

Biodiversity Conservation in India: Techno-Legal Aspects in Current Scenario

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Abstract—Biodiversity is a comprehensive term for the variety and variability of all living forms like plant, animals and microorganisms. It encompasses variations present at genetic, species and an ecosystem at particular time and place. Biodiversity builds a web of life where human beings are an integral part and playing key role in its destruction and conservation. Great number of tribal populations in India is greatly dependent for natural resources directly obtained from biodiversity along with linked traditional knowledge and social belief of general public. Apart from the benefit associated with biodiversity, diverse threats such as habitat destruction, habitat fragmentation, pollution, over-population, overexploitation of resources, invasive alien species and climate change are causing rapid decline in biodiversity across globe and making biodiversity conservation a great challenge. Thus, there is need of hour to integrate all efforts at all level to ensure biodiversity promotion and conservation. There are many strategies under the ex-situ and in-situ methods have been evolved, adopted and executed. These strategies are well supported by legal instruments such as policies, acts, rules and regulations within the constitutional and international legal frameworks. Biological diversity Act 2002, The Indian Forest Act 1927, The Forest Conservation Act, 1980, Tribal Rights Act, 2005, Environmental Protection Act 1987 and rules thereof are key legal instruments directly involved in biodiversity conservation. Indian Courts are also proactive and have delivered many judgments supporting biodiversity conservation. This paper is effort to highlight current biodiversity status, challenges, various laws, policies implemented, classical different advanced tools and techniques such as environment DNA, DNA barcoding, geoinformatics, Remote sensing, camera trapping, GIS and GPS along with basic sciences for database management, monitoring, and interpretation of biodiversity for conservation.

Keywords: Biodiversity, conservation, environmental laws, traditional knowledge, threats.

1. INTRODUCTION

Bio means life and diversity means variety and variability of plants, animals and other organisms present in marine, terrestrial and water ecosystem [1]. However, the simplest definition of biodiversity is the variation of life at all levels of biological organisation [2]. Biodiversity is an inseparable part of human survival and evolution. The mention of protecting biodiversity can be found in the ancient times in the reign of Chandragupta and Ashoka. In those eras, the trees and forest were protected considering their natural importance. The term

"Biodiversity" generally includes Genetic diversity, Species and Ecosystem diversity [3]. India is known for its rich heritage of biodiversity. It is one of the 17 mega-diverse countries in the world. Although, India constitutes only 2.5% of the total earth's land area but it has around 8% of the total biodiversity present in world which includes millions of species and subspecies [4-6].

The distribution and magnitude of biodiversity which we have today have evolved over 3.5 million years as a result of several factors such as speciation, migration, extinction and recent human influences during the years. Biodiversity is most threatened due to the increasing anthropogenic effects on forest, wetland other biodiversity rich ecosystems. As a result, the foundation of sustainable development is also threatened. The core threats to biodiversity are human population growth and unsustainable use of natural resources (over-exploitation) to fulfil their day-to-day needs. Today, the most significant causes of biodiversity loss are habitat loss, introduction of exotic species, deforestation, overpopulation, over exploitation, habitat destruction of biological resources and pollution [7].

Climate change is predicted to be a significant cause of extinction of many species of plants, animals and microorganisms in the coming century. Moreover, unauthorized trade of high value wildlife products and unsustainable uses of resources have seriously threatened many species. Loss of biodiversity threatens our food supply chains, sources of wood, medicine and energy etc. and most precious ecosystem services like oxygen, soil enrichment, recreation etc.. The need of the hour is conservation and sustainable use of biodiversity as an integral component of economic development [8,9].

Areas rich in species, rare species, threatened species, or some combination of both these attributes are known as hotspots of biodiversity. These are increasingly being delineated to help set priorities for conservation. The assumptions that determine how useful a hotspot approach can be for conservation planning has to be tested. Several evidences suggested large geographic scales hotspots do provide useful informations

regarding conservation planning but at smaller scales their value may be more limited [10]. There are two basic strategies of biodiversity conservation are *In-situ* and *Ex-situ* conservation [Figure 1]. Conservation of species within their natural habitat is called *In-Situ* Conservation. It involves naturally maintained areas such as Biosphere Reserve, Conservation Reserve, Community Reserve, National Parks (> 100), Wildlife sanctuaries (> 600), Sacred grooves and lakes. Whereas *Ex-Situ* conservation involves the conservation, breeding and maintenance of all endangered species in artificial habitat such as zoos, nurseries, botanical gardens, gene banks, etc. Although conventional methods of conservation mentioned above are very classical and potent, biodiversity is declining at a very rapid rate.

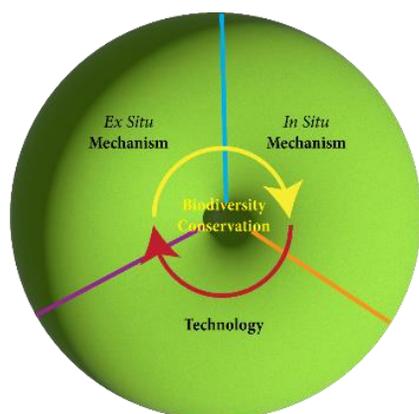


Figure 1: Biodiversity Conservation & Technology

Technologies And Biodiversity Conservation

Human activities are found to be the most important driver for major biodiversity loss and species extinction. For effective conservation of biodiversity meaningful monitoring system is always required with a bundle of human effort. But due to various reasons like bad weather, conflicts and unapproachable sites, human resource are also becomes limiting. Therefore, taking some limitations into consideration, new and novel technologies are available to complement or sometime replace the old classical methods of conservation [11,12]. Computational technologies advancement has revolutionised the field of conservation biology in terms of flora as well as fauna [13,14]. Among various digital methodologies some practical approaches are environmental DNA (e DNA) collection, Camera Trapping (CT), environment sampling by digital sensors, Passive Acoustic Monitoring (PAM), Remote Sensing (RS), DNA Barcoding, Global Positioning System (GPS) and Global Information System (GIS). e DNA, a tool of retrieving DNA sample directly from environment to get information for species, population and community, is emerging and playing a pivotal role in monitoring of biodiversity. This tool is a major breakthrough in the last decade in the field of conservation biology. It is based upon the fact that higher organisms DNA always persists in the environment from where it can be sampled extracted and analysed [15]. The efficacy of e-DNA has been reported for determination of accurate species

distribution of various endangered animals in marine as well as fresh water ecosystem [16]. Moreover, UN scientific organisation has also launched a project in 2021 to protect and preserve biodiversity based upon the study on e-DNA. WWF is also working on this exciting new and novel approach to study polar bears and other species in very non-invasive manner. Several threatened species have already been studied and recovered such as giant catfish, Irrawaddy dolphins with this technique (www.wwf.org/projects2021) [17]. The usage of camera trap and acoustic monitoring is also increasing at a rapid rate for the investigation of wildlife biodiversity. Camera traps is also a non-invasive and cost-effective tool whereas, acoustic recording system records the sounds of various species of animals. It was used for the very first time in 1990 for large mammals conservation and especially focused on tiger [18]. However, these camera traps were used for many flagship species mentioned in IUCN red list to estimate population size. Camera trap with recording system can also evaluate density, distribution, abundance and behaviour at different tropic levels of ecosystem [19,20]. The utility of DNA barcoding was also studied in enhancing biodiversity assessments. It is a molecular tool to classify taxa on the basis of genetic primers of 400-800 bp long. Our understanding about how species evolve, their interaction and how can we slow down their extinction can be easily interpreted by this novel tool [21,22].

Moreover, DNA Barcoding is also playing a pivotal role in betterment and speeding up of the assessments of phylogenetic diversity [23]. This technique has already been used to conserve some tree species such as *Dalbergia* sp., endemic to Indochina region [24]. This tool has proved to be very effective to identify and conserve cryptic species in marine ecosystem threatened by invasive alien species (IAS). Sea turtles, an endangered species, seagrasses, mangroves, marine phytoplanktons and sea birds have already been identified and conserving with this technique [25]. Like many other tools discussed earlier, geo-informatics techniques such as GPS, GIS and RS are also proved to be very advantageous and complimentary for biodiversity conservation and we can easily extract information without coming in contact with that object. These techniques are useful in obtaining the earth observation data globally in very less time and labour. These tools are interdependent and complementary to each other. Habitat classification of mangroves in Sunderban Biosphere Reserve (SBR) has already been attempted. This tool has fulfilled the mapping of grasslands in Gujarat [26]. GIS is also important to store information along with interpretation, visualize and to analyse data in short span of time [27]. The role of RS is to provide raw information of local and global time scale. Some remote sensors record reflected (visible and infrared wavelengths) and emitted energy are mostly used in biodiversity conservation. Satellites such as WorldView, QuickBird, IKONOS are generally used for species mapping. The NASA Landsat series has also proved to very advantageous in ease in data obtaining and low cost. MODIS

and AVHRRR are extremely useful to obtain details about land cover and diversity models [26]. However, all efforts in the direction of conservation go in vain without any law or policies at national as well as international level.

Biodiversity Conservation

Biodiversity conservation is directly and indirectly done with the help of many legal instruments such as constitutional provisions, Acts, Rules and Regulations, Customary and traditional practices. Many Acts have been enacted since British rule, many new Acts are brought to meet current biodiversity loss challenges and Acts have been amended accordingly. Some of the Acts are the Indian Forest Act, 1927; the Wildlife (Protection) Act, 1972; Forest Conservation Act, 1980 were enacted to provide legal protection to biodiversity though forest and wildlife. First National Forest Policy was passed in 1988, which brought revolutionary changes in the conservation and management of biodiversity. Other Acts are in force to protect the environment and biodiversity in India include the Mining and Mineral Development Regulation Act, 1957; the Water and Air (Prevention and Control of Pollution) Act, 1974 and 1981; the Biological Diversity Act, 2002; the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Rights) Act, 2006. Apart from Acts, several rules, policies and plans have been made to protect biodiversity such as Wetland rules, National Biodiversity Action Plan, 2009; CRZ rules, EIA rules and many more.

Indian Constitution and Environment

The Constitution of India was adopted and enacted on 26th November 1949. To ensure biodiversity conservation, initially, no specific provisions were present. Later on, in the year 1976, specific provisions for environmental conservation were added through 42nd Constitution Amendment as article 48-A and 51-A(g) as duty of the state (Directive Principle of State Policy) and citizen, respectively. Under Article 48-A the state has been given duty to protect and improve the environment, forest and wildlife. Whereas, citizens duties embodied in Article 51-A(g) complements by ensuring protection and improvement of natural environment that includes biodiversity conservation implicitly. The states were empowered for biodiversity conservation by incorporating the subject matters like prevention of cruelty of animals (Entry 17), forest (Entry 17-A), protection of wild animal and birds (Entry 17-B) in the concurrent list of seventh schedule of the constitution of India. Such subject matter incorporation wielded more power to states because to enact the legislation on wildlife and environmental conservation [28].

Wild Life Protection Act (1972)

After Stockholm Conference (1972) the urgent need to protect environment and wildlife was agreed. The promises made there was fulfilled by bringing the special legislation for the protection of wildlife (plants, birds and animal species) the Wild Life (Protection) Act, 1972 (hereinafter WPA) by the Parliament of India on August 21, 1972, and implemented on 9 September 1972. The Act defines the term *Wildlife* is defined

under Section 2(37) as “*any animal, aquatic or land vegetation which forms part of any habitat*”. The Act aims for protection of wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensuring the ecological and environmental security of the country. Prior to this Act, the subject matter “*wildlife*” was included in state list of seventh schedule and Union government had no direct power to make any law on this subject that could be applicable to every states. Considering the circumstances and needholistically, Union government brought an amendment in the constitution (42nd amendment, 1976) that shifted subjects like “*Forest*” and “*Protection of Wild Animals*” from state list to concurrent list. The WPA contains 66 section and 6 schedules. Key provisions of WPA are as follows:

1. Constitute institutional mechanism (National Board of Wildlife/State Board Wildlife), appointment of director and wild life warden for protection of wild life with their power procedure and duties to ensure smooth operation of WPA for wildlife and biodiversity conservation.
2. Prohibits hunting of animals specified in schedule I to IV of the Act.
3. Lays down the procedure for declaration of protected areas such as national park, wildlife sanctuary, conservation reserve and community reserve.
4. Regulate possession, access or transfer of or trade in wild animal, plants, animal articles and trophies and taxidermy thereof.
5. Provide penalties for contravention of the act as imprisonment, fine or both.
6. WPA have special provision for protection of plants by prohibiting the picking and uprooting of plants. Governmental licenses are needed for cultivation of specified plants (Opium cultivation) or dealing with specified plants or possession and issues permission for special purpose use (education, scientific purpose etc.). The Act declares that every specified plant or their part or plants growing in particular area are government property.

The WPA under section 38 (a-j) makes provision to establish Central Zoo Authority (CZA). Zoos are an institutional arrangement for *ex situ* conservation. The functions of CZA are to recognize and derecognize zoos across country, promote captive breeding, research and training to the staff, helps in protection and promoting wild life, recreation, spreading awareness and sensitization to society for wildlife and biodiversity. The WPA was amended in 2002 that made forest resource use more stringent and local people were prevented for the commercial use of resources. Recent amendment of Act in 2006, Union government gave legal status to the project tiger by establishing the National Tiger Conservation

Authority (NTCA) and tiger and other endangered species crime control bureau under Section 38(k-y). NTCA works for tiger conservation through approval of Tiger Conservation Plan (TCP) made by states. monitor the tiger reserve, lays down the standard for tourism activity and other duties prescribed through law.

Forest Laws

Forests are natural places to house biodiversity and important component for sustaining healthy environment and source of diverse resources such as oxygen, food, fiber, fuel and responsible for humidity and rainfall, determining the local weather as well as global climatic conditions. In British regime, Indian Forest Act (IFA, 1927) was enacted. The Act consolidates previously existing laws related to forest matters. Later on, to prevent the deforestation and regulation, Union government enacted Forest Conservation Act, 1980 (FCA, 1980). The IFA, 1927 classifies the forest into four main categories on the basis of land ownership and resource access and utilization:

- 1) Reserve forest
- 2) Protected forest
- 3) Village Forest
- 4) Private Forest

Reserve forests are forests where forest resource, land ownership or propriety rights are vested in government. Protected Forest allows resource access to local people but land ownership may or may not be with the government. When the state government assigns the right over any land that comes under the reserve forest to any village, such forests are called as village forest. These forests are controlled by the village community. Private forests are those which are purely owned by private entities and not under propriety of government but have power to regulate private forest by prohibiting cutting of trees, cultivation and grazing like activities. The act also regulates the transit of forest produces and contains provision to levy duty on timber and other forest produces. In this way, the Act tries to classify the forests, levy duty and prevent access of resource to the people. Such ownership diversity and access help in regulation on exploitation of forest resources and thereby helping biodiversity conservation.

Post-independence, the subject matter “forest” was in state list of the seventh schedule of constitution of India allowing only states to enact laws and manage forest. To fulfil the demands of citizens as population rose logarithmically, the state governments diverted indiscriminately forest land for development purpose, industry, settlement and agriculture that led to rapid deforestation and caused great loss to biodiversity and caused widespread concerns. In this light, the subject matter “forest” was transferred from state list to concurrent list through 42th amendment in 1976. To check further deforestation, Union government enacted FCA in 1980. This Act enforced restriction and vested power in Union government to allow the forest land to be used for

developmental purpose with prior approval for following purposes:

- a) De-reserve forest
- b) Use any forest land for non-forest purpose
- c) Lease out forest land to a private agency
- d) Cut naturally grown trees in forest land for the purpose of using it for re-forestation.

Non-forest purpose includes using any forest land for agro-plantation or cultivation, but reforestation is included and can be allowed. Reforestation does not include cutting grown trees without prior approval. Work related to biodiversity conservation, development, management of forest and wildlife or ancillary works are not considered as non-forest purpose. The impact on genetic diversity of forest trees due to habitat fragmentation by human activities is an important concern in forest conservation [29]. The conservation community emphasizes to integrate conservation and livelihood development to explicitly address landscape mosaics composed of agricultural and forested land rather than only protected areas and largely intact forests [30]. Elderly women of a particular socio-ecological system are considered to be "living encyclopaedias" in bio-cultural knowledge systems. These women play a pivotal role in retaining and passing on biodiversity-related traditional knowledge to the next generations. Unfortunately, deforestation and the fast-changing socio-cultural values and the impact of modernity have rendered their knowledge somewhat less valuable and they are being treated as "cultural refugia." It was found that in biocultural knowledge system, elderly women are living encyclopaedias than younger women. Lifelong experiences and cultural diversity were found to influence the significance of biodiversity use and conservation [31].

Biological Diversity Act (2002)

Biodiversity means the variety and variability present in living organisms on earth and includes diversity within species (genetic diversity) and between species (species diversity) and ecosystem (ecosystem diversity). The Biological Diversity Act (BD Act) was brought in consonance with reaffirming the commitment made in UN Convention on Biological Diversity (UNCBD) signed at Rio de Jenerio on 5th June 1992, which was held parallel with the Earth Summit. The Convention reaffirmed the sovereign right of the state or over their biological resources and key principles such as conservation of biodiversity, sustainable utilization and equitable sharing of benefit arising out of utilization of genetic resources and traditional knowledge were accepted. In order to give effect on commitment made at Rio de Jenerio, Indian parliament brought the BD Act. The Act aims to achieve the goals as set in UNCBD by applying the precautionary principle along with establishing three tier institutional mechanism namely, national biodiversity authority (NBA) at union level, state biodiversity authority (SBA) at state level and biodiversity management committees (BMC) at local level [32].

The BD Act makes provisions for preventing unauthorized access and uses (biopiracy) of our biological resources and traditional knowledge by certain persons (foreign nationals, companies) but makes provision to use it by take prior permission from concerned authority or authorities. The BD Act also prohibits the transfer of results of research to any person, companies, NRI where permission and license making any application for obtaining intellectual property (IP) resources approved by authority as necessary. The Act also makes provision for penalties for violation of provisions of the Act. Section 22 of the BD Act, 2002 and rules made there under allows that *'every local body shall constitute a Biodiversity Management Committee (BMC's) within its area of jurisdiction'*. BMC function to prepare peoples biodiversity register (PBR) in consultation with the well-informed locale people having information about availability and knowledge of bioresources. The Act established Biodiversity Heritage Sites (BHS) under Section 37 of the BD Act for biodiversity conservation in an area having rich biodiversity, high endemism, and many other species facing survival threats. State Government in consultation with local bodies may notify in the official gazette and frame rules for the management and conservation of areas of biodiversity importance such as BHS in consultation with Union government. Whereas, there are provisions for framing scheme for ensuring compensation and/or rehabilitation to any person or section of people affected by notification of scheme under Section 37(3).

The examples of BHS established in India are:

1. Dhotrey and Tonglu BHS under the Darjeeling Forest Division, Darjeeling, West Bengal. It is a Medicinal Plant Conservation Areas.
2. Glory of Allapalli, Gadchiroli, Maharashtra. It is a reserved forest being preserved as natural forest having biological, ethnical and historical values.
3. Ambarguda, Shimoga. It is a revenue land located between Sharavathi Wild Life Sanctuary and Someshwara Wildlife Sanctuary. It has Shola vegetation which is primitive vegetation in the Western Ghat along with grasslands.
4. Nallur Tamarind Grove, Benagluru. This BHS spread over 54 acres comprising a population of nearly 300 trees, is a picture of dynamic pattern of plant diversity.

Biosphere Reserve

Biosphere reserve (BR) is one special category of protected area (*In Situ*) consisting of land or sea or both. The unique feature of BR is that it considers the people inhabiting in or nearby protected area as an integral component of the system. The Man and the Biosphere Programme (MAB) was launched in 1971 by UNESCO. It is an Intergovernmental Scientific Programme that aims to establish a scientific basis for the improvement of relationships between people and their

environment. It proposes interdisciplinary research, demonstration and training in natural resource management. The general structure of the BR encompasses core, buffer and transition zones [Figure2.]. It is the core zone which is legally protected undisturbed zone surrounded by buffer zone. The outer most zone that comes in contact with human called transition zone contains human settlements of local people who are actively involved in biodiversity conservation with BR management teams. World Network of Biosphere Reserves currently counts 631 biosphere reserves in 119 countries all over the world and 18 exist in India. The biosphere reserve helps in biodiversity conservation through adopting holistic approach and contributes in sustainable development by allowing research and minimizing the conflict between local people by allowing to use required resource along with their active participation in wildlife conservation.

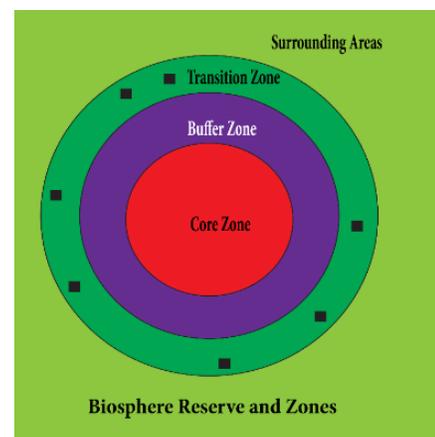


Figure 2: Diagrammatic Representation of Biosphere Reserve & Zones.

Wetland Biodiversity: Conservation Status and Rules

Wetland are lungs of ecosystem, contains great biodiversity and contribute for economic development and livelihood. Wetlands are currently facing great threat due to overexploitation, species loss and habitat destruction. It requires great protection for sustainable utilization by wise use of wetlands. The problem is grave in developing countries in Asian countries including India and China, two highly populated countries [33]. The wetlands play crucial role in ecosystem as they regulate hydrological cycle, support, evolve and maintain rich biodiversity, provide great services to human being and other organisms by storing and purifying water, recharge of aquifer, flood and erosion control making the wetland very highly productive ecosystems. Apart from that they play great role in aesthetic value of landscape, supporting various socio-economic-cultural activities and have become integral part of our rich heritage. But, due to their great utility, many wetlands in India are threatened by reclamation and degradation through drainage and landfill, pollution (discharge of domestic and industrial effluents, disposal of solid wastes), hydrological alteration (water withdrawal and changes in inflow and outflow), over-

exploitation of their natural resources resulting in loss of biodiversity and disruption in ecosystem services provided by wetlands.

Considering the importance of wetlands in terms of possession of great biodiversity, environmental role and social utility, government decided to bring it under legal protection and made the Wetlands (Conservation and Management) Rules, 2010 in exercise of the powers conferred by Section 25, Section 3 and section 23 of the Environment (Protection) Act, 1986. Recently, Union government has brought the Wetlands (Conservation and Management) Rules, 2010 in supersession of 2010 rules with more teeth to give better biodiversity conservation and management. These rules are as per the mandate of National Environmental Policy 2006 and Ramsar Convention 1972 [34]. India is a party to this convention on 01.02.82 and so far, 115 wetlands have been identified across state and UT and 46 wetlands with surface area of 1,083,322 hectares covering 20 States & UTs have been designated as Ramsar sites. The convention allows the wise use and forces conservation of wetlands. The State-wise list of 46 wetlands recognized as Ramsar sites in India. To manage these sites, the centrally sponsored scheme of National Wetlands Conservation Programme (NWCP) was implemented till the year 2012-13 and later merged in February, 2013 with National Lake Conservation Plan (NLCP) under 'National Plan for Conservation of Aquatic Eco-systems' (NPCA) for holistic conservation of lakes and wetlands. The rules made contains provisions of constitution of the National Wetlands Committee, Wetland Authorities, lays down certain restrictions and allows the wetlands shall be conserved and managed in accordance with the principle of 'wise use' as determined by the wetland's authority. The rules also allow the identification of wetlands, listing of activities to be regulated and permitted for notified wetland and its zone of influence, prepare a comprehensive digital inventory of all wetlands. Violation of these rules are made punishable offence. These rules apply to wetlands categorised as 'wetlands of international importance' under the Ramsar Convention wetlands as notified by the Central Government, State Government and Union Territory Administration. These rules shall not apply to the wetlands falling in areas covered under the Indian Forest Act, 1927, the Wild Life (Protection) Act, 1972, the Forest (Conservation) Act, 1980, the State Forest Acts, and the Coastal Regulation Zone Notification, 2011 as amended from time to time (MOEFCC Notification) [35]. Sundarbans, a coastal wetland ecosystem, rich in marine biodiversity and nursery ground for many species. Improper collection of marine target species such as tiger prawn seed (*Penaeus monodon*) has led to its sharp decline along with non-target species such as the juveniles of economic and uneconomic varieties of finfish and shellfish along with a bulk of holoplankters and meroplankters that affects the wetland biodiversity and ecosystem [36].

Biodiversity Conservation in Coastal Areas

The government of India notified new CRZ Rules in 2018 whose key objectives are of promoting sustainable

development and conserving coastal environments by making a no-development zone of 20 m for all island close to coastal and backwater areas. By this rule, all ecologically sensitive areas have been accorded special importance for their better conservation and management. It has made special provisions for pollution reduction in Coastal areas by ensuring treatment facilities as necessary safeguards [37].

Environmental Impact Assessment: A Precautionary Approach

Environmental Impact Assessment (EIA) is an initiative aimed to control environmental and pollution control along with biodiversity conservation by preventing indiscriminate, unplanned exploitation of natural resources and to promote solution of environmental concerns in any developmental projects. The EIA rules are made under the provisions of Environment (Protection) Act, 1986 making EIA mandatory for certain categories of developmental projects [38].

Tree diversity in sacred groves of the Jaintia hills in Meghalaya, northeast India [39], Sacred groves of India act as repositories of a rich heritage and tools for biodiversity conservation [40]. Conservation of biodiversity and techniques of people's activism plays a great and influential role [41]. Rapid increase in population and economy demands better connectivity that leads to development of more transport infrastructure in the form of road, rail track or other pathways. Such development causes encroachment of natural habitat, habitat fragmentation that seriously threatens the biodiversity. After development of such infrastructure, traffic over it causes another threat in terms of accident and prevention of trans-rail or road movement leads to inbreeding that further causes in decline in biodiversity [42]. Lands and biodiversity are increasingly threatened because of human population growth and per capita consumption that have increased demand. Indigenous people inhabit approximately 85% of areas designated for biodiversity conservation worldwide and continue to struggle for recognition and preservation of cultural identities, lifestyles, and livelihoods [43]. Brazil is one of the megadiversity center and harbors great biodiversity. Its agricultural area covers about one-third of the land area and expected to expand further in coming future that will pose threat to its biodiversity. Current threats are minor illegal land use in protected areas under public administration, a large deficit in legal reserves and protected riparian zones on private farmland, and large areas of unprotected natural vegetation in regions experiencing agriculture expansion [44].

Biodiversity Conservation and Sustainable Uses

The Nagoya Protocol on Access and Benefit Sharing (ABS) came into force in October 2014. It provides a legal framework that allows use of the genetic resources for research within the spirit in the Convention on Biological Diversity (CBD) along with meeting regulatory requirements. India has ratified the protocol and introduced for implementing procedures and practices. The aim of ABS of genetic resources is to enable fair distribution of benefits

between the users (such as universities and biotech companies) and providers (such as biodiversity rich countries) so as to both open the doors for innovation and create incentives for biodiversity conservation. Access to genetic resources is crucial for research related to conservation of plant genetic resources as well as R&D for agricultural products and evolved crops that can attain to the new weather conditions climate change brings. Therefore, access to genetic resources in general as well as benefit-sharing from that access is a key element for sustainable development in order to secure research as well as environmental sustainability and resource availability [45]. CBD is implemented by MoEFCC, a nodal agency of Govt. of India with the help of the BD Act in 2002 followed by the rules thereunder in 2004. The National Biodiversity Action Plan (NBAP) is evolved to for promoting biodiversity conservation, sustainable uses and equitable sharing of benefits arising from such use as mandated in CBD. Preparation of NBAP is in pursuance of Article 6a of the CBD, as well as Sections 36(1) and (3) of the BD Act, 2002.

Many countries in Europe, such as the UK, have chosen not to put access controls in place at this time, but others already have laws enacted providing ABS measures under the Convention on Biological Diversity or specifically to implement the Nagoya Protocol. For example, Brazil, although not a Party to the Nagoya Protocol at the time of writing, has Law which entered into force on 17 November 2015, regulated by Decree which was published on 11 May 2016. In this case, export of Brazilian genetic resources is not allowed unless the collector is registered in the National System for Genetic Heritage and Associated Traditional Knowledge Management (SisGen). The process entails that a foreign scientist must first of all be registered working with someone in Brazil and have authorization to collect. The enactment of European Union (EU), Regulation no. 511/2014 implements Nagoya Protocol elements that govern compliance measures for users and offers the opportunity to demonstrate due diligence in sourcing their organisms by selecting from holdings of 'registered collections'. The UK has introduced a Statutory Instrument that puts in place enforcement measures within the UK to implement this European Union Regulation; this is regulated by Regulatory Delivery, Department for Business, Energy and Industrial Strategies. Scientific communities, including the private sector, individual institutions and organizations, have begun to design policy and best practices for compliance. Microbiologists and culture collections alike need to be aware of the legislation of the source country of the materials they use and put in place best practices for compliance; such best practice has been drafted by the Microbial Resource Research Infrastructure, and other research communities such as the Consortium of European Taxonomic Facilities, the Global Genome Biodiversity Network and the International Organization for Biological Control have published best practice and/or codes of conduct

to ensure legitimate exchange and use of genetic resources [46].

The National Environment Policy

The National Environment Policy (NEP) was brought in 2006 to achieve harmonious relation between biodiversity conservation and development processes. The policy further provides framework for the National Biodiversity Action Plan. The policy is intended to streamline environmental concerns in all development activities. The NEP adopts anthropocentric approach where the centre of concerns for sustainable development and they are entitled to a healthy and productive life in harmony with nature. To achieve this, NEP focuses on biodiversity conservation through *ex-situ* as well as *in-situ* measures [47].

Invasive Alien Species & Biodiversity Conservation

Plants, animals and micro-organisms that are not indigenous to a specific ecosystem and become established in a new environment, then proliferate and spread in ways that are destructive to human interests, ecosystems and environment are considered as Invasive Alien Species (IAS). These species cause billions of dollars of damages annually across a wide range of sectors. To prevent the biodiversity loss and ecosystem degradation by IAS Plant Quarantine (Regulation of Import into India) Order, 2003 is the legal tool and utilized [48].

Scheduled Tribe & Biodiversity Conservation

Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act (STOTFD Act) was enacted in 2006 to provide occupational and habitational rights to the people and engaging them in participatory mode in biodiversity conservation as participatory approach of conservation. Empowering people, particularly assigning the ownership of minor forest produce for the purpose of access, processing and trade would enhance their livelihood for sustainable development [49].

2. CONCLUSIONS

The key feature of our blue planet is the existence of huge diversity life forms ranging from bacteria to plants and animals. These life forms play a very important role on the only celestial body known to harbour life in the universe. It is almost impossible for living forms to sustain without support of other living organisms. India is witnessing rapid change in all components of ecosystem because of high population, great economic activities to meet the domestic need and supply of products internationally to sustain economic growth. This is putting high pressure on rich biological diversity available in patches in different regions of country. The pressure is visible as decline in biodiversity due to habitat loss, fragmentation, excessive spread of invasive alien species, pollution, climate change, grazing, deforestation and overexploitation of resources by human beings. Unsustainable development and anthropogenic reasons are the most important cause for this decline. Therefore, there is an urgent need to protect, promote and conserve our biodiversity on priority basis. Modern

technologies' such as GIS, GPS, Biotechnology, Artificial Intelligence, ICT etc., can be greatly helpful. Along with technologies, domestic and international legal regime in changing perspective needs to be amalgamated and/or tuned with current technologies swiftly with new, innovative and stringent provisions with existing laws to get the desired result for faster and efficient biodiversity conservation.

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