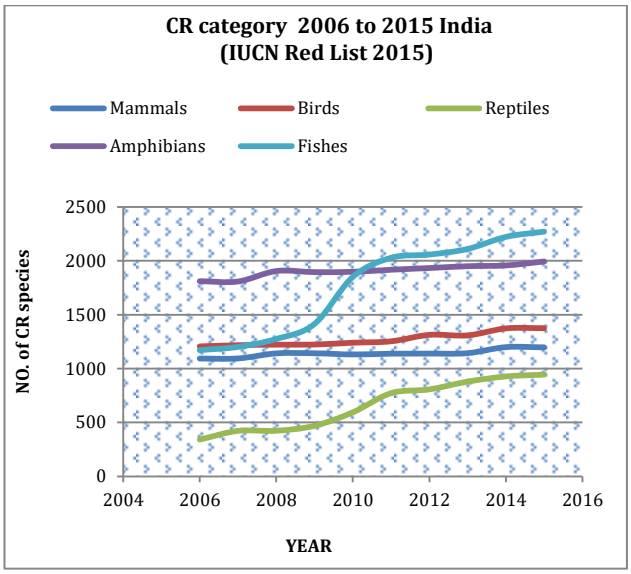


Fig 14 (a) & 14 (b): The changes in the population of mammals for period, India, 1996 to 2018 (IUCN 2018)

5.2.2 The invasive alien species

Species invasion is geospatial and dynamic but generally slow and complicated. It is influenced by the geologic, geomorphic and meteorology of the area. Invasion and extinction may disrupt or change the ecosystem partly or completely. Presence of IAS may split and gradually vanish. India has 1,599 species of alien plants of 841 genera and 161 families. The invasive and alien species shall tend to reduce the population size of other species by reducing their birth rate and immigration of other species. The causes of invasion of species occur due to the land breeze, by climatically and ecological paths or by sweepstake paths such as crossing mountain ranges or large water bodies. Generally the species have complex dynamic distribution with geospatial dawdling changes which may be permanent or temporal. IAS can alter the structure and composition of an ecosystem or even detrimental to the Eco services. For example the ipomeas and hyacinth (the aquatic plants) which is aboriginal species growing in water surface of South America has become IAS to continents of Africa, Asia and North America. The profuse invasion of species has badly affected the eco-health of water bodies by blocking and choking drainage system, navigation channels and canals so that the hydropower capacity, yield of crops, aqua catches, faunal diversity and accelerating the vector-borne diseases.

5.2.3 Protected Area network (PAN)

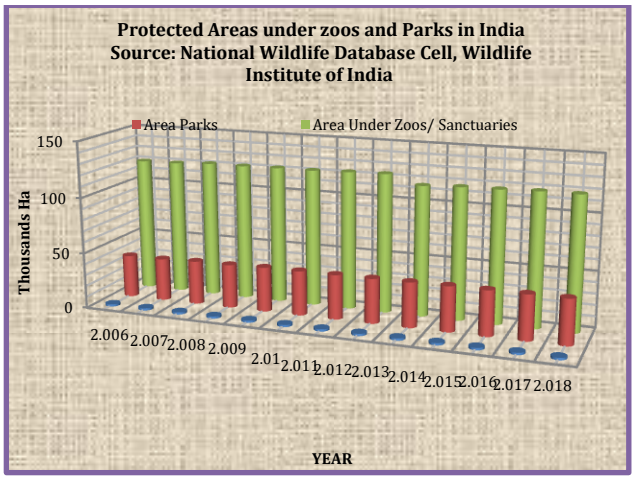


Fig 15: The protected areas under zoos and Parks in India (source: Wild Life Inst. Of India)

The biodiversity of India is under threat due to combined effects of natural and anthropogenic. Natural causes can be calamity and competition between species and IAS to create biological imparity while the anthropogenic pressures are deforestation, population growth, food production, agriculture, mining, urbanization, industrialization, grazing, over-exploitation flora and fauna, enhanced mobilization, tourism. The utmost need of the great acceleration period of the present Anthropocene epoch we must have widespread and well demarcated protected areas for the uninterrupted habitation of the species. A large Network has been initiated by the federal government to protect the flora and fauna of India by the state forest departments. The protected areas cover 4.8% of the total geographical area of the country. The protected areas under zoo and botanical parks in India are in **Fig 15.**

Table 10: Status of the prominent national parks, Area, IUCN types and the year of establishment in India

#	Category	Total No.	Biodiversity zone (Name)	State	Famous Fauna	IUCN Type	Area Km^2	Year
1	National Parks (NP) Prominent	116	Jim Corbett	Uttarakhand	Tiger	IV	1319	1936
			Similpal	Odisha	Elephant	III	846	1980
			Gir	Gujarat	Lion	IV	1412	1965
			Kanha	MP	Tiger	IV	940	1973
			Sundarban	WB	Tiger	I	1330	1984
			Namdapha (Changlang)	Arunachal	Tiger, Leopard	IV	1809	1983
			Bandipur	Karnataka	elephants		874	1974
			The great Himalayas	H. P.	Snow leopard	VI	755	1962
			Kaziranga	Assam	rhinoceroses		860	1974
			Great Rann	Gujarat			7055	2002
2	Marine NP	1	Gulf of Kutch	Gujarat			873	1982
3	Forest reserve	1	Kohli Khera	Hariyana			06	1975
4	Games reserve	2	Lung Nag	JK		V	400	
			Gajneer	Gujarat	Blue Bulls		6.0	

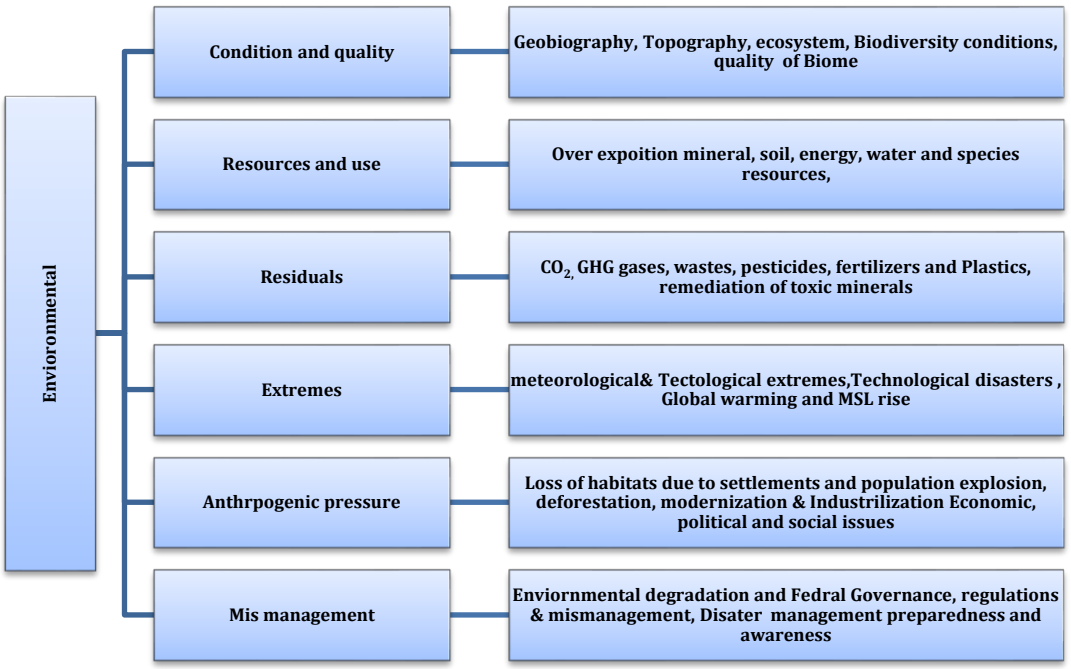


Fig 16: The causes/Framework for reverse gearing for biodiversity distortion in India

Table 10: The RAMSAR Convention Sites in India, https://www.pmfias.com/ramsar-sites-india

Sl No	Ramsar site	State	Area (Km^2)	Sl No	Ramsar site	State	Area (Km^2)
1	Chilika lake	Odisha	1165	15	Koleru lake	AP	901
2	Harike wetland	Punjab	41	16	Bhitarkanika	Odisha	650
3	Keoladeo NP	Rajasthan	28.7	17	Tsomoriri	J&K	
4	Loktak lake	Manipur	266	18	Point Calimere	TN	385
5	Sambar lake	Rajasthan	240	19	Sasthamkota Lake	Kerala	3.73
6	Wular lake	J & K	189	20	Bhoj Wet;land	MP	32
7	Kanji lake	Punjab	1.83	21	Vembanad-Kol WL	Kerala	1512
8	Ropar lake	Punjab	13.65	22	Hokera WL	J&K	13.75
9	East Kolkata WL	WB	125	23	Chandertal WL	HP	0.49
1	Deepor Beel,	Assam	40	24	Renuka Wetland	HP	0.20
11	Astamudi Lake,	Kerala	614	25	Rudrasagar Lake	Tripura	2.4
12	Pong Dam Lake,	Himachal Pr.	156	26	Upper Ganges R. Brijghat to Narora	UP	266
13	Deepor Beel,	Assam	40	27	Nala Sarovar Bird sanctuary (2012)	Gujarat	123
14	Astamudi Lake,	Kerala	614		WL- wetland		

6. Discussion

India became a State Member of IUCN in 1969, through the Ministry of Environment, Forest and Climate Change (MoEFCC). About 15,000 flowering plants, 2546 numbers of fish species, 198 numbers of amphibians, 423 species of mammals, 408 numbers of reptiles and 1331 species of avifauna harbor in India. Out of all the habitats 33% of species are endemic. Species like Nilgiri Tahr, Wild Ass, and the Lion-tailed Macaque of 44 taxa of species are in the endemic list of the country. IUCN had reported India had 47species in 2011 and 132 species in 2012 (Rio summit) critically endangered in India. As per the WWF, India's report on 2018, there were 1,00,000 Indian tigers during the early 20th century whereas at present there are only 2,226 tigers left in India due to anthropogenic factors. The world has lost about 95% of its tiger's population as they need 25000 acres per tigers There are around 187 endemic reptiles, and 110 endemic amphibian species in India. Moreover the human species in form of tribal, aboriginal people of the Biogeographic region need to be preserved to sustain our ecosystem. http://india endangered. com/facts-you-did.

Biodiversity Services

The trifold services provided by the biodiversity of a region are ecological services, biological and social services. The ecosystem provisions are formation and purgation soil and water, climate stability, Nutrient storage whereas the biological services provided are as food, shelter, medicine, fuel, households, orchids, diversity of genes. The social services are cultural issues, research, education, monitoring of species statistics, recreation, tourism.

6.1.0 Indian federal policies for the preservation of species

The Preservation Acts are instituted and administered under the provisions of the Wild Life (Protection) Act, 1972, with subsequent amendments. The forest conservation acts constituted as Indian Forest Act, 1927 subsequently revised Forest (Conservation) Act, 1980, Environment (Protection) Act, 1986 and Biological Diversity Act, 2002 and the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. In order to strengthen wildlife conservation within inter-continent and interstate, India became a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in 1976, International Union for Conservation of Nature (IUCN) in 1983, International Convention for the Regulation of Whaling, UNESCO-World Heritage Committee and Convention on Migratory Species (CMS). The National Mission for Green India (GIM) is one of the eight Missions under the National Action Plan on Climate

Change (NAPCC) with the objective to protect; restore and enhance India's diminishing forest cover and retorting to climate change. It focuses on multiple ecosystem services, biodiversity, water, biomass, mangroves, wetlands, critical habitats with carbon sequestration as a co-benefit on PPC mode. The causes for biodiversity and framework for reverse gearing are in **fig 16.**

6.1.1 The RAMSAR Sites India

The RAMSAR convention has prepared an inventory of Wetlands of global importance for the protection and sustainable usage of wetlands, considering the economic, cultural, scientific, and recreational value of their stakeholders. India has 27 such sites whose details are given in **Table 10.** The RAMSAR convention constituted in 1971 provides "ecosystem services" which provides to the stake Holders of the wetlands from aspects of humanity, freshwater supply, food, habitation, and biodiversity, flood control, groundwater, and climate change. About 64% of the wetlands of the globe have disappeared in the last cen19th and 20th century due to anthropogenic activities and climate change.

In the present epoch, many a species and taxa's have been preserved in name of religion by the ethnic and the aboriginal people. The global protected areas network on land mass has grown significantly in the 21st century. The MPN areas are neglected due to unplanned development work, fishery and projects like power plants and ports. Although all regions have extension in both their marine and terrestrial networks, the global marine area covered by protected areas is still very much under-represented. However, an increasing number of large marine protected areas have been designated over the last few years and it is hoped that this trend will continue so that there is a sufficient marine coverage to protect biodiversity. The Chilika Lake which was a RAMSAR site (Site No 221) was uplifted from Monteux record 2002 due to the overall development of the lagoon.

Conclusion

The last two decades of the 21st century have witnessed apocalyptic acts of nature, the dramatic changes in its biogeography, biodiversity, stratigraphy, mineralogy and the celestial doldrums to name it as the period "Golden Spikes or the great acceleration" in the novice Anthropocene epoch. Our biosphere is an aggregation of flora and fauna found in landmass, and oceans. The biodiversity contributes to variant genetic, species and ecosystem are due to biogeography, geomorphology, limnology and topography, of the area which is under the anthropogenic stress.

The makers of the epoch, the Home Sapiens have tried to catalog the number of extant species and the numbers threatened, and extinct. With a very small time series data it shows only the amphibians are the worst affected followed by the mammals by the erratic climatic changes under anthropogenic pressure.

Since time series record available is scanty, a clear study about the trend, vulnerability, extinction and model development as per the specific biogeography of the area shall be clear and productive. However present study reveals the amphibians, mammals are more susceptible to be threatened, vulnerable and extinct. The pollution, damming, IAS have threatened the endemic fish population. Since the kingdom of protists and microbiology has been less explored, needs to be stressed as they are the worst killers. The huge Oceania species kingdom on the earth should be the focused area of every biologists and data availability is scanty. The flora and fauna of the east coast of India, EGB Hills range are destroyed in the names of human progress which is one of the important migration paths of the Palearctic avifauna and the wild animals.

But the biodiversity has suffered irreversible damage due to anthropogenic activities like urbanization, deforestation, industrialization, tourism, mining and growth in population. Many of the species have become extinct, endangered and threatened `and the gradual increase in their numbers may point to the fact that globe is probably heading towards sixth mass extinction in due course. The present activities of the modern man should be the reverse gear of the technology advancement.

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