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# BIODIVERSITY WATCH

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# BIODIVERSITY WATCH

INTERNATIONAL JOURNAL ON BIODIVERSITY ISSUES

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# About the Journal

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International Journal on Biodiversity Watch is a peer reviewed journal developed to publish original, innovative and novel research articles related to research on Forest Law Enforcement, Forest related policies and laws, Legal framework to support and protect land tenure, ownership and use rights, Concordance of Broader Development Policies with Forest Policies, existence of legal provisions and mechanisms for equitable sharing of forest revenue, cooperation and coordination of national law enforcement agencies, including policy and customs, in forest law enforcement at different levels and across agencies, administration of land tenure and property rights, measures to address corruption, transparency of forest revenue collection, budgeting, expenditure, accounting, redistribution and audit, medicinal plants and practices, Biodiversity Conservation issues, forest governance policy, programs and related issues.

This peer-reviewed scientific journal has been quarterly brought out by VRM Foundation International, Bhubaneswar, Odisha, India.

The Journal publishes investigative and empirical papers covering research findings across the sectors of forest governance, biodiversity conservation, issues relating to climate change, community based conservation, traditional medicine and medicinal plants.

All theoretical and methodological perspectives are welcomed.

The Editorial Board of the journal also encourage the submission of, original manuscript translations, short papers/communications presenting various research based articles related to use of medicinal plants and folk medicine system across different regions of India and world.

## **Aim and Scope**

The main aim of the journal is to publish significant research focusing on Biodiversity Conservation and Forest Governance issues.

This journal aims at publishing investigative research articles covering policies, programs of Biodiversity Conservation, Challenges & threats to forest governance,



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conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity, community based conservation approach and so on.

### **Subjects Covered in the Journal**

The International Journal on Biodiversity Watch presents original research in naturally occurring medicines and their related foods and cosmetics.

The International Journal publishes Reviews, Mini-Reviews, Original Papers, Notes, Rapid Communications, Natural Medicine Notes, and Natural Resource Letters. Three papers in each volume will be honored as Excellent Papers.

It covers different dimensions of biodiversity conservation, sustainable development and environmental governances, best practices of Corporate Social Responsibility, Environmental Auditing, climate and ecosystem practices, sustainability management in corporate culture and corporate practices, substantive engineering in ecosystem functionality.

The International Journal on Biodiversity Watch is an open access journal that provides rapid publication (quarterly) of articles in all areas of the subject related to different issues of Biodiversity Conservation and Forest governance.

The Journal welcomes the submission of manuscripts that meet the general criteria of significance and scientific excellence. Papers will be published approximately two months after acceptance.

### **Types of Paper**

**Regular Articles:** The regular research based articles covering different dimensions of thematic area of the journal are invited from scientist and researchers working in different universities and institutes in India.

The works should be original. The length of a full paper should be the minimum required to describe and interpret the work clearly.

**Reviews:** The journal accepts review of books by scientists and researchers published in India and abroad.

Reviews should be concise and no longer than 4-6 printed pages.

Reviews manuscripts are also peer-reviewed

**Review Process :**All manuscripts are reviewed by an editor and members of the Editorial Board or qualified outside reviewers.

Decisions will be made as rapidly as possible, and the journal strives to return reviewers comments to authors within 3 weeks.

The editorial board will re-review manuscripts that are accepted pending revision.

## Editor's Note

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The tribal communities across different forest regions of the India contribute significantly to maintain harmonious relationship between cultural diversity and biodiversity. These people live more sustainable lifestyles and work as stewards of biodiversity. The environmental beliefs, their traditional ecological knowledge system and ecological practices enable them to devise appropriate coping mechanism to address the impact of climate change, demographic shifts, nutritional transactions and cultural homogenization. These communities are best diversity managers who ensure agro diversity, genetic diversity and cultural diversity. They show case vibrant dimensions of sustainable lifestyle and biodiversity conservation.

One of the best examples of sustainable community is Dongaria Kondh of Odisha. Dongaria Kondh of Niyamgiri Hills of Odisha have created historical landmarks over their battle against bauxite mining by Vedanta Ltd. This tribe is one of the most sustainable communities in the world. This tribe has fought for last 10 years to safeguard their cultural rights over sacred landscape of Niyamgiri hills. The concern of this tribe has been well recognized by Supreme Court of India. In April 2013, the Supreme Court of India directed that mining activities cannot be initiated in Niyamgiri region without approval of local communities and execution of Forest Right Act of 2006. This tribe has been enforcing traditional customary laws to safeguard biodiversity and unique natural resources of the Niyamgiri hills since generations together. The top of the hill is treated as most sacred and home of Niyam Raja, ancestors and supernatural forces. The dynamics of indigenous coping mechanism of Dongaria Kondh provide wide spectrum of different components that are functionally interlinked and inter related. These components are supernatural world, biological resources, natural world, biocultural heritage, human world and traditional ecological knowledge. The supernatural world is the mother of human world and natural world. Supernatural world provide rain to sustain both human and natural world and gifts knowledge to human beings to explore natural resources in sustainable manner for their survival. The genetic and agro diversity is ensured by gift of rain and favourable climate from supernatural world. Niyam Raja, the Supreme Power along with ancestors and other supernatural forces live on hill top of Niyamgiri. These people celebrate different rituals and festivals to appear these supernatural forces so that they will be rewarded with good harvest, rain and climate. This community claim collective ownership on territories and landscapes of Niyamgiri hills. This tribe

has unique sets of customary laws which have been evolved from natural resources use. These laws defend their collective rights and responsibilities and cater to needs of community and future generation. The enforcement of customary laws by Dongaria Kondha promotes biodiversity conservation and sustainable use of natural resources since time immemorial.

The enforcement of customary laws of the community has been sustained through collective ownership of natural resources, joint ownership of intellectual property rights collective observation of soil festival, seed festival on sacred landscape of Niyamgiri hills and sustainable use of natural resources by this tribe. The sustainability of this tribe has been characterized by their collective decision making through democratic institutions and balancing mechanism between biodiversity and cultural diversity. The world view of Dongaria Kondh is unique. They believe that intangible component such as ecological knowledge and tangible component such as bioresources cannot be separated. These two components are transmitted together. They believe cultural and spiritual values of land, soil and biodiversity are controlled by Niyam Raja. They strongly believe that ecological knowledge on use of plants comes from spirits associated with wild species, mountains, sacred landscapes and sacred plants. Ecological knowledge and bioresources have been developed collectively. Individuals cannot claim right over ecological knowledge awarded by Niyam Raja. The sustainable lifestyle of this tribe gets manifestation through their practice on non timber forest produce collection, celebration of seed festivals, management of common property resources, collective farming such as land leveling, raising of bunds, mulching, transplantation of seeds, crop rotation, relying on self saved seeds, practice of seed exchange among villagers.

The secrecy of sustainable lifestyle of this tribe lies in mode of governance of customary rules and belief system. The customary rules are operated at landscape level through customary institutions for management of common property resources.

Niyamgiri hills provide different sacred landscapes such as sacred stream, sacred groves, sacred hill top, sacred forest, sacred mountain etc. The customary laws of Dongaria Kondh are governed by principle of reciprocity, principle of equilibrium and principle of duality. Dongaria Kondh believes that everything has dual function such as tangible Vrs intangible, male Vrs female cultural diversity Vrs biodiversity. These components have strong interrelationship for survival of earth and life support system of the planet.

Dongaria Kondh community enforces customary laws to maintain necessary equilibrium in community relationship. Dongaria Kondh adopt traditional practice of natural resource management which are mostly based on their cultural norms and religious beliefs. They form the foundation for sustainable use and conservation of biodiversity. The communities have strong traditional social organization for controlling access to natural resources within the community. The traditional natural resource management practices of this tribe cover customary norms and procedures for control acquisition maintenance and transfer of resources and traditional use and conservation

practices. This tribe has promising success stories to share with modern world as to how balance can be maintained between economic development and biodiversity conservation. Their messages are reflected in multiple components of their harmonious relationship with nature and benefit sharing approach. They ensure sustainable use of natural resources through benefit sharing and knowledge dissemination protocols incorporated in seed festivals and earth rituals of the community.

The forces of globalization have opened up market linkages and encroachment of indigenous territories through mining and industrialization. The mining in tribal regions has not only to loss of religions, social and cultural identity of tribals but also murdered community life, their collective ownership, collective consciousness, collective decision making which govern diversity management spirit and sustainable forest governance by indigenous communities. The mode of community based natural resource management and benefit sharing mechanism have been hijacked by governmental focus on economic development at the cost of environment damages. Dongaria Kondh community share great messages to the world in terms of maintaining harmonious relation with nature to preserve and conserve diversity at all sphere. Our planet has lost diversity in all spheres genetic, cultural, forest and agro diversity. It is a danger signal for survival on this planet. Globalisation and industrialization have made world culturally and biologically uniform. Globalisation has commodified knowledge, ceremonies and cultural expressions of tribal communities all over the world. Their festivals, art, cultural icons have been commercialized without sharing benefits to them. It is a great threat to their cultural diversity. The encroachment of indigenous territories and landscape change has led erosion of genetic diversity from indigenous territories which tribal communities have preserved through generation together. A good number of international conventions have emphasized on biodiversity conservation, sustainable use of natural resources, fair and equitable sharing of benefits arising out of utilization of genetic resources. The components exist in the community based conservation mode of natural resources practiced by Dongaria Kondh since time immemorial. They have many lessons to teach and share our environmental experts on natural resource management and protecting life support system on this planet. Let us decode their traditional coping mechanism and customary use of biodiversity and long term perspectives of ecosystem dynamics based on ancestral contacts and interactions with species and landscapes.

*Editor*  
**R.N. PATI**

# Achievements of Odisha State Pollution Control Board

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Rajiv Kumar is an Indian Forest Service Officer of 1987 batch of Odisha cadre. He graduated from St. Columba's College, Hazaribagh with honours in Zoology and thereafter did his post graduation in Zoology from Ranchi University. After getting training from IGNFA and LBSNA, he joined in the state of Odisha and served as Working Plans Officer, Sambalpur where under his active guidance, the Working Plans of Bonai Division was prepared. Thereafter he served as Divisional Forest Officer in Athmallick Division, Baripada Division, Rourkela (KL) Division, Khurda Forest Division where he was actively involved in the management of forest, wildlife and environment. After getting his promotions to the rank of Conservator of Forests, he served as Conservator of Forests, Sambalpur Circle where he managed and actively involved in the supervision of the forest and wildlife management activities of the different divisions under the circle as well as guided the DFO and Working Plans Officer in writing of different Wildlife Management Plan of the Sanctuaries of the circle as well as Working Plans of Sambalpur and Rairakhol Division. Thereafter, he served as Joint Project Director and Additional Project Director in JICA assisted Odisha Forestry Sector Development Project, Bhubaneswar where he was actively involved in rehabilitation of degraded forests and improvement of the livelihood of the people living in the fringe villages of forests through constitution of more than 2500 Vana Surakhya Samities (Village Forest Protection Committees) and 6500 SHGs. Presently he is working as Member Secretary, State Pollution Control Board, Odisha where he is primarily responsible for implementing various mechanism, rules and regulations related to control of different types of pollutions so as to provide clean air and water to the people.

Pollution control has a big role in environmental management. It means the control of emissions and effluents into air, water or soil. Without pollution control, the waste products from consumption, heating, agriculture, mining, manufacturing, transportation and other human activities, whether they accumulate or disperse, will degrade the environment. Pollution disturbs our ecosystem and the balance in the environment.

In his tete-a-tete with Pratap Aditya Mishra, , Biodiversity Watch he discussed in details on the subject and how far the Board has been able to contain pollution so far and the steps that are being taken to tackle this problem on an ongoing manner.

**What are the parameters to measure Air, Water and Soil Pollution?**

Environment can get affected due to many factors, i.e. pollution of Air, Water, Soil, Noise, Heat, Radioactive and others. But, pollution in air, water and soil are profound and they affect the environment in a big way. These are measured on the basis of different parameters. The parameter is required to be measured in a specific area depending upon the type of environmental problem is being experienced. However, in general, Suspended Particulate Matter (SPM), Respirable Suspended Particulate Matter (RSPM), Sulphur Dioxide and Oxides of Nitrogen are measured to determine the general air quality. Similarly, in water, 36 parameters are measured to determine the water quality. The soil parameters are determined on the basis of specific conditions prevailing in the soil of the area taking into account the physical, chemical, and biological behaviour of the soil contaminants, the industrial activities, agricultural activities through chemical utilization, waste disposal and accidental oil spills.

**Could you please throw some light on the functioning of OSPCB and its co-ordination with Central Pollution Control Board, NGT and other regulatory bodies/authorities ?**

The State Pollution Control Board is constituted to discharge the functions laid down in the Water (Prevention & Control of Pollution) Act, 1974, Air (Prevention & Control of Pollution) Act, 1981 and some specific rules like Hazardous Waste (Management, Handling and Transboundary Movement) Rule, Biomedical Waste (Management and Handling) Rule, Municipal Waste (Management and Handling) Rule etc. promulgated under the Environment (Protection) Act. The above Acts and Rules mandate the Board to regulate various activities relating to the Industries, Mines, Health Care facilities and Urban Local Bodies, so that the pollution generated is regulated to extend that the overall environmental quality of an area is not affected significantly. In this exercise of regulation Central Pollution Control Board provides the technical guidance and in critical cases of pollution control in highly polluting industries the Central Pollution Control Board provides the guidance for monitoring and regulation.

**What are the major areas of concern in the State?**

Water is getting polluted due to discharge of untreated urban sewage from the major cities and also due to improper management and disposal of municipal solid waste. Similarly, air pollution in industrial/ mining clusters and some important cities and water pollution are the major concern for the State. In this context, the problems from urban bodies are more profound in Cuttack, Bhubaneswar, Sambalpur and Puri than other cities. Similarly the environmental problem of Talcher-Angul area, Ib Valley-Jharsuguda area and Paradeep are matter of concern.

**Which kind of industry does make maximum pollution and what are the steps that are being taken to curb pollution?**

All major industries in Odisha are mineral based. Maximum challenge for pollution control is posed from the iron and steel sector, particularly sponge iron plants. The sponge iron plants owing to their technological characteristics and their numbers (more than 100 plants established in Odisha), pose several challenges for controlling pollution. Similarly, the thermal power plants because of their scale of operation and use of low quality of coal pose significant threat to the environment in terms of emission and solid waste generation.

The challenge has been taken head-on. A policy to discourage establishment of small sponge iron plant is implemented so that this sector grows sustainably and better technologies replaces the DRI technology of sponge iron plant. Besides this in order to upgrade the pollution abatement technology an evaluation study was conducted in association with IIT, Kharagpur and the pollution control equipment are upgraded on the recommendation of IIT, Kharagpur. Similarly, in thermal power sector several technological upgradation projects are also being taken up.

**As per the new Companies Act 2012, Industries and Mining Sector are supposed to have CSR activities. Is there a way to monitor whether these activities are being executed properly?**

The State Pollution Control Board is mandated to implement the provisions of Water (Prevention & Control of Pollution) Act, 1974 and Air (Prevention and Control of Pollution) Act, 1981. Since the Company's Act is not within the domain of State Pollution Control Board, the CSR activities are not monitored by the Board.

**Big plants release effluents to the nearby river causing heavy contamination of water and creating diseases of the consumers downstream. There are regular reports coming from those villages near river Brahmani and Mahanadi. Even Mahanadi's water in Sambalpur has been classified as "D" category. How does OSPCB ensure that plants conduct proper effluent treatment before releasing the waste water to the river ?**

The classification of river is done on the basis of Designated Best Use (DBU). The Designated Best Use of Class 'C' river is that it can be used for drinking purpose after conventional treatment and disinfection. There are several places like down stream of Rourkela, Talcher in Brahmani, Sambalpur, Cuttack, Bhubaneswar, where the river water quality do not conform to Class-C river quality. In these stretches the river water of the BOD and TC remain above the desirable level. Increased level of BOD and TC indicates that the water is contaminated due to in stream use and untreated sewage disposal. Therefore, sewage treatment of such Cities like Sambalpur, Cuttack, Bhubaneswar and Talcher are now taken up on priority basis by the State Government.

**What steps have been taken by you to curb pollution done by Crusher Plants?**

Air pollution due to pollution is a major issue of air pollution. The problem is mostly localized and profound in Chandikhol and outskirts of Khurda. Abatement of pollution from the stone crushers has been envisaged through proper siting and adequate pollution control measures. In order to regulate the pollution from the Stone Crusher, the State Government has formulated a siting criteria and prescribed pollution control measures to be adopted by the Stone Crusher.

At present about 1900 crushers have been identified out of which more than 700 have been found to be violators. Notices have been issued to defaulting crushers along with closure direction, and so far, about 240 crushers have been sealed by the District Administration.

**There are regular complaints against some Hotels in Puri who cause heavy pollution to the area and to Bay of Bengal, a tourist destination. What measures are being taken to curb pollution there ?**

In Puri the problem lies with collection of sewage and its treatment. At present a good amount sewage from the hotels of Puri, particularly the hotels located along the beach Puri town goes to Banki Muhan through a sewer system from where it is discharged to sea, without any meaningful treatment. In Banki Muhan a sewage treatment system based on facultative pond and a High Rate Transpiration System (HRTS) was established in consultation with NEERI, Nagpur. After few years of its operation the project failed to produce desired results. However, in the meantime construction of a full-fledged Sewage Treatment Plant at Mangalahat is completed. We expect that the hotels and the household will connect to the STP through sewer lines.

**In the year 2015 Puri is going to celebrate Nabakalebara festival and this will Attract around 5 million people from all over the world. What preventive measures and post festival steps will be taken so that pollution level can be minimized ?**

Puri has a modest population of about 2 lakhs. A sudden influx of 5 million people can have significant environmental impact. Sudden influx of such large crowd will result in increasing volume of sewage, wash water in the drain and increased volume of domestic solid waste. In view of this, first of all, we expect that the sewage collection and treatment system should be fully functional before 2015 Nabakalebar. It is also expected that Municipal Solid Waste generation will witness spike of about 2000 Tons per day against a normal level of 100 tons per day. It is therefore necessary that we should be prepared to collect, transport and dispose of such high volume of solid waste.

**You have currently started asking industries to furnish Bank Guarantee. How has it been responded by the industry fraternity ?**

There are two methods by which compliance to any regulation is achieved. The first one is command and control and other one is economic instrument. Bank guarantee falls within



the category of economic instrument, where the Board seeks bank guarantee against an assurance submitted by the industry for taking up pollution control measures within a specified timeframe. In the event of the industry failing to implement the pollution Control measures within the stipulated period the amount of bank guarantee gets forfeited. Initially the industries were little unconformable with the system of imposing bank guarantee, however, eventually imposition of bank guarantee has ensured timely completion of pollution control measures in many cases.

**There is always a conflict between industrialization for development of the state and following the stringent rules and regulation for pollution control. How to find a way where the environment is protected and simultaneously the industry is given space to operate for the development of the state?**

Trading off some environmental space with the development space has always remained a challenging task. It is extremely difficult to take a decision on how much of environment can be sacrificed for the sake of the development. In this process of trading off, two aspects come out very prominently. The first one is adoption of advanced technology for pollution control, and the second is putting in place innovative practices of environmental management. Various combination of these two have resulted in development without significant pressure of the environment. For example disposal of fly ash is a major problems of the state. We are producing about 25 million ton of ash in a year. In conventional technology, the fly ash is mixed with water which is 10 times its volume and is disposed off in ash pond. Over the last decade advancement in technology have resulted in utilizing about 60% of the ash generated and requirement of water for ash disposal has come down from 10m<sup>3</sup> per ton to 1m<sup>3</sup> per ton.

**Is OSPCB equipped enough to tackle/ curb pollution? If no, then what steps should be taken immediately ?**

The nature and magnitude of pollution depends upon scale and technology of industrial process. For scenario like this, it is essential that State Pollution Control Board remains in the forefront of technological advancement taking place in the industrial space. This demands that, the skill level of Scientists and Engineers of the State Pollution Control Board have to be updated continuously. In order to fulfill the social demand of stricter pollution control, it has become necessary to adopt advanced technology for monitoring and control. Online continuous monitoring of emission and wastewater quality is one such area. Our Scientists and Engineers skill level is continuously being updated on this format.

**Will OSPCB recommend/ adapt to new technology to curb pollution? If yes, then let us know how and when you would like to implement.**

Abatement of pollution is the responsibility of the industries and mines concerned, and the monitoring of performance of these abatement system is responsibility of the State

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Pollution Control Board. In order to ensure continuous monitoring the State Pollution Control Board is implementing the State of the art continuous online monitoring system for air pollution from the major industries of the State. Similarly, continuous Ambient Air Quality Monitoring Stations are being established in Critically Polluted Areas of Angul-Talcher, Ib Valley-Jharsuguda area. With the establishment of the online monitoring system one would know the level of pollution at remote location in real time basis. We plan it to make this system fully functional by the next fiscal year.

**What are the major achievements of OSPCB ?**

Board's regulatory activity has resulted in upgradation of existing process technology to less polluting technology like conversion of mercury cell technology of Jayashree Chemicals to less polluting membrane cell technology, adoption of 100% recycling system in ash pond, adoption of high concentration slurry disposal system in new power plants.

Besides this the monitoring network for ambient air quality has been expanding to more cities and towns and we are also taking steps to install online monitoring system in major industries and in Critically Polluted Areas like Angul-Talcher and Ib Valley-Jharsuguda. The Board is also implementing an Online Consent Management System in association with NIC, New Delhi. This will make the process of grant of consent more transparent and the application can be disposed at a faster rate. The Board has also successfully sensitized various other departments on the issue of urban pollution.

In the area of awareness generation the Board has imparted training in various fields like ash management, climate change etc. The Board has also conducted several training program for younger generation under State Youth Policy.

**What actionable plan you would like to design and implement in coming 10 years to come ?**

The State Pollution Control Board has prepared a Vision Document 2020-30. This document has flagged many issue of Capacity Building, streamlining procedures for efficient service delivery, adoption of new technology for advanced level of monitoring. In coming 10 years we will analyse each of these aspects in great detail and implement them in phased manner so that our regulatory efforts become effective.

# Guidelines for Contributors/ Subscribers

---

## **A. GUIDELINES:**

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The themes of the submitted article should be on forest governance, policy and programs on Biodiversity Conservation, conservation of medicinal plants and mainstreaming traditional knowledge into protection of biodiversity. Original research articles are invited on specific thematic area of forest governance and biodiversity conservation. The spectrum is very broad. It covers a wide range of issues relating to research on Biodiversity Conservation and forest governance.

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The **Observations** should interpret the findings in view of the results obtained in this and in past studies on this topic. State the conclusions in a few sentences at the end of the paper. The Results and Discussion sections can include subheadings, and when appropriate, both sections can be combined.

The gaps in policy and programmes must be highlighted along with suggestion for appropriate remedial measures. The findings of the research need to address deficiencies in implementation process and provide feed back for appropriate actionable strategic plan.

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# 1

## Anuran Diversity of Southern Rajasthan, India

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— *Satya Prakash Mehra*

### ABSTRACT

Amphibians are among the faunal group of major concern due to continual decline in their population. In general, efforts are required at every level with the widespread approach of surveys and checklist preparations for the conservation measures. The paper deals with the study of anuran diversity of the southern parts of the Rajasthan State (India) in general and elevations of Aravallis in particular.

Using visual encounter method and call detection for the monitoring of species and population, seasonal surveys of the study area and periodic transect sampling of the sites - Abu Hills and Kumbhalgarh Hills, were undertaken for the observations for the period from 2006 to 2009.

Ten anuran species were recorded from the study area whereas only seven species showed their presence on the elevations of Aravallis. Three species were distributed throughout the study area along with the higher altitudinal ranges. The species richness decreased with the elevation. The altitudinal range of 800-1000msl of Abu Hills and 600-800msl of Kumbhalgarh Hills were found as important range for the anuran diversity.

Habitat alteration was found to be major cause of concern for the regular decline in the population of anurans in the study area.

**Keywords:** Abu, Anuran, Aravallis, Kumbhalgarh, Rajasthan

### Introduction

Due to the important role of amphibians in food webs at different tropic levels such as herbivores (at the larval stages they feed upon vegetation); predators (prey upon small animals); and prey (serve as food for larger predators), they are particularly sensitive to environmental changes. Even than they are systematically underrepresented in international conservation plans (Hedges 2006, Pawar *et al.* 2007). Declining amphibian

populations have been observed around the world in the last 20 years. Potential causes of the world-wide amphibian decline are still embroiled in controversy (Alford and Richards 1999, Houlahan *et al.* 2000). In spite of being at high risk of extinction, amphibians are the terrestrial vertebrate groups least studied in the world, with only 5% of the total number of studies conducted on vertebrates and the effects of habitat loss (Lawler *et al.* 2006). There is also a very little information available on the consequences of anthropogenic effects and land use changes for amphibian fauna. Anuran represents the largest proportion among amphibians (Frost 2009), hence largely taken for the representation of group.

From many parts of India information on the current status of amphibian fauna is lacking especially from Rajasthan (Sharma and Mehra 2007, Mehra 2010). There is need of widespread approach of surveys and preparation of checklists along with quantitative estimates so as to devise potential conservation measures (Padhye and Ghate 2002).

In Rajasthan, southern part is provided with transects of Aravallis with discrete wetlands and unique habitat characteristics of high altitudinal water bodies. This study describes current trends of knowledge regarding the status and distribution of amphibian fauna from Aravallis particularly anuran species.

## Material and Methods

### *Study Area*

The State of Rajasthan lies between 23°30' - 30°11' North latitude and 69°29' - 78°17' East longitude, occupying 342,239 km<sup>2</sup> which accounts 10.41% of the geographic land area of the country. In general, six districts of Udaipur Division, viz., Banswara, Chittorgarh (Pratapgarh), Dungarpur, Rajsamand and Udaipur; and three districts of Jodhpur Division, viz., Jalore, Pali and Sirohi were explored for assessing the status and distribution of anurans. Thus, nine districts were explored in general and the high altitudes in particular for the amphibian fauna in the present investigation (Fig.1). Pratapgarh is newly formed district in 2008, therefore, during the data collection it was observed within Chittorgarh throughout the study. This southern part of the state under present investigation constitutes approximately 21% of the total geographic area of state (DoF, 2009).

The study area consisted of plain desert at about sea level of Jalore (Hathigaon village approximately 20 msl) to the highest elevations of Sirohi (Guru Shikhar, Mount Abu approximately 1,722 msl). The western part of the study area was under arid and semi-arid zones with plainer terrains of Thar Desert. Similarly, the southern parts of the study area in the Dungarpur and Banswara were on the lower altitudes comprising of variety of wetlands in the plainer and plateau terrains. The central parts (parts of Sirohi, Pali and Udaipur) of the study area comprised of the hilly terrains of Aravallis with all the higher altitudes particularly the range of 800msl and above. The northern

and eastern parts (parts of Rajsamand, Udaipur, Chittorgarh and Pratapgarh) were also hilly terrain with the lower altitudes ranging between 300 to 600 msl. The altitudinal cross section of the study area is shown in figure 2. The two sampling sites (high altitudes) of Aravallis were Abu Hills and Kumbhalgarh Hills.

### Method

The present study was carried out during 2006 to 2009. Seasonal surveys (day and night) were carried out in different habitat types of the study area. Observed species were examined carefully. The diagnostic keys given by Boulenger (1890), Dutta (1992), Chanda (2002), Daniel (2002) and Daniels (2005) were used for species identification. Other than morphological identification, advertisement calls were used for identification and differentiation among individuals (Sharma, 2005 a,b). Night sampling (1900 hrs to 2100 hrs for hilly terrains and 1900 hrs to 2400 hrs for plains) was carried out with the aid of a spotlight.

The Visual Encounter Method and Visual Observation were used to survey the anurans in each site during the day and night (Heyer *et al.* 1994). Transects sampling were conducted for selected sites in the study area in different directions. Two replicates for each transect was done in an analogous habitat. All individuals encountered on the transect line were only identified to the species level and the mean number of live and trampled individuals was recorded for analysis of the characteristics of the population and diversity.

### Results and Discussions

Anuran species are already showing a fast rate of extinction throughout the globe (Blaustein and Wake 1990, Stuart *et al.* 2004). Biologists have approached unaltered habitats, such as the tops of mountains etc. to document the anuran species before extinction. In this study the investigation has been carried out in the habitats of southern Rajasthan with main focus on the distribution pattern of anurans in higher elevations of Aravallis. Very few studies have been carried out on the related aspects of anuran diversity of higher altitudes (McCann 1942a,b, Waltner 1974, Ravichandran 1998, Krishnamurthy *et al.* 2001, Naniwadekar and Vasudevan 2007) especially in Aravallis (Sharma and Mehra 2007). McCann (1942a,b) had been the pioneer for Aravallis but that was merely a firsthand documentation of anurans at the table land of Abu Hills. No work has been done so far on the species distribution and attributes of anuran from high altitude from Aravallis. Thus, it is the first of the kind of scientific work carried in the Aravallis specifically for the anurans.

Among the current list of 13 anurans, presence of *Bufo viridis* has not been reported by any worker in the last three decades other than the author (Saxena, 1999). This was also not observed from the study sites in the present research. Thus, 12 anuran species of four families and ten genera have been documented time to time by

different investigators (Sharma and Mehra 2007). These are *Euphlyctis cyanophlyctis*, *E. hexadactylus*, *Hoplobatrachus tigerinus*, *Fejervarya limnocharis*, *Sphaerotheca breviceps*, *S. rolandae*, *Duttaphrynus melanostictus*, *Bufo stomaticus*, *Microhyla ornata*, *Uperodon systoma*, *Kaloula taprobanica* and *Polypedates maculatus*.

Ten anuran species, out of the twelve, were recorded from the study area of southern Rajasthan in the present study namely *E. cyanophlyctis*, *H. tigerinus*, *F. limnocharis*, *S. breviceps*, *D. melanostictus*, *B. stomaticus*, *M. ornata*, *U. systoma*, *K. taprobanica* and *P. maculates* (Table 1). Among the ten species from southern Rajasthan, only seven species namely, *E. cyanophlyctis*, *H. tigerinus*, *F. limnocharis*, *S. breviceps*, *D. melanostictus*, *B. stomaticus* and *M. ornata*, were encountered on the higher altitude (above 800msl) whereas one species *U. systoma* was recorded from the foothills of Abu Hills (Table 1). McCann (1942a,b) also observed seven species from plateau regions of Abu Hills which is about 29 sq. km. at the average altitude of 800msl. It is quite possible that *U. systoma* which show its occurrence in the foothill areas of Abu Hills could not be recorded by McCann (1942a,b) because he covered only table land of Abu Hills whereas the area of about 326 sq. km. including the foothills was covered in the present study. This species was not observed by McCann (1942a,b) as well as by us from the high altitudes.

**Table 1** Distribution of the anuran species in Study Area

Sr. No.	Scientific Name (Common Name)	Distribution			
		Study Area	Altitudinal Range		
			Study Area	Sampling Sites	
		Abu Hills		Kumbhalgarh Hills	
<b>Family Ranidae</b>					
1	<i>Euphlyctis cyanophlyctis</i> (Indian Skipping Frog)	Whole study region	All the ranges	All the ranges	All the ranges
2	<i>Hoplobatrachus tigerinus</i> (Indian Bull Frog)	Whole study region	Below 900m	Below 900m	All the ranges
3	<i>Fejervarya limnocharis</i> (Cricket Frog)	Whole study region	All the ranges	All the ranges	All the ranges
4	<i>Sphaerotheca breviceps</i> (Short-headed Burrowing Frog)	Pali, Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	Below 900m	Below 900m
<b>Family Bufonidae</b>					
5	<i>Duttaphrynus melanostictus</i> (Common Asian Toad)	Pali, Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	Below 900m	All the ranges
6	<i>Bufo stomaticus</i> (Marbled Toad)	Sirohi, Chittorgarh, Pratapgarh, Udaipur	Below 900m	800-1,000m	600-800m



Sr. No.	Scientific Name (Common Name)	Distribution			
		Study Area	Altitudinal Range		
			Study Area	Sampling Sites	
		Abu Hills		Kumbhalgarh Hills	
<b>Family Microhylidae</b>					
7	<i>Microhyla ornata</i> (Ornate Narrow-mouthed Frog)	Whole study region	All the ranges	All the ranges	All the ranges
8	<i>Uperodon systoma</i> (Marbled Balloon Frog)	Jalore, Sirohi, Udaipur, Chittorgarh, Pratapgarh	Below 600m	Foothills	-
9**	<i>Kaloula taprobanica</i> (Indian Painted Frog)	Chittorgarh, Pratapgarh	Below 600m	-	-
<b>Family Rhacophoridae</b>					
10	<i>Polypedates maculatus</i> (Indian Tree Frog)	Chittorgarh, Udaipur	Below 600m	-	-

\*\* First Record from Rajasthan (Mehra 2010)

The altitudinal distribution pattern on Aravallis, in general, showed ubiquitous presence of *E. cyanophlyctis*, *F. limnocharis* and *M. ornata* on all the ranges from lower elevations or foothills to the highest elevations or peaks whereas *U. systoma* was observed from the foothills of the study areas only. *K. taprobanica* and *P. maculatus* are two other species which are not found in either of the sampling sites. Although, these two species are present in the lower elevations, below 600msl, in other sites of Aravallis in districts Chittorgarh and Pratapgarh districts. Rest four species out of ten namely *H. tigrinus*, *S. breviceps*, *D. melanostictus* and *B. stomaticus* showed their presence only below 900msl.

The altitudinal distribution pattern on Sampling Sites, in particular, showed distribution of *E. cyanophlyctis*, *F. limnocharis* and *M. ornata* on all the ranges very common followed by the presence of *H. tigrinus*, *D. melanostictus* and *B. stomaticus* which were commonly distributed. Presence of *S. breviceps* was occasional (Table 2 and 3). It could be due to its burrowing nature.

This is in accordance of the earlier studies made to assess similar species attributes (Navas, 2006). Species such as *E. cyanophlyctis* has been reported very common from high altitudes 2,000 and 3,000 above msl in Western Ghats (Daniels 1999, Ravichandran 1998) and Himalayas (Waltner 1974). The altitudinal range of 800 to 1000msl of Sampling Site 1 (Abu Hills) was important for the diversity of anuran species. Whereas at Sampling Site 2 (Kumbhalgarh Hills), the middle altitudinal range (600-800msl) was important for the anuran diversity.

**Table 2** Species abundance in different altitudinal ranges of Abu Hills

Sr. No.	Scientific Name	Distribution
<b>&gt;800msl (Higher altitudes)</b>		
<b>Family Ranidae</b>		
1	<i>Euphlyctis cyanophlyctis</i>	Very Common
2	<i>Hoplobatrachus tigerinus</i>	Common
3	<i>Fejervarya limnocharis</i>	Very Common
4	<i>Sphaerotheca breviceps</i>	Occasional
<b>Family Bufonidae</b>		
5	<i>Duttaphrynus melanostictus</i>	Common
6	<i>Bufo stomaticus</i>	Common
<b>Family Microhylidae</b>		
7	<i>Microhyla ornata</i>	Very Common

**Table 3** Species abundance at higher altitudes (>800msl) of Kumbhalgarh Hills

Sr. No.	Scientific Name	Distribution
<b>Family Ranidae</b>		
1	<i>Euphlyctis cyanophlyctis</i>	Very Common
2	<i>Hoplobatrachus tigerinus</i>	Common
3	<i>Fejervarya limnocharis</i>	Very Common
4	<i>Sphaerotheca breviceps</i>	Occasional
<b>Family Bufonidae</b>		
5	<i>Duttaphrynus melanostictus</i>	Common
6	<i>Bufo stomaticus</i>	Common
<b>Family Microhylidae</b>		
7	<i>Microhyla ornata</i>	Very Common

Relative abundance of species was more on the rainfed sides of Aravallis. The eastern and southern parts in case of Sampling Site 1 whereas central and eastern parts of Sampling Site 2. There may be several reasons for the abundance and anuran diversity in particular sections of the sampling sites. Ovaska (1997) and Donnelly and Crump (1998) described about the changes in temperature and precipitation regimes could result in changes in the distribution and abundance of amphibian populations. The distribution of any species of organism is limited by the distribution of suitable environments. The combination of precipitation and temperature is fundamentally important in determining the distribution of general vegetation, which, in turn, determines the distribution of animal life.

The landscape characteristics decide vegetation of any habitat which in turn affects the abundance of particular anuran species (Buskirk 2005, Piha *et al.* 2007, Pillsbury and Miller 2008). There are some species which are evidenced from its habitat site and the surrounding environs (Radhakrishnan *et al.* 2007). The vegetation of the area mainly comprises of plant species of arid and semi-arid region. Though, the deep valleys in the Aravallis, which have perennial streams, have riverine forests of semi-evergreen species. The anurans were mainly found distributed nearby the aquatic environment. In the sandy tracts of western parts especially Jalore and Pali, the agricultural fields were most important site of occurrence of the *E. cyanophlyctis*, *F. limnocharis* and *M. ornata*. Agricultural ponds formed were occupied by these anuran species all over the study area. In Sirohi and Pali, *U. systoma* was another species found nearby the agricultural fields in abundance. *B. stomaticus* was another species found abundant near the farm lands in districts of Udaipur region. The waterlogged paddy fields of the Banswara and Dungarpur districts were preferred site of all the commonly distributed anuran species mentioned above. Knutson *et al.* (2004) also conclude that small farm ponds may sustain amphibian populations in landscapes where natural wetland habitat is rare.

The species richness decreases with the elevational gradient at both the sampling sites in the present investigation (Tables 4 and 5). At Sampling Site 1, seven species were encountered in the foothills whereas only three species were recorded from the high altitudes. Though, seven species were also encountered on the central plateau region of average altitude 800msl. Similarly, only five species were encountered on the high altitudes of the Sampling Site 2 whereas six and seven species were recorded from the lower elevational gradients. The results are in accordance with the patterns of species richness at elevational gradients with that of earlier work (Rahbek 1995, 1997). Inger *et al.* (1987) found associations between species richness and forest types at low and middle elevations in the southern Western Ghats.

At Sampling Site 1 (Abu Hills) (Tables 4), highest diversity (1.56) in year 2007 was found at the foothill areas followed by plateau table at altitudinal range of 800-1000 msl which was 1.7. The case was reverse for the consecutive years 2008 and 2009 where highest diversity 1.65 and 1.62 respectively, accounted for plateau region. The diversity index for higher altitude above 1000 msl was lowest for all the study years, 1.02 in 2007, 1.05 in 2008 to 1.08 in 2009.

At Sampling Site 2 (Kumbhalgarh Hills) (Tables 5), highest diversity (1.46) in year 2007 was found at the foothill areas followed by middle altitudinal range of 600-800msl and than higher altitudes which was 1.5. The same pattern was followed for all the study years where highest diversity indices were calculated for foothills followed by the middle altitudes. The diversity indices for the highest altitudes were lowest for all the study years, 1.17 in 2007, 1.3 in 2008 and 1.29 in 2009.

In the present study, low diversity was found on the highest altitudinal ranges at both the sampling sites which is contrary to that of Ravichandran (1998) who concluded that Tamil Nadu owes its rich amphibian diversity to its forests in higher elevations

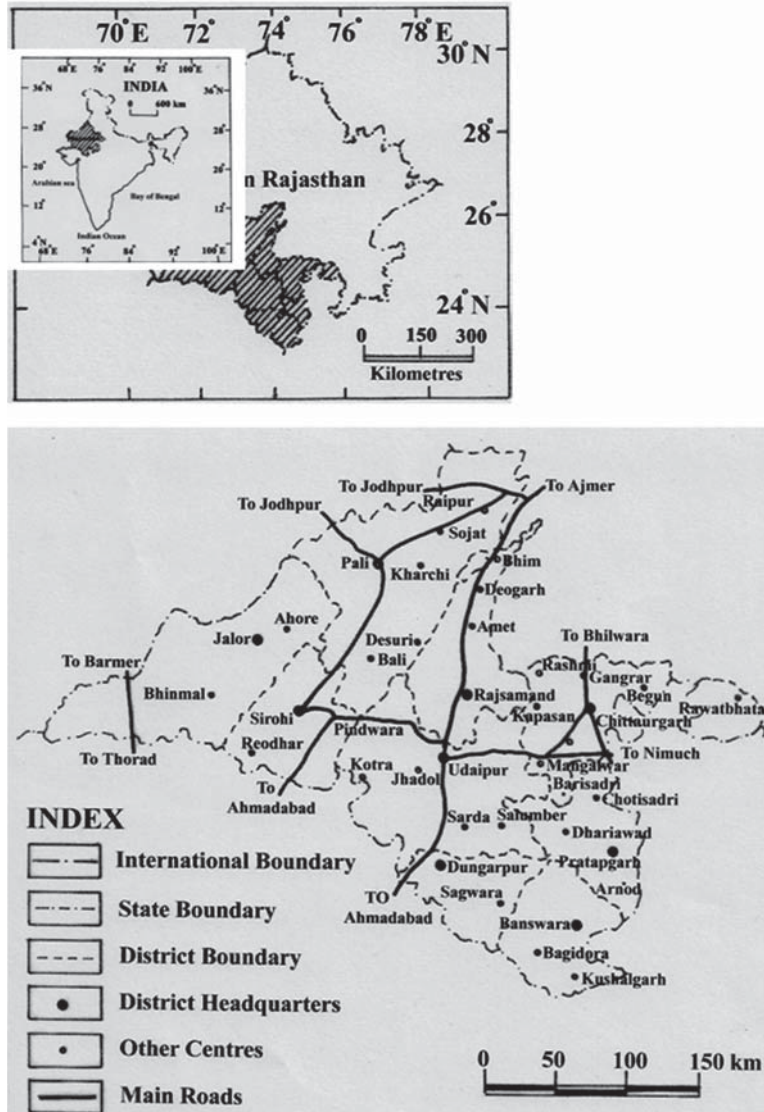
**Table 4** Species attributes for different altitudinal ranges of Abu Hills

Species Attributes	2006-07	2007-08	2008-09
<b>&lt;600msl (Foothills)</b>			
Species Richness (S)	7	7	6
Total Abundance	3010	3237	4059
Simpson Diversity Index (D)	0.227	0.209	0.212
1-D	0.77	0.791	0.788
1/D	4.398	4.775	4.717
Shannon-Weiner Diversity Index (H')	1.563	1.654	1.617
Evenness (E)	0.803	0.85	0.903
<b>600-800msl (Middle altitudes)</b>			
Species Richness (S)	5	6	6
Total Abundance	2479	2410	3279
Simpson Diversity Index (D)	0.271	0.279	0.253
1-D	0.729	0.721	0.747
1/D	3.695	3.589	3.95
Shannon-Weiner Diversity Index (H')	1.41	1.422	1.478
Evenness (E)	0.876	0.794	0.825
<b>800-1000msl (Higher altitudes)</b>			
Species Richness (S)	7	7	7
Total Abundance	5338	4573	4413
Simpson Diversity Index (D)	0.321	0.203	0.206
1-D	0.679	0.797	0.794
1/D	3.117	4.934	4.855
Shannon-Weiner Diversity Index (H')	1.455	1.7	1.684
Evenness (E)	0.748	0.873	0.865
<b>&gt;1,000msl (Higher altitudes)</b>			
Species Richness (S)	3	3	3
Total Abundance	396	420	485
Simpson Diversity Index (D)	0.385	0.355	0.347
1-D	0.615	0.646	0.653
1/D	2.599	2.821	2.88
Shannon-Weiner Diversity Index (H')	1.022	1.065	1.079
Evenness (E)	0.931	0.97	0.982

**Table 5** Species attributes for different altitudinal ranges of Kumbhalgarh Hills

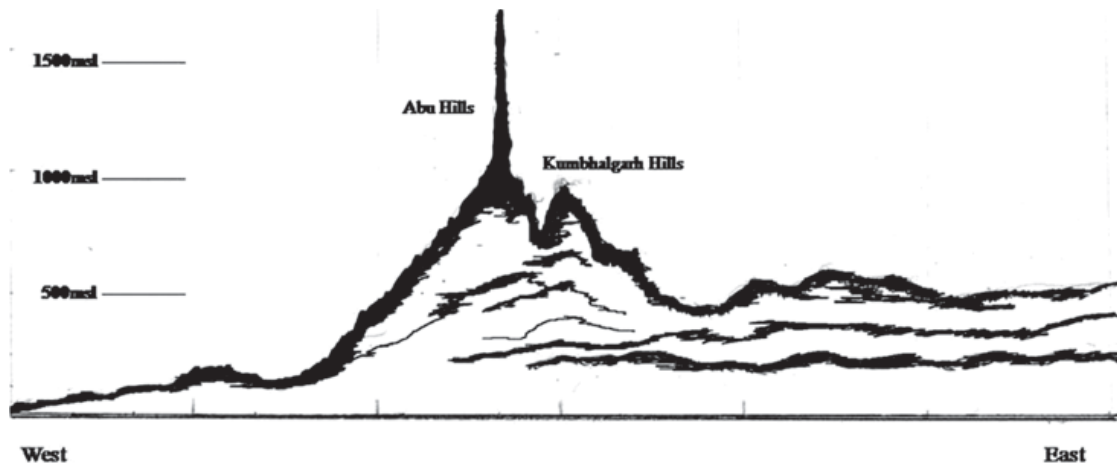
Species	2006-07	2007-08	2008-09
<b>&lt;600msl (Foothills)</b>			
Species Richness (S)	6	6	6
Total Abundance	2970	2767	3144
Simpson Diversity Index (D)	0.262	0.252	0.253
1-D	0.738	0.748	0.748
1/D	3.812	3.966	3.961
Shannon-Weiner Diversity Index (H')	1.46	1.496	1.505
Evenness (E)	0.815	0.8351	0.84
<b>600-800msl (Middle altitudes)</b>			
Species Richness (S)	7	7	7
Total Abundance	2290	2277	2524
Simpson Diversity Index (D)	0.304	0.305	0.295
1-D	0.696	0.695	0.705
1/D	3.292	3.278	3.388
Shannon-Weiner Diversity Index (H')	1.324	1.319	1.366
Evenness (E)	0.68	0.678	0.702
<b>&gt;800msl (Higher altitudes)</b>			
Species Richness (S)	5	5	5
Total Abundance	1366	1194	1419
Simpson Diversity Index (D)	0.346	0.306	0.311
1-D	0.654	0.694	0.689
1/D	2.893	3.267	3.214
Shannon-Weiner Diversity Index (H')	1.177	1.297	1.284
Evenness (E)	0.731	0.806	0.798

along the eastern slopes of the Western Ghats. This may be because the pattern of forest and related habitats in Aravallis particularly the Abu Hills, Kumbhalgarh, Parshuramji and Jarghaji are different from the other high altitude habitats such as Western Ghats. Aravallis have the climax forest types (Mathur 1960) with the dry deciduous vegetation. Thus, due to absence of dense moist habitats on the high elevations of the Aravallis, low diversity of the amphibians was observed. It is evident from the fact that the high diversity of anurans observed for the ranges of the two Sampling Sites, viz. 800-1000msl range of Site 1 and 600-800msl range of Site 2, were having dense and moist habitats in form of perennial streams, ponds etc.



**Figure 1:** Location Map of the Study area

Using the remarks on the habitat use of the amphibians by Srinivasulu and Das (2008), the eight species of amphibian of southern Rajasthan could be categorized as human commensals or tolerant of disturbed habitats. These are *B. stomaticus*, *D. melanostictus*, *M. ornata*, *U. systoma*, *E. cyanophlyctis*, *F. limnocharis*, *H. tigerinus* and *S. breviceps*. The two species which were mentioned human commensals, namely *K. taprobanica* and *P. maculatus* were only found in the forest patches. As the sightings of these two were rare during the course of work, therefore, it would be not justifiable



**Figure 2:** Cross section of the study area of Rajasthan

to comment on their habitat use. In terms of gross habitat usage are the fossorial (*K. taprobanica*, *M. ornata* and *U. systoma*), terrestrial (*D. melanostictus* and *B. stomaticus*), aquatic or aquatic-margin (*E. cyanophlyctis*, *E. hexadactylus*, *F. limnocharis* and *H. tigerinus*) and arboreal (*P. maculatus*). Skittering on the water surface is known for one species (*E. cyanophlyctis*).

In the present investigation, it was found that habitat loss is major cause of concern. The study area falls in the semi-arid tract but the sampling sites were among the areas of high rainfall. Abu Hills receive highest average annual rainfall than any other parts of the state. Similarly, Kumbhalgarh Hills have riverine pocket in its central parts along with dense forest patches with relatively rich sources of water to maintain the wetland habitats. Despite of these conditions, the investigated areas are receiving low rainfall from past few years and the anthropogenic interferences are increasing. In such conditions it is necessary to check the further exploitation through strict implementation of the rules and regulation.

Recommendations were made by Mehra (2006) for the fragile ecosystem of Abu Hills in year 2006 which resulted in the notification of Eco-Sensitive Zone for the human habituated area of the Abu Hills in year 2009. This is welcome step to protect the ecosystem of the Abu Hills. The notification will check further alteration of the aquatic habitats. The anuran diversity was found high for this range due to presence of aquatic bodies, drainage, agricultural farms and many other water logged areas which are of great importance for the anurans.

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## 2

# Managing Natural Resources for Sustainable Livelihoods: Threats to the Future of Sustainable Wild Collection and Field Experience with Implementation of the Fair Wild Standard for Medicinal Plants

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— *Josef A. Brinckmann, Katie Huggins and Zoë E. Gardner*

### ABSTRACT

The majorities of medicinal and aromatic plant (MAP) species in international trade are not grown on farms but rather are collected from wild populations by local, rural or indigenous people, a practice that will continue for agronomic, ecologic, and economic reasons.

While there is a finite inventory of wild plants available for trade, albeit dwindling due to encroachment from development and conversion of biodiversity to cropland, global demand is increasing due to growing interest in natural health care. The number of people willing to collect wild plants for household income is steadily declining because more can be earned from other activities. At the same time, countries are implementing export promotion programs to commercialize and globalize their systems of traditional medicine that employ plant-based drugs, i.e. Ayurvedic medicine from India and traditional Chinese medicine (TCM) from China.

Part of the solution is found in the recent development and implementation of rigorous sustainability standards that link local producer communities with product companies that require sustainable wild harvested ingredients with independent certification. The FairWild Standard (FWS) combines fair trade principles supporting economic

and social sustainability with sustainable resource management plans that support ecological sustainability. Compliance with the FWS for the selected managed species can be certified through independent inspection and certification organizations.

Based on the authors' experience in collaborative implementation of sustainability standards with communities that make their livelihoods from wild harvesting of medicinal plants, this article describes experiences from different regions and the pioneering companies and organizations that are investing in sustainable harvesting, trade and use.

**Keywords:** Biodiversity, FairWild, Herbal medicine, Medicinal and aromatic plants, Natural resource management, Sustainability.

**Abbreviations:** CBD, Convention on Biological Diversity; CITES, Convention on International Trade in Endangered Species of Wild Fauna and Flora; FWF, Fair Wild Foundation; FWS, Fair Wild Standard; IMO, Institute for Market Ecology; ISSC-MAP, International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants; LIK, local and indigenous knowledge; MAP, medicinal and aromatic plants; NGO, non-governmental organization; TEK, traditional ecological knowledge; TMK, traditional medical knowledge.

## **Introduction**

Through careful observation of the natural world over many generations, local, rural and indigenous communities developed and implemented natural resource management systems and strategies for sustainable use necessary for their own long-term survival. Traditional resource management systems contain the local knowledge of precisely how, when and where to collect and process plant parts for dye, fiber, food, and medicine uses, as well as for ritual and religious uses, providing a foundation for cultural security, food security, and local medicine security. Such traditional management systems are now considered within concepts including local and indigenous knowledge (LIK), traditional ecological knowledge (TEK) and traditional medical knowledge (TMK). TEK has been defined as “a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment” (Berkes, F., et al. 2000). Reddy (2006) states “TMK includes ethnobotanical knowledge on plant and genetic resources as well as folkloristic oral traditions that deal with medicinal applications of these resources,” and asserts that “ownership and control over TMK and biodiversity have become the new realities and tropes of medical globalization” (Reddy, S. 2006). While traditional systems exist for management of natural resources for sustainable local production of traditional foods and herbal medicines, the push towards commercialization and globalization of traditional herbal medicines creates new demand for extraordinary quantities for the export market that test the limits of local resource management systems.

There are an estimated 50,000 to 70,000 medicinal and aromatic plant (MAP) species used in local and traditional systems of medicine but only about 3,000 occur in the global

import/export trade. Of the approximately 3,000 species in international trade, about two-thirds are wild collected and are likely to continue to be wild collected for agronomic, ecologic, and economic reasons (Medicinal Plant Specialist Group 2007). Some medicinal plants take several years to reach maturity, many medicinal roots requiring at least four to five years before a first harvest is indicated and tree barks obtained from branches or trunks even longer. Farmers would need to plan a crop rotation system spanning over decades before determining feasibility and profitability, with no return on investment during the first several years of experimental cultivation. Small- to medium-sized farming enterprises cannot generally afford such long-term speculation (Brinckmann, J. 2009). Additionally, the cultivation of formerly wild-only species generally requires conversion of natural ecosystems of biodiversity into cropland. A study funded by the United Nations Environment Programme (UNEP) reports that expansion of cropland in tropical countries is now one of the principal causes of biodiversity loss (Phalan, B., et al. 2013).

While there is a finite inventory of wild plants available for local use and international trade, the available quantities of certain economic plant species are decreasing due to development encroaching on wild lands, conversion of natural ecosystems to cropland, and non-sustainable harvesting practices associated with the loss of TEK, among other factors. At the same time, global demand continues to increase due to growing interest in natural health care and correspondingly herbal medicinal products and natural health products.

Contributing to loss of TEK is a worldwide mass migration of young people from rural to urban areas. Internal migration appears as a massive phenomenon, exceeding international migration with young people being 40 per cent more likely to move from rural to urban areas than older individuals (Decent Rural Employment Team 2013). In the People's Republic of China, the world's largest producer, user and exporter of MAPs (Brinckmann, J. 2011), 700 million people now live in cities compared to 200 million in 1980. At the current rate of migration nearly 1 billion Chinese will live in cities by 2030 (Miller, T. 2013). India, the world's second largest producer, user and exporter of MAPs, also faces rapid urbanization, with an estimated 590 million living in cities by 2030 (Planning Commission Government of India 2013).

The number of people willing to collect wild plants as their source of household income is steadily dropping mainly because more can be earned from other activities. As an example, the European Union (EU) funded project "Traditional and Wild" aims to preserve the TEK on wild collection that is being lost rapidly in eastern European countries. The flow of TEK from previous generations has been disrupted largely due to weak economic incentives of wild collection for household income and increasing urbanization of society. Other disincentives for the next generations to choose wild collection as their source of income include uncertain legal access to natural resources (land tenure) and legal requirements to register as collectors while there is still only a limited number of forward-thinking ethical companies willing to pay a sustainability

price mark-up and social premium for botanical raw materials with organic and fairtrade certifications (TRAFFIC International 2013).

Part of the solution to these significant problems that indeed challenge biodiversity conservation can be observed in the recent development and implementation of rigorous standards for sustainable wild collection and resource management applying ecological, economic and social criteria within a whole ecosystem approach, i.e. the long-term survival of the people, plants and animals are taken into consideration.

The preservation of TEK and TMK, respectively, as it pertains to wild collection of medicinal plants, traditional post-harvest processing methods, and preparation of traditional medicines may be intrinsically linked to biodiversity conservation and the local economies that are dependent on produce of sensitive ecosystems. Furthermore there is data demonstrating the co-occurrence of high biological diversity with high linguistic and cultural diversity. It has been suggested that indigenous economies and management practices essentially enable high biological diversity to persist. Biodiversity and linguistic diversity are, however, experiencing an extinction crisis with an estimated annual loss of species at 1,000 times or more greater than historic rates and 50-90% of languages disappearing by end of this century (Gorenflo, L.J., et al. 2012). Thus, the conservation of sensitive ecosystems, which provide essential raw materials for herbal medicines and natural products, may not be possible without incorporating endemic languages and traditional cultures into biodiversity conservation strategies.

Since the early 2000's selected local wild harvesting communities have been participating in the test implementation of newly established sustainability standards with the support of buyer/importer companies that require procurement of sustainably wild harvested ingredients with independent certification. Initial implementation in some cases has also occurred in collaboration with non-governmental organizations (NGOs) and governmental agencies charged with nature conservation activities. The FairWild Standard (FWS) is one such standard having been test implemented in several countries of Africa, Asia, Europe and South America in the 9 years thus far from 2005 through 2013.

### **The Fair Wild Standard (FWS)**

The purpose of the FWS is to ensure the continued use and long-term survival of wild species and populations in their habitats, while respecting the traditions and cultures, and supporting the livelihoods of all stakeholders, in particular collectors and workers (FairWild Foundation 2010a). Implementation of the FWS can also contribute to fulfilling regulatory requirements of national resource management systems as well as compliance with international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD).

The development of the ecological module of the FWS, originally called the “*International Standard for Sustainable Wild Collection of Medicinal and Aromatic Plants*” (ISSC-MAP), was supported in part by the German Federal Agency for Nature Conservation (BfN), TRAFFIC International, the World Wide Fund for Nature (WWF), and the International Union for Conservation of Nature (IUCN). The development of the social module of the standard was initiated by the Swiss Import Promotion Programme (SIPPO) (operating under the Swiss State Secretariat for Economic Affairs (SECO)) in cooperation with Forum Essenzia e.V. (Kempten, Germany) and the Institute for Market Ecology (IMO) (Weinfelden, Switzerland).

In October 2008, during the IUCN IV World Conservation Congress, an agreement was signed between the four founding institutions of the ISSC-MAP to endorse global implementation of the standard through the newly established FairWild Foundation.

The FWS Version 2.0 is comprised of 11 principles and 29 criteria addressing ecological, social and economic requirements for sustainable wild collection, which are outlined in Table 1. The FWS couples fair trade principles with sustainable resource management plans to ensure social and ecological sustainability of wild harvested plants. In fulfilling the resource assessment and management plan requirements of the FWS, local botanical experts are generally contracted to conduct species-specific and region-specific research on sustainable collection rates for each botanical to be collected. Harvest methods and practices for each site must be based on this research and may be modified (adaptive management) as new research becomes available. Incorporating fair trade principles, collectors are paid a steady and fair price for collected botanicals. In addition to the fair price, a premium is paid to the collectors and is kept in a separate account that is used to improve the quality of life for the collectors. Use of the premium funds are decided by the collectors, funds may not be taken in cash but rather used to purchase goods that will be of benefit to collectors or to the communities in which they live. Additional principles of the FWS include other social requirements and responsible business practices.

**Table 1.** FairWild Principles and Criteria for Collection Operations

<b>SECTION I: WILD COLLECTION AND CONSERVATION REQUIREMENTS</b>
<b>Principle 1. Maintaining Wild Plant Resources:</b> Wild collection of plant resources shall be conducted at a scale and rate and in a manner that maintains populations and species over the long term.
<b>Principle 2. Preventing Negative Environmental Impacts:</b> Negative impacts caused by collection activities on other wild species, the collection area and neighboring areas shall be prevented.
<b>SECTION II: LEGAL AND ETHICAL REQUIREMENTS</b>
<b>Principle 3. Complying with Laws, Regulations and Agreements:</b> Collection and management activities shall be carried out under legitimate tenure arrangements and comply with relevant laws, regulations and agreements.

<b>Principle 4. Respecting Customary Rights and Benefit-Sharing:</b> Local communities' and indigenous peoples' customary rights to use and manage collection areas and wild-collected target resources shall be recognized, respected and protected.
<b>SECTION III: SOCIAL AND FAIR TRADE REQUIREMENTS</b>
<b>Principle 5. Promoting Fair Contractual Relationships between Operators and Collectors:</b> Collectors have the structures and access to information needed to represent their interests and participate in FairWild Premium decisions. There is no discrimination against particular groups as collectors.
<b>Principle 6. Limiting Participation of Children in Wild-Collection Activities:</b> Collection and processing by collectors is done without substantial work contribution of children.
<b>Principle 7. Ensuring Benefits for Collectors and their Communities:</b> Trade intermediaries are minimized, collectors are ensured a fair price for the collected goods, and community social development is supported through means of a FairWild Premium fund.
<b>Principle 8. Ensuring Fair Working Conditions for all Workers of Wild-Collection Operations:</b> The collection operation ensures good working conditions for all workers of the wild-collection operation.
<b>SECTION IV: MANAGEMENT AND BUSINESS REQUIREMENTS</b>
<b>Principle 9. Applying Responsible Management Practices:</b> Wild collection of target species shall be based on adaptive, practical, participatory and transparent management practices.
<b>Principle 10. Applying Responsible Business Practices:</b> Collection of wild resources shall be undertaken to support quality, financial and traceability requirements of the market without sacrificing sustainability of the resource.
<b>Principle 11. Promoting Buyer Commitment:</b> The buyer of wild-collected products (e.g. importer) strives for mutually beneficial long-term trade relations with the wild-collection operation based on respect, transparency and support for the supplier in quality aspects.

**Source:** (FairWild Foundation 2010a).

### ***Fair Wild Standard Development and Test Implementation***

During the mid-2000's, early versions of both the FWS and the ISSC-MAP were developed, test implemented and refined through a multi-stakeholder process directly engaging wild MAP producer organizations in several countries, particularly in central- and eastern- European countries (e.g. Bosnia & Herzegovina, Croatia, France, Hungary, Macedonia, Poland, and Romania) and Asian countries (e.g. Afghanistan, Cambodia, India, Kazakhstan, Nepal, Uzbekistan, and Siberian Federal District of Russian Federation) but also in some African countries (e.g. Lesotho and Namibia) and South American countries (e.g. Brazil and Peru).

The first companies to attain FairWild certification for certain wild harvested plant materials within their wild resource management plan areas were situated in republics of the former Yugoslavia including three companies in Bosnia & Herzegovina (BiH),

namely Boletus d.o.o. (Hadžići, BiH), Elmar d.o.o. (Trebinje, BiH), and Smrčak d.o.o. (Zvornik, BiH)), one company in Croatia, Terra Magnifica (Donji Stupnik), and another in Macedonia, Alkaloid A.D. Skopje (Skopje). Implementation of the FWS at many sites has been made possible by partnerships between producers (those who collect the plants), processors and distributors (those who process and resell to manufacturers), and manufacturers of finished products. Such partnerships help to ensure that the costs of implementation and maintaining annual certification will be offset by companies willing to pay the full costs of sustainable resource management.

One of the first high volume MAPs to be prioritized by companies and government-funded country projects was licorice (root and stolon of *Glycyrrhiza glabra* L. and/or of *G. inflata* Bat. and/or *G. uralensis* Fischer; Fabaceae). Chinese licorice (*G. uralensis*) is an endangered and nationally-protected medicinal plant species within China where it is one of the most widely used botanicals in the traditional Chinese system of medicine (Zhang, J.T. 2010). Indeed, licorice is among the most widely utilized of all MAP species for domestic consumption in its various countries of origin as well as being one of the highest volume MAPs in the global export trade.

In 2005, implementation of the standards for sustainable wild licorice began in the Almaty Region of Kazakhstan through the financial and technical support of an EU company Martin Bauer GmbH & Co. KG (Vestenbergsgreuth, Germany). Also in 2005 implementation began in the Badakhshan, Baghlan, Bamyan, and Herat Provinces of Afghanistan as part of a program funded by the Dutch development organization Oxfam-Novib with trade support of another EU company, Organic Herb Trading Company (Somerset, UK). First audits were carried out in both Afghanistan and Kazakhstan in 2006 by the Swiss inspection and certification body, Institute for Market Ecology (IMO). In 2007, implementation began in the Amur Darya delta region of Uzbekistan with support of the German Agency for Technical Cooperation (GTZ) and a Swiss trading company W. Kündig & CIE AG (Zurich, Switzerland). More recently the Organic Herb Trading Company mandated implementation of the FWS for wild licorice with a producer group in Spain. Among other potential sustainable licorice projects under consideration, the Georgian Ministry of Economy and Sustainable Development is discussing the possibility of implementing the FWS for wild licorice harvesting in eastern Georgia near the border with Dagestan.

Table-2 provides information on the companies, governmental agencies and NGOs who have played a significant role thus far in the implementation of the FairWild Standard for sustainable licorice root and thereby protecting the sensitive ecosystems where licorice occurs in the wild. Table 3 provides the list of producer groups, brokers, processors and traders, and finished product manufacturing companies presently committed and invested in the FairWild system.

**Table 2.** Partners for the sustainable harvesting of wild licorice root

<b>ISSC-MAP and FairWild® implementation projects for sustainable wild licorice root</b>		
<b>Producer group</b>	<b>Governmental and/or NGO supporting institutions</b>	<b>Trading companies supporting implementation</b>
Various tribal groups involved with licorice collection (Afghanistan)	Oxfam-Novib (Netherlands); UKAID Department For International Development (DFID) Research in Alternative Livelihoods Fund (RALF)	Organic Herb Trading Company (UK)
Herbes del Moli (Spain)	None	Organic Herb Trading Company (UK)
Shirin Mukhid (Uzbekistan)	German Agency for Technical Cooperation (GTZ)	W. Kündig & CIE AG (Switzerland)
A licorice harvesting firm (Kazakhstan) supported by Martin Bauer (Germany)	None	Martin Bauer GmbH & Co. KG (Germany)

**Table 3.** FairWild Operations as of October 2013

<b>Companies</b>	<b>Countries</b>
<b>FairWild-certified Operators (Producers)</b>	
Alkaloid A.D. Skopje	Macedonia
Amin Organic Farm	Azerbaijan
Arid Land Resources (supported by Arbor Oils Kenya)	Kenya
Asociacion de Recolectores de Cacao Silvestre Yuracare	Bolivia
Asva-Raf LLC	Armenia
Boletus d.o.o.	Bosnia & Herzegovina
Herbes del Moli (supported by Organic Herb Trading Co.)	Spain
Martin Bauer GmbH (Germany) supported producer group	Bulgaria
Martin Bauer GmbH (Germany) supported producer group	Kazakhstan
Runo Spólka z.o.o.	Poland
Schmidt und Co. Kft.	Hungary
Viola Ltd. (supported by Organic Herb Trading Company)	Bulgaria
<b>Brokers for FairWild-certified Operators</b>	
Inproplant GmbH	Germany
Josef Weber & C.L. Meyer GmbH	Germany
<b>Processors and Distributors of FairWild-certified Ingredients</b>	
Agrimed Hessen w.V.	Germany
High Quality Organics	United States



<b>Companies</b>	<b>Countries</b>
Martin Bauer GmbH & Co. KG	Germany
Organic Herb Trading Company Ltd.	United Kingdom
W. Kündig & CIE AG	Switzerland
<b>Manufacturers and Marketers of Finished Products with FairWild-certified Ingredients</b>	
Alkaloid AD Skopje	Macedonia
Neal's Yard Remedies	United Kingdom
Pukka Herbs Ltd.	United Kingdom
Traditional Medicinals®, Inc.	United States, Canada

***Wild plant populations managed under the FairWild system***

Presently there are 29 plant species occurring in 11 countries that are being managed under sustainable resource management plans according to FWS requirements for certification. The wild collection sites are subject to annual inspections by an independent third-party inspection and certification organization, the Institute for Market Ecology (IMO) or other organizations authorized to make FWS inspections under agreement with IMO for example Austria Bio Garantie (ABG). Table 4 shows the wild harvested medicinal plants that are commercially available with FairWild® certification as of October 2013.

**Table 4.** Wild Plants with FairWild® Certification as of October 2013

<b>Botanical name</b>	<b>Common name</b>	<b>Plant parts</b>	<b>Countries</b>
<i>Althaea officinalis</i> L. [Malvaceae]	Marshmallow	Leaf, Root	Hungary
<i>Betula pendula</i> Roth. [Betulaceae]	Birch	Leaf	Macedonia
<i>Boswellia neglecta</i> S. Moore [Burseraceae]	Frankincense	Gum-resin exudate	Kenya
<i>Commiphora confusa</i> Vollesen [Burseraceae]	Myrrh	Gum-resin exudate	Kenya
<i>Cornus mas</i> L. [Cornaceae]	Cornelian cherry	Fruit	Azerbaijan
<i>Crataegus monogyna</i> Jacq. [Rosaceae]	Hawthorn	Flower-bearing branches with leaves	Bulgaria
<i>Equisetum arvense</i> L. [Equisetaceae]	Horsetail	Sterile aerial parts	Macedonia
<i>Foeniculum vulgare</i> Miller [Apiaceae]	Fennel	Cremocarps and mericarps	Macedonia

Botanical name	Common name	Plant parts	Countries
<i>Gallium aparine</i> L. [Rubiaceae]	Cleavers	Flowering aerial parts	Hungary
<i>Glycyrrhiza glabra</i> L. [Fabaceae]	Licorice	Root and stolon	Spain
<i>Glycyrrhiza uralensis</i> Fisch. [Fabaceae]	Chinese licorice	Root and stolon	Kazakhstan
<i>Hypericum perforatum</i> L. [Clusiaceae]	St. John's wort	Flowering tops	Macedonia
<i>Juniperus communis</i> L. [Cupressaceae]	Juniper	Ripe cone berry	Bulgaria, Macedonia
<i>Matricaria recutita</i> L. [Asteraceae]	Chamomile	Capitula	Macedonia
<i>Melissa officinalis</i> L. [Lamiaceae]	Lemon balm	Leaf	Bulgaria, Macedonia
<i>Myrtus communis</i> L. [Myrtaceae]	Myrtle	Leaf	Macedonia
<i>Robinia pseudoacacia</i> L. [Fabaceae]	Black locust	Flower	Macedonia
<i>Rosa canina</i> L. [Rosaceae]	Dog rose	Receptacle and remains of the dried sepals	Armenia, Bulgaria, Hungary, Macedonia
<i>Rubus caesius</i> L. [Rosaceae]	European dewberry	Leaf	Hungary
<i>Rubus fruticosus</i> L. [Rosaceae]	Blackberry	Leaf	Bosnia & Herzegovina, Bulgaria
<i>Rubus idaeus</i> L. [Rosaceae]	Raspberry	Leaf	Bosnia & Herzegovina, Bulgaria
<i>Sambucus nigra</i> L. [Caprifoliaceae]	European elder	Flower	Bosnia & Herzegovina, Bulgaria, Hungary, Macedonia
<i>Taraxacum officinale</i> F.W. Wigg. [Asteraceae]	Dandelion	Leaf; Underground parts	Bulgaria, Hungary, Poland
<i>Theobroma cacao</i> L. [Sterculiaceae]	Cacao	Kernels of the ripe seed	Bolivia
<i>Tilia cordata</i> Miller [Tiliaceae]	Linden	Inflorescence	Bosnia & Herzegovina, Hungary, Macedonia
<i>Tilia platyphyllos</i> Scop. [Tiliaceae]	Linden	Inflorescence	Bosnia & Herzegovina, Hungary, Macedonia

Botanical name	Common name	Plant parts	Countries
<i>Tilia tomentosa</i> Moench [Tiliaceae]	Silver lime	Inflorescence	Bulgaria
<i>Urtica dioica</i> L. [Urticaceae]	Stinging nettle	Leaf	Bosnia & Herzegovina, Bulgaria, Hungary, Macedonia, Poland
<i>Urtica dioica</i> L. [Urticaceae]	Stinging nettle	Rhizome and root	Bosnia & Herzegovina, Poland

Source: (FairWild Foundation 2013).

There are also funded country projects where the FWS is presently being implemented within a national strategy as well as company-driven implementations that are in their early stages with certification anticipated in the coming years. For example, the Applied Environmental Research Foundation (AERF) of Pune, Maharashtra has signed an MOU with an EUherbal product company Pukka Herbs (Bristol, UK) who, in collaboration with the Durrell Institute of Conservation and Ecology (DICE) at University of Kent, aim to establish a sustainable supply chain of selected wild medicinal plants from the North-western Ghats with a goal of FairWild certification by 2015 for “bibhitaki” or belleric myrobalan fruit (*Terminalia bellerica* (Gaertn.) Roxb.; Combretaceae) and “haritaki” or chebulic myrobalan fruit (*Terminalia chebula* Retz.; Combretaceae). This partnership between AERF, DICE and Pukka Herbs is part of a three-year (2013-2016) project, “Socio-ecological landscapes for biodiversity conservation and climate change adaptation,” funded under the Darwin Initiative by the UK Department for Environment, Food and Rural Affairs (DEFRA) (University of Kent 2013).

Similarly, the US herbal product company Traditional Medicinals®, Inc. (Sebastopol, California) signed an MOU with the Shuijing Traditional Chinese Medicine Materials Cooperative (Shuijing Town, Pingwu County, Sichuan Province, China) for the long-term sustainable supply of “nanwuweizi” or southern schisandra fruit (*Schisandra sphenanthera* Rehder & E.H. Wilson; Schisandraceae), with project goals of FairWild, Organic Wild, and Panda Friendly certifications. The MOU between the US company and the cooperative was signed as an outcome of a five-year (2007–2011) project, “Sustainable Management of Traditional Medicinal Plants in the High-Biodiversity Landscapes of Upper Yangtze Eco-region,” which was a field project within the EU-China Biodiversity Programme (ECBP), funded by the EU and implemented by the United Nations Development Programme (UNDP) in cooperation with China’s Ministry of Environmental Protection. One of the very positive lessons learned in this project was through the early identification and targeting of socially responsible herbal product companies nearly at the start of the five-year project. The inviting of interested companies to participate as stakeholders contributed significantly to the successful implementation of sustainability standards, meeting the goal of achieving third-party certification, and resource management continuity through establishing a long-term

fairtrade relationship between the cooperative and two companies (a Chinese extraction company and a US herbal product company). Experience has shown that it is more common for similar sustainable development projects to come to an end after government funding and technical cooperation stops, particularly in cases where reliable buyers for certified botanicals have not been invited into the project. This case demonstrated that responsible companies can play a useful role towards biodiversity conservation through trade agreements based on the FWS (Brinckmann, J., and Morgan, B. 2012).

Country projects where the FWS is presently being implemented but where linkages to buyers of the eventually FairWild certified ingredients has not yet been established include a UNDP country project for Morocco, “*Mainstreaming Biodiversity into Value Chains for Medicinal and Aromatic Plants in Morocco*,” funded by the Global Environment Facility (GEF) involving sustainable resource management plans for Moroccan wild oregano aerial parts (*Origanum compactum* Benth.; Lamiaceae), Moroccan wild thyme flowering aerial parts (*Thymus saturejoides* Coss.; Lamiaceae), and wild rosemary leaf (*Rosmarinus officinalis* L.; Lamiaceae), possibly among other MAPs (Global Environment Facility 2010).

The “Traditional and Wild” project, a Central Europe Programme co-financed by the European Regional Development Fund (ERDF), is implementing the FWS in several eastern European countries including Czech Republic, Hungary, Poland, and Slovenia. The project has already carried out and published resource assessments for several MAP species (Central Europe Programme 2013). Table 5 provides a list of the assessed wild species and the collection regions where the FWS is being applied.

Additionally, a number of EU and US botanical ingredient processing and distributing companies plan to invest further in FairWild implementation at selected sites within their own networks of wild harvesting enterprises, including the companies High Quality Organics (US), Martin Bauer GmbH & Co. KG (Germany), Organic Herb Trading Company (UK), W. Kündig & CIE AG (Switzerland), and Worlée Naturprodukte GmbH (Germany).

**Table 5.** Resource Assessments for MAP species in Traditional and Wild Project

Botanical name	Common name	Plant parts	Countries
<i>Betula pendula</i> Roth. [Betulaceae]	European white birch (silver birch)	Leaf	Region of Rzeszow, Poland
<i>Equisetum arvense</i> L. [Equisetaceae]	Horsetail	Sterile aerial parts	Rzeszow’s Region, Poland
<i>Juglans regia</i> L. [Juglandaceae]	English walnut	Leaf	Šentjur’s region, Slovenia
<i>Juniperus communis</i> L. [Cupressaceae]	Juniper	Ripe cone berry	Region of Kiskunság, Hungary

Botanical name	Common name	Plant parts	Countries
<i>Rosa canina</i> L. [Rosaceae]	Dog rose	Receptacle and remains of the dried sepals (hip)	Czech Republic
<i>Rubus idaeus</i> L.; Rosaceae	Raspberry	Leaf	Lokve's region, Slovenia
<i>Sambucus nigra</i> L. [Caprifoliaceae]	European elder	Flower, Fruit	Czech Republic; Ormánság Region, Hungary; Šentjur's Region, Slovenia
<i>Urtica dioica</i> L. [Urticaceae]	Stinging nettle	Aerial parts, Leaf	Czech Republic; Lokve's Region, Slovenia
<i>Vaccinium myrtillus</i> L. [Ericaceae]	Bilberry	Fruit, Leaf	Rzeszow's region, Poland

Source: (Central Europe Programme 2013)

**How collectors are deciding to use the FairWild Premium Fund and the difficulties faced**

An unanticipated difficulty with implementing certain parts of Principles 5 and 7 of the FWS has been reported similarly by many of the certified producer operations. Principle 5.1 requires that an economic relationship exist between the wild collection enterprise and its registered collectors that is fair and transparent, thus allowing the collectors to be involved in important decisions such as FairWild premium fund use or pricing agreements. Principle 7.2 deals with the actual administration and use of the premium fund for community social development purposes, i.e. collectors should form a representative committee or democratically elect a stakeholder board that is accountable for the receipt, administration and decisions on appropriate use of the premium fund monies.

The problems faced thus far with the premium fund requirements of the FWS vary from country to country. In some countries it has not been possible for the collectors to establish a separate bank account for the receipt and administration of premium fund monies due to complicated national regulations. Buyers have had to experiment with different ways to transfer these funds without putting the producer enterprise at risk of violating a regulation. In several countries, we have learned that each collector is required to pay income tax on a proportional share of the overall premium fund (as though it was income, which it is not) which diminishes the amount made available for community social development purposes.

In certain cases, making a democratic decision on equitable use of the premium fund has been complicated in that some communities have stated that they would

prefer to not have the money used towards an expenditure that would benefit the entire community. Issues of fairness are raised, in that some households include collectors who are working full-time, while other households may include collectors working only part-time and some villagers are not participating in the collection at all. Thus, the registered collectors may not view it as “fair” if non-collectors in their village benefit from the community development fund. In most cases, the individual collectors state that they would prefer to instead receive additional cash and be allowed to make their own personal decisions on how best to spend it towards improving the quality of life for their family. The latter suggestion could be problematic for FWS requirements that the funds are used to improve quality of life depending on the cultural context and who in the household is actually empowered to make decisions on how money is spent for the family.

In wild collection operations where there are only a few collectors working together in a brigade, the establishment of a democratic framework for deciding on how best to use the social premium fund each year has worked rather well. However, in collection operations where there may be hundreds of collectors, not all living in the same community or village, this aspect of the standard for supporting social sustainability remains a complicated issue to sort out.

### **Consumer’s Willingness to Pay the Price for Biodiversity Conservation**

While there are certainly other relevant sustainable harvesting practice standards for MAPs being implemented around the world, the FWS is presently the most visible standard that is specifically linked to management of wild plant populations in context of biodiversity conservation. Popular branded herbal products, now bearing the FairWild® certification mark on their labels, are found on retail store shelves in several EU and non-EU European countries, throughout Canada and the United States, and in several Asian and Oceanic regions, in particular Australia, Hong Kong, Japan, New Zealand, the Philippines, and Taiwan. The website address of the FairWild Foundation is presented on labels which enables consumers to learn more about biodiversity conservation and how they are playing a role by choosing to purchase and use products from responsible companies who are investing in natural resource management, sustainable production, trade and use.

Other sustainability standards being implemented that are playing a positive role in biodiversity conservation and sustainable harvesting of MAPs include, among others, the Fair for Life Social and Fairtrade Programme for Wild Collection Operations (Bio-Stiftung Schweiz 2011) and the STD01-Ethical BioTrade Standard (Union for Ethical BioTrade 2012).

For labelling and marketing of sustainable herbal and natural products at the retail level, especially in the North American market, compliance with multiple standards is becoming more commonplace and product labels from ethical companies are beginning to

display a range of several relevant certification marks that communicate different aspects of sustainability, not only for the product's wild-collected botanical ingredients but also for plant-based packaging components. For example, there are finished products labelled with the FairWild certification mark that are also labelled with the United States Department of Agriculture (USDA) organic certification mark which shows compliance with the USDA National Organic Program (NOP) Wild-crop Harvesting Practice Standard (United States Department of Agriculture 2011) as well as with the Non-GMO-Project verification mark which shows compliance with the Non-GMO Project Standard for product ingredients and plant-based packaging components (Non-GMO Project 2013).

## **Discussion**

The theory asserting that biodiversity conservation can be facilitated through sustainable management, use and ethical trade of economic plants is still being tested. In this new social business model, the local, rural or indigenous people, who earn some or all of their household income from wild collection of plants, are to be paid fairer prices that not only cover the costs of resource management activities in the long term, including required conservation investments, annual inspections and certification, but also provide for a reliable annual income leading to local economic security with funds also available for community social development (FairWild Foundation 2010b). The hypothesis is that wild collection communities will be incentivized and empowered to become stewards of the ecosystems that they themselves are a part of - so long as the certified sustainably harvested products that they bring to market will command an appropriate price premium. The incentive needs to be high enough to ensure long-term economic viability of wild collection enterprises in rural areas so that the transmission of TEK from generation to generation can continue and so that the dwindling number of young people interested in carrying on the ancient tradition of wild collection will reverse and start to increase.

For the FWS and other sustainability standards to have measurable positive impact for the long-term survival of MAP species in healthy ecosystems there also needs to be a large enough public willing to pay premium prices for sustainably produced products of biodiversity. That theory is also being tested, mainly in the North American and Western European countries where the largest markets for certified organic, non-GMO and fairtrade products exist and continue to grow year after year. For example, in the US market, sales of natural products featuring third party certifications surged in 2012 with non-GMO verified products increasing 18% over the previous year, fair trade certified product increased 17%, and certified organic products increased by 12% (Watson, E. 2013).

Approaching the end of the first decade of FWS implementation, the number of certified producers, registered processors and traders, and finished product licensees continues to grow steadily but many more companies need to join and invest in the FairWild system and/or other comparable resource management systems before we'll reach a significant global impact on biodiversity conservation.

A growing number of product companies are indeed becoming interested in the implementation of sustainability standards in collaboration with their producers and suppliers because it appears to economic sense in the long term. Businesses that invest in the independent certification of sustainable resource management for their botanical ingredients find that it complements and supports their overall quality assurance system, reduces supply chain risk and uncertainty, supports compliance with food safety regulations by offering full traceability and transparency, and most of all enables a sustainable supply of raw materials based on long-term planning and equitable trade agreements between the sellers and buyers as required under the FWS. The ongoing monitoring and adaptive management requirements for FWS compliance should protect at least the mapped and controlled wild collection areas subject to inspection and certification. And in some cases we have seen a positive influence made on neighboring or nearby resource managers who may consider joining the FairWild system once they observe the economic and social benefits to their local community.

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## Water Governance and Climate Change Policy in Delhi

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— *Rabidyuti Biswas and Jasprit Kaur*

### ABSTRACT

Climate change is likely to increase the frequency, intensity, and duration of extreme events in unpredictable ways and will require cities to develop adaptation strategies that enable them to manage this variability and uncertainty (ACCCRN, 2009). The affect of climate change in relation to water availability is a debated issue. The impacts of climate change on urban water systems are not always direct. However the water in urban may suffer from scarcity of water due to drought, sudden high intensity precipitation will create flood in urban area, reduce permeable surface will not allow water to recharge ground water which is a major source of water in urban area or water lines may be destroyed in such flood or storm.

Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021. The growth of population exerts severe stress on the water supply system in Delhi. Delhi urban area has highest per capita supply of water in India. The estimated demand of water is 1140 million gallon per day (mgd) in 2011 where as the supply has been only around 830 mgd. It is predicted that with existing pressures on water availability and use, the impacts of climate change on water will be strongly felt by water managers. In this context, municipal water systems and water governance need a strategy to enact and follow a more sustainable, resilient and equitable water management approach.

National Action Plan for Climate Change and Climate Change Agenda for Delhi have a separate Water Mission. New National Water Policy 2012 has also integrated climate change issues as a part of its policy. Integration of water management and climate change policy had been attempted in Delhi. This paper tries to analyze the water governance and current methodology adopted in Delhi for climate change action plan and water management. Finally this paper also explores the possibilities of better integration of water management and Climate Change Agenda for Delhi.

**Key word:** Urban, Climate Change Action Plan, Water Management, Water Mission

**Introduction**

Water is a natural resource available in atmosphere, on ground and underground. The availability of water is finite but renewable. The per capita water availability in the country is reducing progressively due to increase in population. The average annual per capita availability of water in the country was 1816 cubic meter in 2001 which reduced to 1545 cubic meter as per the 2011 census. According to the UNDP, if per capita annual water availability is below 1700 cubic meter per person the area is considered as water stressed. So for the present situation of availability of water India is a water stressed country. Limited availability of water and growing demand of water due to increasing population, urbanization and industrialization is a serious concern. In addition due to the contamination of water sources and poor water treatment facility it is often difficult to have safe drinking water in urban area. On the other hand the level of urbanization increased from 27.81% in 2001 to 31.16% in 2011 (Census 2011). To provide drinking water to the increased urban area is becoming critical because the absence of new sources near these urban areas, existing fresh water sources are becoming polluted, per capita water consumption is increasing and because of the high wastage of water due to extended large network of water supply system without proper maintenance.

Climate change refers to changes in averages in temperature and extremes in the weather of a region or of the planet as a whole over time. It can be measured by changes in temperature, precipitation, wind, storms and other weather indicators. These changes sometimes lead to extreme events, which creates disasters. Urban areas witness high concentration of population, industries and infrastructure making them more susceptible to these effects of climate change. Climate change is likely to increase the frequency, intensity, and duration of extreme events in unpredictable ways and will require cities to develop adaptation strategies that enable them to manage this variability and uncertainty. The affect of climate change in relation to water availability is a debated issue. The impacts of climate change on urban water systems are not always direct. However the water in urban may suffer from scarcity of water due to drought, sudden high intensity precipitation will create flood in urban area, reduce permeable surface will not allow water to recharge ground water or water lines may be destroyed in sudden flood or storm. In this context judicious planning for water resources is necessary for urban area. The municipal water systems and water governance need a strategy to enact and follow a more sustainable, resilient and equitable water management approach with effective integration of climate change adaptation and mitigation policies at city level.

Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021 (Master Plan of Delhi, 2021). The growth of population exerts severe stress on the water supply system in Delhi. Delhi urban area has highest per capita supply of water in India. The estimated demand of water is 1140 million gallon per day (mgd) in 2011 where as the supply has been only around 830 mgd. It is predicted that with existing pressures on water availability and use, the impacts of climate change on water will be strongly felt by water managers.

Therefore Delhi also needs efficient water governance with more sustainable, resilient and equitable water management approach.

The integration of water management and climate change policy had been attempted in Delhi through Climate Change Agenda for Delhi (2009-2012) with a separate Water Mission. This paper tries to analyze the water governance and current methodology adopted in Delhi for climate change action plan and water management.

### Water governance in Delhi

Delhi is situated on the banks of river Yamuna, located at 28.38° N and 77.13° E on the northern part of India and stretched over an area of 1483 sq. km. Delhi is experiencing population increase from 0.4 million in 1911 to 16.75 million in 2011 and the population is expected to become 23 million by 2021 (Table 1). The growth of population exerts severe stress on the water supply system in Delhi.

**Table 1.** Population growth and estimated population of Delhi

Year	Population (million)	Growth rate (%)
1971	4.06	52.93
1981	6.22	53.00
1991	9.42	51.45
2001	13.85	47.02
2011	16.75	20.94
2021(estimated)	23.00	37.31

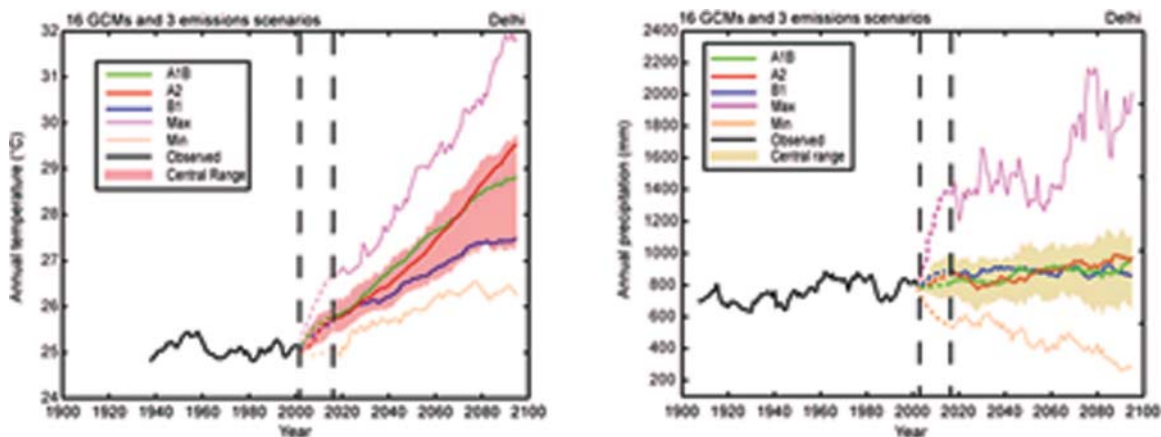
Source: [www.delhiplanning.nic.in](http://www.delhiplanning.nic.in) and Mater Plan of Delhi, 2021 and Census 2011(Provisional).

The Delhi Jal Board (DJB) is responsible for the production and distribution of potable water after treating raw water from various sources and also provides treatment and disposal of wastewater. DJB supplies treated water in bulk to the New Delhi Municipal Council (NDMC) and to the Delhi Cantonment Board (DCB) areas both of which are responsible for the distribution of water within their own territories. The provision of water in the areas under three Municipal Corporations of Delhi (MCD) is the responsibility of DJB. There are several authorities engaged in the provision, development and maintenance of water supply in Delhi. The Delhi Development Authority (DDA), MCD, DCB and NDMC are directly responsible for provision of water and plan for new development activities. Besides these, Ministry of Water Resource in the National Level and Central Ground Water Authority (CGWA), Central Ground Water Board (CGWB), Central Public Works Department (CPWD), State Public Works department (PWD) and other government and non-governmental organizations are engaged in preparations of policy and technological implementation and other aspects of water management in Delhi. Because of the presence of a large numbers of organizations involved directly and

indirectly for the development and related water provisions in Delhi it is necessary to involve these organization in the climate change action plan formulation for Delhi and the responsibilities are to be clearly defined for the proper implementation of the plan.

### Climate Change and Water Issue in Delhi

The climate change projection for Delhi (Figure1.) portrays that an increase in temperature and increase in the precipitation with high fluctuation may cause water logging, flooding and water availability for a limited period of time. The significant changes are expected due to climate change in the river morphology that will influence the water availability and increase water scarcity for Delhi because water sources of Delhi depends on rivers and distant dams. Climate change has enhanced the concerns for rising risks from extremes climate and particularly those influencing water related hazards. The water related hazards in Delhi might include water scarcity, river flooding, flash flooding, ground water depletion, lack of supply and no supply to the slum and poorer areas, which are more vulnerable. All of these hazards are likely to be intensified with rising temperature, declining or sudden high intensity precipitation. The uncertainty associated with monsoon is further likely to amplify the problems of flash flooding and less ground water recharge in Delhi.



**Figure 1.** Climate change prediction for Delhi (Mehrotra, 2009)

The following section briefly looks at the water problems associated with Delhi, which are likely to exacerbate as a result of climate change. The water related vulnerability in Indian cities as established in the case of other Indian city by ISET and Pacific Institute, 2011 are

- Demand-supply gap in water and dependence on a single distant surface water source,
- Lack of access to water by the poor,

- Poor management of water utility: finances, infrastructure, complaints,
- Lack of groundwater management,
- Lack of water quality monitoring and regulation,
- Lack of information and understanding of climate change impacts,
- Lack of networking and information flow between different water managers.

Some of these issues were discussed in Climate Change Action Plan (2009-2012) for Delhi but vulnerability analysis or assessments for any of these aspects were not done. The issue of risk reduction and adaptation to climate change has received little attention (Sharma, et al, 2010) in the climate change action plan for Delhi. Some of these aspects of risk and vulnerability issues are discussed in this report in detail.

### **National Action Plan on Climate Change (NAPCC)**

It is predicted that India may face a major threat in the sectors such as water, agriculture and forestry because of the projected climate change as its economy closely tied to the natural resource base. It has been realized that India needs a national strategy to adapt to climate change and to further enhance the ecological sustainability in all its development. In order to address the climate change in the country, the National Action Plan on Climate Change (NAPCC) outlining policies and programs addressing climate mitigation and adaptation was released in June 2008.

The NAPCC identifies key sectors that are likely to get affected as a result of climate change. Each of these sectors has been discussed in the form of missions, wherein policy interventions have been carved out to address climate change at that sector level. The NAPCC identifies eight missions representing multi pronged, long-term and integrated strategies for achieving key goals in the context of climate change. These missions are (1) National Solar Mission, (2) National Mission for Enhanced Energy Efficiency, (3) National Mission on Sustainable Habitat, (4) National Water Mission, (5) National Mission for Sustaining the Himalayan Ecosystem, (6) National Mission for a Green India, (7) National Mission for Sustainable Agriculture, (8) National Mission on Strategic Knowledge for Climate Change. As this paper is discussing the water governance and policy in light of climate change, the description on National Water Mission is important.

### **National Water Mission**

The National Water Mission was formulated and envisaged to ensure integrated water resource management helping to conserve water, minimize wastage and ensure more equitable distribution both across and within states. The water mission considered the provisions of the National Water Policy. Optimisation of water use by increasing water use efficiency by 20% through regulatory mechanisms with differential entitlements and pricing was encouraged. It also emphasised that the urban water need to be met through

recycling of waste water and the water requirements of coastal cities with inadequate alternative sources of water to be met through adoption of new and appropriate technologies such as low temperature desalination technologies.

### **Delhi Action Plan on Climate Change (DAPCC)**

Different ministries were directed to submit detailed implementation plans to the Prime Minister's Council on Climate Change. Following this, the Ministry of Environment and Forests (MoEF) has also asked Delhi government to submit state level action plan on climate change on the lines of the NAPCC. To respect the climate change initiative for Delhi government wanted to integrate the agenda for climate change into policy framework and wanted to make these agenda operational through the action plans of different departments and organizations. The Department of Environment and Forests, Government of National Capital Territory of Delhi prepared the Delhi Action Plan on Climate Change and assigned targets to the individual departments and government bodies. It also regulates and monitors the implementation of the targets under DAPCC.

The Climate Change Agenda for Delhi comprises of the six missions (1) Solar mission, (2) Enhance energy efficiency, (3) Sustainable Habitats, (4) Green Delhi, (5) Water mission, (6) Strategic Knowledge. The agenda primarily aims to reduce Delhi's carbon footprint by identifying a set of 65 action points that each department within the Delhi government would have to follow. Out of these six missions, the Water Mission formulated the policy and action plan for addressing the water problems in Delhi.

### **Water Mission for Delhi**

The Water Mission specifies different ways through which water problems shall be addressed in the case of Delhi. These have been identified as targets that should be achieved. These include water efficiency, installation of water recharge systems, re-use of wastewater, treatment of wastewater through interceptor sewers, wastewater treatment by connecting all houses to the sewer system, wastewater treatment for industries by improving the work of the Effluent Treatment Plants (ETPs), water recharging by restoring water bodies, treatment of all the wastewater by setting up Sewage Treatment Plants (STPs) in villages, collecting storm water from villages and providing proper drainage system and enhancing the water availability for Delhi by constructing Renuka Dam. In order to address these targets, the agenda also specifies the respective authorities, which shall be responsible for the implementation of the same. There is a long list of departments and organizations identified for implementations of the action plans these are DJB, MCD, DDA, Public Works Department (PWD), Engineers India Limited (EIL), Delhi State Industrial and Infrastructure Development Corporation (DSIIDC), Department of Industries (DI), Department of Urban Development, Department of Environment, Department of Irrigation and Flood Control, etc.

The Department of Environment and Forests himself is responsible for restoring water bodies in Delhi to ensure ground water recharge. The DJB was assigned to take action to construct ground water recharge system, waste water treatment through interceptor system, connecting all houses with sewer system, setting up STPs in all villages, waste water reuse, water recharging by restoring water bodies. The MCD to construct the systems of collection of storm water from villages and proper drainage, waste water collection and treatment from unauthorised colonies, waste water reuse, ground water recharging by restoring water bodies. The DDA should do waste water reuse and ground water recharge by restoring water bodies. The DSIIDC to construct waste water treatment at industrial level, installation of Effluent Treatment Plants (ETPs) and ground water recharge by restoring water bodies. Analysis of these action plans and achievements are discussed in following sections.

### **Water Source and Interstate Dependency**

One of the targets of the Climate Change Action Plan for Delhi was for enhancing the water availability for Delhi by constructing Renuka Dam. The Yamuna River is the main source of water for Delhi. Delhi gets 83% of its raw water from surface water sources and 17% from ground water sources. The surface water sources in Delhi basically comprise of the river Yamuna, canals, drains and the lakes or ponds. The surface sources of water supply of Delhi are through different interstate arrangements. Delhi is presently sourcing major part of its water from long distance. Dependence on such distance source for Delhi is a major concern in the perspective of climate change. This also adds in the cost of transport and treatment.

All planning for future water supply in Delhi is based on anticipated raw water inflow from three large dams under construction in the Himalayas, which may not be able to supply water for near future due to the environmental controversies associated with these projects and climate change effects on these sources are also major concern for the availability of water for Delhi. The approach of sourcing water from distance source is against the principle of climate adaptation. It also discourages the search for the use of local potential sources and maintaining these for sustainable water use.

The DJB's approach is basically a supply side approach by exploiting additional water resources to meet the increasing water demand of Delhi. The Central Ground Water Board also has provided details of fresh water sources in the city to the DJB but DJB has not exploited the potentials of those sources. The Central Ground Water Board (CGWB) also assessed 215 billion cubic meters surplus monsoon runoff that can be stored and utilized for future but DJB has not utilized the potential yet and DJB did not consider it as an alternative source. In the present water mission there is no role provided to CGWB which is responsible to ensure sustenance of ground water in Delhi. The surface water source of Delhi depends on many interstate treaty and understanding. Representation of these states and central government organizations related to water governance should have been included as stakeholders in the action plan.



**Water Efficiency**

As per the climate change action plan the DJB is to ensure water efficiency by power reduction (10%) in Sewage Pumping Stations and in the water supply system and a detailed plan for 20% efficiency needed to be prepared. The National Water Mission also proposed increase in water use efficiency of 20% through better regulatory mechanisms with differential entitlements and pricing. The enhancement of water efficiency through water saving appliances is one of the important steps. This has not been encouraged or policy has not regulated to ensure that the people should use such appliance to reduce water demand and increase water use efficiency. About 3.99 lakh connections are unmetered and 4.00 lakh are defective meters (Economic Survey of Delhi 2012-13). This leads to a lump sum water tariff for the consumer. As the tariff is not based on actual consumption people do not practice water conservation. This issue also has not been considered in climate change action plan for Delhi. Whether it is rich or poor all pay the same cost and while the distribution system in rich areas is better and hence the availability is also better but the same is not true for poorer areas of Delhi. New strategies need to be tried out to conserve water and increase the efficiency of water use and equitable supply to all.

The National Water Policy 2012 has the objective of increasing water use efficiency and cover wide range of actions such as adequate provision for operation and maintenance of water resources projects, promotion of water efficient techniques and technologies, improving efficiency of water supply systems, efficiency labeling of water appliances and fixtures, equitable distribution of water and rational charges for water facilities and promotion of mandatory water audits, including those for drinking water purposes. All these probable actions were not considered as a part of the Water Mission in Delhi.

**Demand and Supply Coverage**

The water mission also asks to ensure 100 % connection (3% per year) by DJB, but as per the Census 2011 it is seen that only 81% of the total households in Delhi have piped water connection. This also does not include slum and unauthorized area of Delhi. Water scarcity is rather a more common hazard in Delhi. Due to constant population growth and increasing temperature that water scarcity has become more frequent. Recently Delhi experienced some major water scarcity in the year 2002, 2011 and 2012. South Delhi areas are affected regularly in such water scarcity incidents. The water treatment and supply capacity was 66 million gallons per day (mgd) in 1965 and rose to 855 mgd in 2012 (Economic Survey of Delhi 2012-13) where as the estimated demand of water was 1140 mgd in 2011 with almost 25% demand supply gap and this will continue to increase because there is less possibility of getting water from new distance sources. There is also an alarming transmission loss of 48 percent (Basil, 2004), which reduces the actual treated water available to consumer. The Master Plan of Delhi, 2021 (MPD, 2012) has given the water requirement 80 gpcd (360 lpcd) with breakup of domestic

and non-domestic as 50 gpcd (225 lpcd) and 30 gpcd (135 lpcd) respectively. The MPD-2021 provided a water requirement of 1380 MGD by DJB estimation and 1840 by DDA estimation for 2021 (Table 2), whereas the maximum water augmentation capacity by DJB is around 940 MGD by 2021. Therefore the supply and demand gap will continue to increase and people will depend more to the unsustainable arrangement of water to reduce the gap.

**Table 2.** Estimated water demand in Delhi

Year	Populations in million	DJB estimation (MGD) (@60 gpcd)	DDA estimation (MGD) (@80 gpcd)
2006	16.5	990	
2007	17.5	1050	
2011	19	1140	1520
2021	23	1380	1840

Source: DJB and MPD 2021

The proposed steps to meet the shortfall as per MPD, 2021 is to expedite the construction of more dams and increase the height of dam and transfer of large volume of water through interstate agreement but there is no proposal for reducing the water demand through demand management. As a general principle the sustainable sources of water responds more to the climate change adaptation, which is missing in water management plan for Delhi.

The standards on which the DJB and DDA is working are very high as compared to other Indian Cities (Mumbai 135 lpcd, Chennai 80 lpcd, etc.). Moreover standards set by two organizations are different show the lack of understanding between the two organizations for water provision in Delhi. The DJB is unable to provide continuous supply of water which leads to water wastage, water contamination and responsible for reducing the life of the system. Most of the European, Asian and African cities able to manage 24 hour supplies with much less water than Delhi (Lal, 2005). The present water supply standard appears to be unrealistic, which also need to be reconsidered for the perspective of climate change affect.

The estimated breakup of the per capita demand as given in Table 3 (Khare, et al, 2006) clearly shows that the other demand except domestic demand need not to be the potable water, recycled water or water from other sources can be used for the same. It is necessary to classify the quality of water required for different activity in our day-to-day life, like for drinking and cooking, for washing, for toilet flushing, for industries, for recreation, for maintaining garden and urban green etc. The dual supply (water for drinking and cooking and water for other uses) needs to be seriously considered for Delhi to reduce the demand of treated water so that the GHG emission on the treatment of potable water can be reduced.

**Table 3.** Break up of water usage for 50 gallon per capita per day (gpcd)

Purpose	Potable @30gpcd (135 lpcd)	Non-potable@ gpcd (90lpcd)
Drinking	05	
Cooking	10	
Washing clothes	30	
Washing utensil	20	
Washing hand and faces	10	
Bathing	60	
Floor washing		30
Flushing of toilets		60
Total @225 lpcd	135 lpcd	90lpcd

Source: Khare et al, 2006

***The per capita demand can be reduced through policy measures and with appropriate technology. DJB has initiated a water saving programme through media to educate people, but these efforts are not sufficient. More over DJB or any other organizations in this context are not encouraging the use of water saving devices in the system. Presently the market doesn't provide water appliances and water use devices with information on water saving whereas the National Water Policy 2002 and 2012 has given emphasis on water efficiency.***

However to improve the situation the MPD-2021 has given emphasis on the following guide lines

- To promote water conservation through an integrated and community driven model.
- Recycling of treated wastewater with separate lines for potable water and recycled water.
- Groundwater recharging through rain water harvesting, conserving water bodies and controlling encroachments.
- Focused planning and action to be taken to prepare and implement rain water as roof water harvesting schemes both with the aim of optimizing water use and ground water recharge.

The above issues have been addressed in MPD 2021 but not considered in Water Mission and no action plan is properly formulated for the same. There is a need for proper technical, physical and economical investigation to offer consumers the appropriate options for efficient water management. The benefit in terms of reduction of Green House Gas (GNG) and options to climate change adaptation should be demonstrated and proper policy and institutional arrangement should be made for implementation. There is no consideration for water use efficiencies and use of water saving devices to reduce the demand. With the increase of the water demand in Delhi and due to prevalent

supply gap, the dependency groundwater, packaged water, tanker water supply etc. will multiply the cost of health and environment in Delhi if there is no alternative approach initiated.

### **Wastewater Management**

Installation of water recharge systems, re-use of waste water, treatment of wastewater through interceptor sewers, wastewater treatment by connecting housing at all levels to the sewer system, wastewater treatment for industries by improving the work of the Effluent Treatment Plants (ETP), water recharging by restoring water bodies, treatment of all the waste water by setting up Sewage Treatment Plants (STP) in villages, collecting storm water from villages and providing proper drainage are considered to be the action plan for water mission in Delhi. MCD has to provide drainage, wastewater treatment by mini STPs facilities to all villages in Delhi, water reuse to be started (50MGD) by DJB, interceptor wastewater treatment facilities to be installed (JnNURM) by DJB.

Wastewater treatment capacity of Delhi is about 515 MGD as in 2012. The actual quantity of wastewater treated is much below around 63% of the installed capacity due to incomplete sewer connectivity and chocking of sewer lines. A proper inventory of existing sewer system and network plan is necessary to find out actual area coverage and missing link. As per the Economic Survey of Delhi report 2012-2013 the sewage treatment plants are not functioning up to their optimal level due to various reason such as low flow of sewage to STPs, trunk and peripheral sewer still to be connected to the STPs, rehabilitation of silted and settled trunk sewer lines yet to be completed. The total sewage generation is about 670 MGD and treatment is around 322 MGD and untreated sewage around 348MGD falling in river Yamuna. Cleaning of the river Yamuna had been given top priority. Measures for treatment of industrial wastewater in Effluent Treatment Plants, decentralized wastewater treatment facility had also been given priority. About 200 villages were considered for connecting with sewer line with proper drainage system. But the improvement in this regards is hardly visible. The treated wastewater is hardly being used and the horticulture water needs are not met. The result is all the public parks and their lawns and gardens are not maintained and remain parched ([www.vigyanvijay.org](http://www.vigyanvijay.org)).

The untreated sewage is released directly into the 14 open drains in Delhi, which finally discharge in to Yamuna. The officials have not properly considered how the treated effluent would be disposed and if indeed it could be reused. A city will be more efficient if it collects water locally, supplies it locally and disposes waste locally (Narayan, 2006). So the decentralized system of waste water treatment can ensure effective use of recycled waste water and can help to achieve the target set by the water mission. A new management strategy needs to be devised for this with an effective regulatory mechanism (Mehta, 2009).

**Floods**

The floods in Delhi are due to the mismanagement of the situations by concerned authorities and it is clear from the recurring phenomenon of floods in the river Yamuna and flash floods caused by rains due to choked drains of Delhi. Delhi experiences also floods from the river Yamuna and the Sahibi River via the Najafgarh drain. In last thirty-three years, the Yamuna River crossed its danger level for twenty five times (DDMA, 2010). However, the major events of flooding have been less. The major floods of the last century were flooding in 1924, 1947, 1976, 1978, 1988 and 1995. One common aspect of all floods was that the poorer areas located near the floodplain of Yamuna were most affected. Studies also note that the risks from flooding in Delhi have increased over time. In 2010 the river Yamuna flowed two meters above its danger mark (fixed at 204.83m), which caused an evacuation of over 2000 people from North and East Delhi (DDMA, 2010). The flood affected the low-income group colonies worst than other areas. Vulnerability mapping and adaptation strategies for such risk has not been identified and initiated in the Water Mission of Climate Change Action Plan for Delhi. Delhi Disaster Management Authority (DDMA) is responsible for preparation of vulnerability map. Action Plan for climate change does not include DDMA as a stakeholder of climate change action plan and vulnerability due to climate change is not considered for mitigation and adaptation.

**Local Flooding**

Local flooding is a significant phenomenon, which has been increasing during recent years in Delhi. There are more impervious surfaces (roads, pavements, houses etc) in Delhi. High rates of development along with the resultant loss of soft landscape have led to high surface water run-off rates. This results in flash floods in the low-lying areas even after moderate precipitation. Another factor adding to this effect is that of river because the river is already flowing at a higher level within its embankments. Thus, the water gets logged in the city areas and it takes several days to mechanically pump it out and bring the situation under control. Similarly, during the past few years, flooding due to the city's 18 major drains has also become a common phenomenon. Already under the pressure of the city's effluent discharge, these drains experience reverse flow from the Yamuna and cause flooding the neighboring colonies (DDMA, 2010). These are the area where the effect of the climate change will be more and needs to be mapped for preparation of mitigation and adaptation strategies.

**Ground Water Depletion**

Ground water is another major source of water in Delhi. As per the report release by CGWB, 2008, the dynamic ground water resources in Delhi have been assessed as 292 Million Cubic Meter (MCM) in 2003 (withdrawal equals to 312 MCM) as compared to 428 MCM in 1983 showing an overdraft and reduction of around 130 MCM over past 20

years and about 75% of area of Delhi ground water levels are declining at an alarming rate of 0.20 m per annum. It is a matter of serious concern. Total volumes of ground water extraction by private tube wells are very high where the natural recharge of ground water in the Delhi found to be lower than five per cent in most of the area (Datta, et al, 1996). According to a study done by the CGWB it will take just 2,600 additional tube wells running at an average of ten hours per day to exhaust the entire reserve of underground water in Delhi (Jha, 2006). The net result is the alarming depletion of ground water and deterioration of ground water quality. The change in the rainfall pattern with more intense precipitation for limited period due to climate change will farther reduce the recharge of ground water, if serious efforts on artificial recharge are not enhanced and abstraction of ground water illegally totally stopped. The Climate Change Agenda for Delhi does not talk about this issue at all.

### **Conservation of Water Bodies**

The water recharging by restoring water bodies also one of the action plan of the Water Mission of the Climate Change Agenda for Delhi. The Mission identifies 620 water bodies that shall be restored and used for water recharging and also mentions which organization and bodies shall do the same, however, it does not outline in detail the manner in which this is to be achieved and how the role of each organization will differ in this. The deepening of old lakes and other water bodies, preserving and developing the forest area in Delhi, construction of check dams at Asola Wild Life Sanctuary and plantation of trees, some of the steps being taken to improve ground water resources in Delhi (Economic Survey of Delhi 2012-13). But the traditional water bodies like ponds in Delhi are either defunct or encroached upon. The excess water, causing flooding in some areas, can be used as the potential recharge water to reduce the flooding. The 36000 sq. ft. Mayapuri Lake is one such example. This water body is partially filled up for a common effluent treatment plant. A park has come up on the 31000 m<sup>2</sup> water body in Vinod Nagar. A hospital is to come up on an 8400 m<sup>2</sup> water body in Jilmil Tahirpur (Lalchandani, 2008a). An independent body set up by the court has identified 794 water bodies, out of which 629 water bodies exist officially in Delhi (Lalchandani, 2008b). There are also numbers of micro watersheds present in Delhi, which prove excellent topographical formation to conserve monsoon runoff through simple recharge structure. New tanks, reservoir can be created in low-lying areas where there is a natural slope in the terrain and runoff water can be harnessed managed and administered. The Yamuna flood plain (area 97 km<sup>2</sup>) in Delhi offers a good scope for development of groundwater resources for storage monsoon water. Out of 580 MCM of monsoon flow allocated to Delhi about 280 MCM goes unutilized due to lack of storages. There is a need to prepare a plan to conserve these resources. Though 620 water bodies were identified under the Water Mission for conservation no significant improvement is seen in these regards.

**Conclusion**

The Energy Research Institute in Delhi interviewed 1,114 people from across Delhi. The survey highlighted that majority of the respondents in Delhi were not aware that government policies exist for climate change in Delhi (IANS, 2013). Even officials from concerned organizations responsible for water management in Delhi are not clear about the climate change action plan for Delhi. It has been observed that in spite of this role allocation that the mission did, there are certain areas, where more than one authority is responsible for fulfilling the target. In such cases, it is essential to demarcate the exact role to be played by each of the authority to achieve that single target. Also, it is important to raise awareness about this mission to all stakeholders and key actors of water governance in Delhi so that these targets can be integrated with the implementation policies and action plan.

Climate change and water problems shall not be seen in isolation. The present policy sees its own targets in isolation without proper integration at the institutional policy and action plan level. The water mission for Delhi does provide some opportunity for this but it needs to be more focused.

The Water Mission for Delhi does not identify vulnerability areas for water risk due to climate change. The vulnerability of the poor population in the city due to climate change has not been considered in the context of Delhi. It did not directly talk about the climate change mitigation and adaptation approaches. The NWP 2012 talks about mitigation at micro level by enhancing the capabilities of community to adopt climate resilient technological options, which is absent in the Delhi Climate Change Agenda can be integrated in the next action plan.

One of the Climate change adaptation strategy in National Water Policy 2012 is increasing water storage through revival of traditional water harvesting structures and water bodies and through efficient water use. Increasing water storage in its various forms (soil moisture, ponds, ground water, small and large reservoirs and their combination) will provide a mechanism for dealing with increased variability because of climate change. Delhi also has given importance in revival of water bodies but implementation of such programme is not up to the mark. This needs to be given more importance with a clear responsibility to different organisations. Also, it is imperative for the authorities to develop coordination mechanism especially for targets assigned to multiple authorities, to avoid any confusion or overlap and help achieve the target within the time period.

NWP's adaptation strategies also include better demand management approaches to enhance the water use efficiency and the capability for dealing with increased variability because of climate change. Water demand management approaches are missing in Climate Change Agenda for Delhi. This also is to be included with water efficiency rating in water devices and in all developments.

It is seen that there was a lack of monitoring mechanism which has led to the delay in the overall implementation of action plan in Delhi. Thus there is a need of a

monitoring mechanism and needs to be mandatory as a part of the action plan of climate change for Delhi.

Another significant area of concern is funding, since at present the plan does not have provisions for target wise funding allocation along with the sources that could ensure smooth implementation. This should be also part of action plan. There should be integration of Clean Development Mechanism for different water projects at the target level and this can be regulated by the local authorities itself. The authorities also need to outline exact manners through which the community, the people could be actively involved in achieving these targets and combating climate change, since their role as stakeholders and as victims of climate change events is also equally important.

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# 4

## Biodiversity Conservation for Sustainable Use: Challenges for Future

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— *Pranab Pal*

### ABSTRACT

Biodiversity in its holistic sagacity encompasses every stages of natural variety ecological and evolutionary progression including normal ecosystems, wild species and diversity undeveloped ecosystems, domesticated and varieties. It is not consistently dispersed lying on the soil. According to a few experts 5.50 million class of living forms on our earth and of these merely 1.7 million contain been recognized and comprise 3,20,000 kind of green plants and fungi, 75,00,000 species of insects, 45,000 species of vertebrates and 3,50,000 species of micro creatures newly it have predictable so as to the figure of insects unaccompanied might live because elevated as million. Biodiversity is vital to the mitigation of scarcity, owing to the essential merchandise and bionetwork armed forces it provides. Biological diversity is basic to the completion of human requirements. It is important to input development divisions such while cultivation, forestry, fisheries and going to places of interest, resting on which extra than 1.3 billion populace depend on intended for their livelihoods. The rough country is currently quickly vanishing and merely minute wreckage stay. The rising human population and the speedy augment of farming and manufacturing split the liability designed for the obliteration of come again is gone of the wilderness. Protection of natural assortment determination exists on top of main concern plan intended for the world's professional in the 21<sup>st</sup> century. India seeing that solitary of the megabiodiversity centers. India's Biodiversity is one of the majority noteworthy within the planet and have its customary knowledge for conserving the reserve in usual systems. The varied climate regions of the country- with unique floristic and faunal richness, their vastness, endemism, heterogeneity, and also inaccessibility of large area. The Indian sub-continent is recognized intended for its varied bioclimatic regions behind solitary of the richest floras and fauna. Rising human being interventions resting on the ecosystems contain accelerated the procedure of biodiversity loss. The skills of the precedent hardly any decades contain exposed so as to since industrialization

in addition to fiscal growth obtain put, the outlines of expenditure, manufacture and requires alter, damage, modify in addition to still obliterate ecology. Global Biodiversity Assessmen, approximation the whole figure of animal and plant species to live flanked by 13 and 14 million. It auxiliary records so as to distant merely 1.75 million species encompass been described plus deliberate. A number of scientist express that by 2100 merely 20-50 % of the plants and animals creation awake ecosystems inside worldwide, moist steamy forests might stay because we identify them nowadays. The modify in the climate situation be already felt through the biodiversity and wildlife habitats crosswise the earth. A lot of plant and animal species be ultimately flattering extinct while a consequence of the climate changes. Some of the plant and animal class are not capable to become accustomed to the changing weather.

**Keywords:** Biodiversity, Conservation, Human Intervention , Strategies for Changes

## Introduction

There are more than 1.8 million species within the planet which are recognized in the direction of science, the predictable whole figure is probable toward subsist stuck between 30 to 50 million. It have been probable so as to the destruction of class might be happening by the side of the pace 10 to 20 thousand per year. Further 95% of species with the intention of more (*Heywood, 1995*) continue living are at this time vanished. The usual living thing species within the oceans have a period of about 4 million year. This is an amazingly extensive instance through creature edifying average but amazingly petite in contrast towards the almost 4000Ma times gone by the existence resting on soil. Approximately 25% of oceanic species turn into wiped out all million years. Resting on pinnacle of normal, two three species wide-reaching ought to turn into extinct every year on or after usual courses. In a developing nation such as India, where a burgeoning population, intense agriculture and urbanization expand at great rate, the task of preserving creatures that represent the diversity of life in wild places presents a variety of challenges. India is the Seventh main country in the world, by means of ropes populace (million) plus 18% of the live stock population. The Himalayan heap variety in India is one of the nearly all gorgeous environmental speculates within the world. On the identical instance it is solitary of the majority in danger rising (*Parmer. A, 2012*) facts of walker, trekkers and scenery fans contain been creation the yearly pilgrimage of these peaks within such amount so as to the environment's normal symmetry is in danger. More then 5,80,000 villages within the nation almost 35% exist in and about woodland region. Forest and Tree wrap (*FSI-2011*) of the country is 78.29 mha which be 23.81% of the geographical area. It have 2.76% of the World's wood wrap. Consist of there is decrease is of 367 km<sup>2</sup> in the wooded area cover up. Ground area dilapidation happening owing in the direction of the usual and human induced causes, similar to storm wearing absent and water logging, is solitary of the main concern in India. Some experts dwelling Sapiens contain been causing extermination of additional species intended for at smallest amount 50,000 years and almost certainly longer. For the duration of the precedent 500 years the pace of human caused extinctions has augmented exponentially. The unreliable

degrees in addition to types of dreadful conditions stalk mostly as of indefensible make use of and unsuitable land management practices. Loss of plants happens since a consequence of deforestation, hurtful further than the silviculturally acceptable restrictions indefensible fuel-wood in addition to provisions taking out, irregular farming, infringement within wood lands, forest fires in surplus of grazing, each solitary of which area under discussion the earth to degradation forces. In India 60% of country's cattle 700 million graze in forest area. The disappearance of variety is a indication of such indefensible enlargement, in addition to destroys the option of their make use of intended for the betterment of humanity within the prospect. Unless we expand a new-fangled prototype of sustainable lifestyles the earth's restricted bio-resources have to inexorably exist worn out. According in the direction of some scientists, overgrazing which inside occasion be able to alter grassland to desert, The villagers stay great numeral of livestock to get together their agriculture and domestic prerequisite. Our possess nation's extended expression goals of monetary growth are to be content, the conservation of its only one of its kind biodiversity have to take its put in programmes of resonance environment management. In India grave require of grass for thatching and for fodder, consequently for the duration of shortage land area have changed in forest area. On the subject of 50% of the forest area 70 mha is prone toward forest fire. Owing to shortage huge fraction of the wooded area periphery population is dependent on forest property resulting in its unsustainable exercise. Illicit felling of precious timber also poses a grave threat to defense of forest. In the vicinity of the end of the 20<sup>th</sup> century and the beginning of the 21<sup>st</sup> century a lot of types of human activities (*Bill deval, 2006*) are creating a increasing consequence so as to experts describe the "catastrophe of destruction". The earth is losing its steamy forests next to the disturbing pace of roughly 45 million acres per year. This resources with the intention of virtually 1.3 acres of humid forest fade away each second. Green houses gasses are the major cause intended for the type of weather change which in revolve posses the danger to the enormous biodiversity. This determination shift the great fraction of inhabitants in addition to strength others to wander. The hotness modify in the weather circumstances be able to be most excellent felt at mountains. The altering type of weather situation are as well the harsh danger on the coastal areas, which have led on the way to the main area of wooded area loss. Seeing that a great deal earth because probable have to be place aside as wilderness to defend this precious livelihood prosperity. The reduction of type is consequently a immense fiscal beating to humanity. Since wilderness is gradually more transformed to agricultural, countrified and lastly manufacturing and urban land, the numeral of extinctions quickly increases. A good number variety of plants and animals be able to merely stay alive in quite whole natural ecosystems. Normal landscapes as well carry out more than a few armed forces for humankind. A number of these landscapes are ecologically vigorous in addition to be able to endure a pale quantity of commotion with no a grave defeat of biological diversity. While humid evergreen were known to be enormously affluent in class, this became a major cause of anxiety in the 1070s and 1980s. Mangroves are surrounded by the oldest in addition to mainly creative marshland forests of our earth. They are perfect

environment against tempest rush and coastal wearing away. In India's biodiversity is mirrored within its human being enriching assortment. By means of 615 recognized cultural societies and 1652 speech clusters, India status second into the planet in human edifying miscellany. In India, nearby 34 variety (Teri, 2012) accurate Mangroves. Bhitarkanika Orissa has 31 species. The Sundarban include 27 and Andaman & Nicobar Islands contain 24 species. Mangroves make available precious overhaul but contain been declining universal as a consequence anthropogenic and further pressure. Tropical forests immobile have quite widespread tracts, the swampland of the preceding century were disappearance still extra quickly. The enclosed space of these failing habitats was at the present emphasized because a main matter in preventing the destruction of species. The confront for forest and wildlife management stay behind intimidating. India evidently is next to the intersection. On top of the solitary give in attendance is a required designed for quick fiscal growth and alleviation in the direction of defend environment, forest and wildlife and make sure glowing organism of its inhabitants. In India medicinal plants countenance a variety of pressure on the way to their continued existence. Appropriate toward elevated insist triggering far above the ground quantity extraction, which strength too engage destructive methods of harvesting , on the way to create up and about the manufacture within the (Survey of the Environment,2012) slightest obtainable instance, such unhelpful harvesting procedures, determination habitually harm the populace and subsequently the usual renewal of the class gets exaggerated. Bearing in mind the big figure of medicinal plants variety and more than a few mammals are under threat, the challenge is how in the direction of the conservation priorities.

### **Anthropogenic Pressure and Habitat Loss**

Unluckily biodiversity loss is rising by the side of an unparalleled pace, intimidating the incredibly base of sustainable expansion. A lot of species are fading earlier than they are still exposed or described. Further than 12,200 species of plants and animals (State of environment Assam, 2004) are incorporated within the IUCN Red List of in danger species. Other than this integer is considered to be the angles of the iceberg, since merely a portion of recognized class contain been assessed. The most important pressure are environment loss, over-exploitation, invasive species and type of weather change. The snowballing result of all one these feature strength demonstrate the technique to accretion disappearance. The natural fruition has shaped an astonishing choice of flora and fauna including microbes, which are essentially related with myriad continued existence and livelihood desires of human being the social order. Put aside intended for owing to still growing number of dangers and pressures, biodiversity have turn out to be not merely an issue of nationwide apprehension other than as well as matter of worldwide apprehension. Deforestation is exacting concern within (Photo:-1,2) the western Himalayas wherever augmented insist, intended for firewood, widespread tree trimming during arrange to give food to domestic animals and edifice of roads

Deforestation

**Photo: 1**

Source: PA

**Photo: 2**

Source: Tehri Dam

in the annihilation pace of forests and the integer of avalanche fast enlargement of population has accelerated pollution. In this method the ecosystem of Himalayans has been concerned within a variety of parts owing to together man made activities and usual calamities. Dreadful conditions in addition to destruction of the environment causing harsh man-animal conflict, insist of tiger parts within the worldwide marketplace, contain compulsory the tigers rear to the barrier. The addiction resting on woodlands owing on the way to rising human(Jain. P, 2001) as well as livestock inhabitants within about tiger territory are causing enormous force on top of the tigers since the expansion schemes contain not reached them as well as consequently their nourishment stay put resting on the forests. Human being activities contain led to stern changes in natural ecosystems so as to have resulted in destruction of a lot of plant and animal species, and are pressure a lot of additional. According to 1997 IUCN Red List of Threatened Plants, worldwide 33,418 species are (Current Science,2009) incorporated beneath endangered group. Of this, 4070 species are beneath the category of undefined. India is one of the mega diversity nations in the planet. It has concerning 17,000 species of flowering plants and 5400 widespread species. Of the 1236 threatened species in India,690 species are placed beneath undetermined condition. So as to is 12.2% of species on universal level. Damage of normal environment coupled through profitable felling of trees, infringement of forests for settlements and farming, Jhum (shifting) cultivation surrounded by the hill predispose in addition to a variety of additional infrastructural expansion activities have emerged as solemn threat to the biodiversity of India. By means of pressures as of the increase in population and a ensuing add to require of forest land designed for agriculture, there has been a reduce in the alternation of the jhuming sequence, causing reduction of forest wrap at an disturbing level. Thus patches of forest are currently burnt extra repeatedly at gaps of five to six years – an instance stage so as to is disgustingly

insufficient designed for a tainted forest to get better. Jhuming is solitary of the main sources of livelihood intended for numerous tribal communities inhabiting the North-eastern states of India. Arranging of railways lines as well as construction of four line roads all the way through forests, large-scale bamboo harvesting different parts of the country, searching of oil and natural gas in India pose conservation threats. Forest Land converted for open cast coal mining in India (Jharkhand, Assam, Meghalaya etc) mineral excavation, brick manufacturing in the main lands, cement and manure plants, etc are some of the economic activities of the state which are answerable intended for the damage of environment. While Coal be on fire, the Carbon so as to was accumulate contained by the coal is released reverse into the atmosphere as CO<sub>2</sub>. More then 70% of the world's energy comes as of burning fossil fuels. In India Traditional and substantial reliance on biodiversity resources used for fodder, firewood and minor forest produce has been an accepted system of existence designed for the rural population that accounts for virtually 75% of India's population. By means of fundamental demographic modify, the land to man ratio and forest to man ratio has quickly declined. The lifestyles and the biomass resource necessitate having remained unaffected, the relic forest have move about in the direction of underneath persistent pressure of infringement for cultivation, and unsustainable resource removal depiction the very resource pedestal infertile and exhausted of its biodiversity. At present, hydropower has led in the direction of the construction of over 4000 dams across India. The conception of valley underneath reservoirs within wilderness areas has brought on top of the annihilation of a number of the optimum forests in(*State of Environment Report India,2009*) addition to biodiversity – wealthy exclusive ecosystems. Deforestation owing toward hydropower as well as mining projects are maybe the maximum pressure to biodiversity in India. India have human population compactness more than 800 populace per square mile, additional than double that of China and in excess of ten times so as to of the USA. It is no revelation that a great deal of the biological affluence of India is endangered. By means of hundreds of threatened and endangered species, India position fifth in the world into its information of birds (*WWF, 2000*) in danger by means of destruction, in addition to third in the earth in endangered mammals. At present half of India's primate species are put in danger. Appropriate in the direction of the pressure in India on forests and further normal habitats, numerous species of primates encompass exposed on the way out populations and some are endangered through disappearance.

**In excess of over grazing:** Unrestrained grazing through domestic stockpile is too a main difficulty, particularly within the grasslands, While the majority of the grassland are restricted toward a small number of pockets of Pas, of course the pressure is serve. Grasslands contain in history been solitary of the nearly all derelict ecology within India, in spite of their marvelous biodiversity in addition to serious function while grazing (Shahabuddin.G, 2012) lands intended for rural populace. Within the

shade as well as snivel in excess of the desertion dilapidation of forests, the fortune of grasslands has been totally hid. According to Satellite imagery used by ( FSI ,2011) presently Geographical area of India is Total Forest Cover 21.05%, Scrub 1.28%, Non-Forest 77.67% consequently of grassland of ecosystem is in grave problem. Grassland holds up livelihoods of pastoralists as well as play crowd to a number of the nearly all endangered species in India.

Grazing also reduces probability of trees imminent up which sporadically colonies and sprout on their own. So far, in excess of grazing (Photo:-3,4) through farm animals be able to evenly fine contribute to single species ascendancy and extend of invasive weeds so as to can obliterate grasses. Overgrazing by domestic animals has unfavorable effects on the vegetation in the container of together alpine grasslands and forests. Overgrazing can increase soil erosion. In India, Ranthambhore National Park the human and livestock populace of 91 villages and three townships (Singh. D.P, 1994) are totally dependent on forest resources for meeting their biomass requirements and thus countless species of fauna and flora are disappearing fast. Grazing by livestock has sternly threatened our wildlife and their habitats in various ways? The noticeable effect is the decline of wild herbivore populations as they have to compete with livestock for their food source. Because more cattle graze and nibble the natural vegetation there is less palatable biomass for wild herbivores. Since livestock supperimer palatable population indigene plant species every so habitually unpalatable species of plants occupy the area. Overgrazing occurs at what time plants are exposed to livestock grazing for extended periods of time, or not have adequate enhancement periods. It's through there reduces the usefulness of the work on the land and is one cause of desertification and erosion. Sustainable lowland production is based on grass management, animal under this management, conjunction livestock marketing, grazing management is the groundwork of grassland-based livestock creation since it affects both of them animal and plant health and productively. Grazing decreases plant life shelter, soil loss and compaction augment, water infiltration decreases and runoff increases, cover up decreases remain at rest more, and so kind onward. In the severest cases, it is difficult for vegetation to reestablish at rest when grazing strength is reduced. The initial plant obliteration leads to effects that create it more difficult for plants to reinstate, which go in front to better losses of vegetation consequently onward. Overgrazing causes animals to run short of meadow. Overgrazing can also have (The Beehive-India, 2012) an effect on livestock performance and situation. Owing to this, the forests and the grasslands turn into nude and afterward prone to soil erosion. By pounding the soil with their hooves, livestock press the subsoil into fine soil which can be carried easily by wind and water. Reduced earth depth, soil organic matter, and soil fertility hurt the land's future productivity.

### Grazing Protected Area and Mount Area



**Photo: 3**



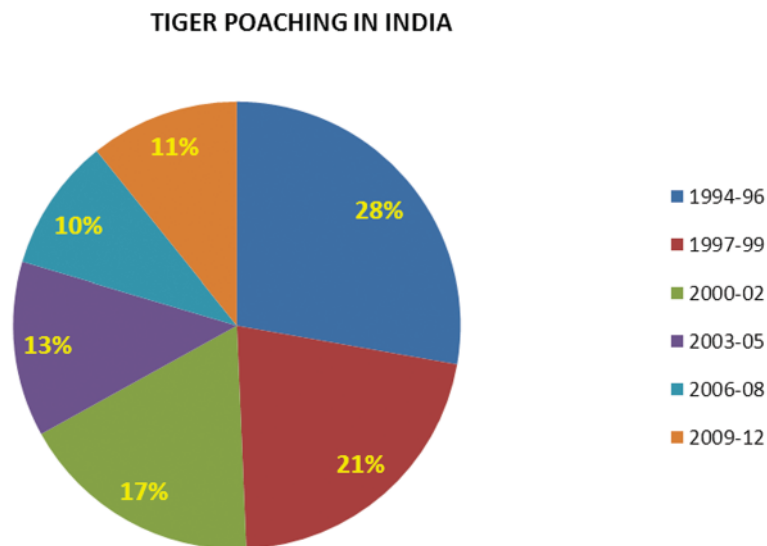
**Photo: 4**

### Poaching Crisis

Poaching is the against the law pursue, killing or capturing of mammals. Populace poach since animal manufactured goods , such seeing that conceal, ivory, horn, teeth, hair, bone, are sold to traders who create garments, trinkets in addition to additional cloths from them. The poaching causes an assortment of belongings, its nearly all straight collision is disappearance, also worldwide or surrounded by a specified area. As the create of the poaching plague in 2008 South Africa have mislaid in excess of 1600 Rhinos. Rhino populations opposite genuine dilemma beneath the danger of huge augments and poachers take life Rhinos intended for their horns. Even though they are complete awake mostly of keratin, the identical substance that's in your hair and fingernails, might populace in Asia consider so as to crushed Rhino be able to heal whatever thing as of headaches to gout, fevers to rheumatism. Consequently rhino horn is used seeing that a constituent for customary medicines. According to prominent Vietnamese Rhino horn could be cure of cancer. Consequently it has led to a enormous augment in insist for Rhino horn foodstuffs in Vietnam. India Rhino (*Rhinoceros unicornis*) usually have a preference the alluvial unadorned grasslands of the Terai and Brahmaputra sink. It is underneath threat of floods, human intrusion, grazing, hunting, contract passageway thrashing, near to the ground propagation rate, communication (*Venkataraman.K 2012*) of base in adding up to lips diseases as of domestic cattle etc. Its horn, tail, corpse parts, hooves, urine, blood etc are demand in the International market. India while one of the mega diverse countries of this planet, the stage an significant (*Sinha.Samir, 2010*) universal function in the deal of wildlife, which comprise every one varied existence forms originate untamed in nature. According to expert environment thrashing was consideration to be the main solitary risk to the outlook of wild tiger (*Panthera Tigris*) in India. It has at the present recognized so as to operate in tiger skeleton, intended for utilize in oriental drug exterior the nation, is pretentiousness an even big risk. Tiger has (Fig:1) been (*WPSI,2012*) killed 965 numbers since1994 -2012 in India. Tiger are under attack since their parts particularly their bones, which Chinese texts utter assist



endorse curative in addition to have anti-inflammatory properties are award-winning in customary Chinese medicine as well as twist great proceeds on top of the black marketplace, other than they are barely the merely animals poachers go away behind.



**Figure 1.**

Source: WPSI

Snare traps are successfully used intended for hunting spotted deer, sambar, barkingdeer, wildpigs (<http://conservationthreats.org/understandthreats/poaching>) in addition to additional herbivores. Frequently great, gravely in danger of extinction animals like tigers and leopards as well obtain trapped along with die within snares. The poaching of Elephants intended for ivory, meat, hide and additional parts mostly designed for make use of in conventional medicine is motionless widespread in numerous countries crossways Asia. Expert analysis of elephant (*Elephas maximus*) Poaching and deliberately killed in India 175 numbers since 2006 to 2012. In spite of universal defense from side to side the Convention on International Trade in endangered Species (CITES) agreement, the worth located on elephant habitat resources so as to present are those that immobile kill elephants meant for proceeds. Elephant ivory have been worn through humans seeing as the initial period. It is vital toward condition so as to Asian elephants are distant fewer flat to poaching than African elephants as merely a number of Asia males contain tusks and together sexes are tusk attitude in African elephants. According to expert of Africa during 2012 Poacher have killed 633 Rhinos in South Africa and thousands of elephant. Elephant hide though does encompass worth in addition to elevated excellence clothing as well as furnishings of elephant skin are sold in boutiques crossways Asia. Against the law killing, thrashing of habitat as well as additional forms of disagreement by means of humans are every one main threats in the direction of Asia's elephants as well as

these pressure are rising as the continent's human populace continues toward grow. All through Asia, hunters carry on to aim elephants, capitalizing on top of sustained demand meant for their ivory tusks. The population of Asia elephants have declined appreciably in current decades, in addition to the species is measured in danger of extinction, which resources in attendance is a extremely far above the ground danger of this animal's disappearance within the in their natural habitat.

### Poaching method for killing of animal in India

Sl. No.	Poaching method	Reason for Poaching
1.	Poisoning	This method generally positioned within the carcasses of domestic buffaloes and cows. For the duration of the dry, hot summer months small woodland pools are too disillusioned by poachers, otherwise depressions dug and filled by means of water intended for this reason.
2.	Shooting	Most common, specially 60% Rhino has been killed by using of Shooting
3.	Pit Poaching	More then 35% Rhino has been killed by using digging of pit.
4.	Steel Traps	Which are complete through nomadic blacksmiths? These traps are hugely strong.
5.	Electrocution	Poacher use through tapping 230 volts -11KV in the clouds electrical wires and laying a live rope on top of mammal tracts.
6.	Use of noose	This method very common in Africa.

Leopard poaching in addition to smuggling in India in the primary decade of the 21<sup>st</sup> century, judgment so as to in excess of with the intention (Tab:1) of epoch an normal of four leopards encompass been killed every week, by means of their corpse parts toward inside the black souk. According to geometric study toward effort to approximation hidden smuggling, the information says with the purpose of now beneath 3000 leopards were ( <http://www.treehugger.com/endangered-species/4-leopards-killed-poaching> ) killed through poachers as of 2001-2010. Leopard solitary lived crossways a huge swath of ground from Siberia to South Africa, other than environment loss and hunting contain radically abridged their variety. IUCN classifies leopards because creature close to—in danger, single pace underneath living being measured on top of the in danger of extinction range in addition to solitary on top of creature of slightest apprehension. In India poachers use the following different methods for killing of animals. The Worlds Conservation Union gathers information gathers in sequence as of Scientists every a small number of years to estimate the figure of in danger species. We are losing species on sandwiched flanked by 100 and 1,000 times the (Glenn. Murphy, 2008) normal charge, in addition to approximately every one of this augment is caused through humans. While poaching as well as habitation annihilation engages in recreation a main element. Because as many as 1 in 3 amphibians and 1 in 4 mammals are at this time underneath threat. Most important pressure is thrashing situation corridors, anthropogenic pressures,

environment disintegration, hunting, rail accident, contamination, inter-specific rivalry, woodland fire etc. Body parts, meat, bones, tusks contain elevated insist within international marketplace. Large mammals are much in danger of extinction species.

**Table 1.** Leopard Mortality In India

Sl.No	Mortality	2009	2010	2011
1.	Poaching	24	48	48
2.	Seizure	137	132	139
3.	Found Dead	52	78	65
4.	Killed by Villagers	28	24	32
5.	Shot by deptt.	21	13	9
6.	Killed in Road Accidents	17	22	30
7.	Died in Rescue Operation	6	7	14
8.	Electrocuted	3	2	—
9.	Killed by Tiger/Lion	3	2	12
10.	Infighting	—	—	9
	<b>Total</b>	<b>291</b>	<b>328</b>	<b>358</b>

Source: WPSI

Stipulation the killing does not conclusion, after that a number of living thing countenance disappearance otherwise gone on top of world.

### **Erosion Problem**

Enduringly tainted lands are rising by the side of a yearly rate of 6Mha. Globally, moving the livelihoods of millions of populace coupled with land degradation seriously undermines the livelihood opportunities, consequently most important in the direction of scarcity, relocation in addition to foodstuff uncertainty. Earth is solitary of our valuable possessions. The defeat of this resource, from side to side soil dreadful conditions processes such since blustery weather as well as water erosion, is single of the the majority solemn environmental problems. We are faced by means of seeing that it is destroying the resources of producing our foodstuff. Top soil erosion is a usual procedure in addition to have occurred all through geological history. Human being behavior, mainly cultivation and deforestation, though, contain augmented erosion rates, since they be inclined toward take away the defensive plant life in addition to decrease the constancy of the soil. This human prejudiced procedure be termed accelerated erosion. In view of the fact that 1950 accelerated erosion has resulted within the defeat of 1/5 of the topsoil as of the earth undeveloped land and 1/5 of the topsoil on or after steamy forests. Erosion be a solemn crisis within the United States in addition to in the region of the planet. According toward the Federal Emergency Management Agency (FEMA), U.S.

coastlines be unable to find 1 to 4 feet every year owing in the direction of erosion. The possessions contain ecological as well as fiscal outlay. Intended for ecosystems, Erosion translates keen on environment beating since coastal wetlands get worse. The plants and wildlife so as to depend on top of these ecosystems are unenthusiastically impacted through the possessions of erosions. Soil erosion within India is surrounded by the foremost areas of apprehension designed for the Government of India. It affects farming and undeveloped within the country in unpleasant and adverse habits. Soil erosion away leads to deficiency of corporeal individuality of soils and compensation plant and crops. In India approximately 1.30 million hectares of land, so as to is 45% of whole geographic and ditch, variable farming, cultivated wastelands, covered in dust areas, deserts and water cataloguing. Indian Forests contain been exaggerated by means of soil erosion at diverse levels. The forests within the Southern zone be slightest precious from beginning to end soil erosion, while the rest of the areas are almost consistently exaggerated. The southern Zones hold the finest preserved forests in the country. The uppermost plane of erosion is seen going on within the Central zone. The Eastern Zone is the most horrible. Floods encompass turn into an annual attribute of Assam. Owing to serious siltation, the river-bed of the Brahmaputra (Photo-5,6) is going up and as a result its water-baring ability is deteriorating. Still a slight rainfall inundates extensive are other than a associated of floods is the trouble of land erosion.

### Erosion of Brahmaputra



**Photo: 5**



**Photo: 6**

*Source: P.Pal*

The exceedingly creative in addition to prolific soil of Assam is facing a risk from erosion. According to study erosion is consumption gone eight thousand acres of land every year, Since 1954 the circumstances have lost about 4.25 lakh hectares of land accumulation owing to river bank erosion. Supplementary then 1.5 lakh populace contain missing their hearths and homes and the precious land so as to twisted crops and constant them. Soil erosion cruelly affects agriculture which is the nearly everyone imperative and extensive work of the state. Corporeal smash up is the nearly all observable as of

soil thrashing and the majority probable in the direction of remedied. Tainted lands are regularly mislaid of erosion, desertification, and nutrient exhaustion. Environment damage is not the merely danger in front of wildlife, other than it is rather probable the most threat. Stipulation the exhaustion of normal habitat about the sphere does not slow, accumulation extinctions are convinced to go after.

## **Conclusion**

Biological diversity is a precious usual resource intended for the continued existence of mankind, a slow decrease of which might consequence inside vanishing of class economic worth in the direction of the person contest. Surroundings challenges is consequently in the direction of make out the policies, institutions and technologies which will enhance the positive and mitigate the unenthusiastic property of grazing, poaching etc atmosphere challenges, matter and alternative be different considerably according to type of weather and earth capabilities. The imperfect protection resources obtainable have to be listening carefully tactically on top of opportunities probable toward give way the most conservation advantage. Conserving Biodiversities nowadays are vital not merely intended for the continued existence of the class that continue living in that, other than too intended for human belongs seeing that we are reliant designed for our endurance resting on them. Conserving biodiversity is concerning restoring the equilibrium sandwiched between humans and atmosphere. This resolve assists us in the direction of not get in the way with the bio-diversities there by minimizing our actions in that area. This method, biodiversity of this region is gone un-tampered by means of as well as protected. Sustainable development requires entities toward redefine their policies resting on earth use, food, water, energy, growth, protection, economics and deal. Protection and sustainable use of biodiversity requires the contribution of accountable organization designed for such areas because farming, forestry, fisheries, power, visiting the attractions, trade etc, energy safety, land issues, water issues in addition to type of weather be the challenges in front of India, the length of with biodiversity conservation, as well as medicinal plants in the age old Ayurvedic scheme of medicine. Corporates in India require in the direction of learn their carbon footprint and alleviate it. Conserving resources, recycling, reducing carbon footprint in addition to inventing cleaner processes in addition to comprehensive enlargement are significant. Protection of biodiversity as well as its make use of in sustainable development contain been impeded through a lot of obstacles. The require to normal the conservation in addition to sustainable make use of natural resources crossways every one segment. Consciousness in addition to acquaintance concerning biodiversities is a input to guard the identical. It would go away of extended method to put aside biodiversities. Natural habitats require being sheltered. The apprehension organization requires to be made sure and manage the management of the species present. A great deal of defeat of biodiversities is since of the thrashing of habitats, which in fact is the put, wherever they exist. Biodiversity conservation be alive addressed inside the circumstance of sustainable development. Biological Diversity is as

well a basis intended for new-fangled crops and livestock, given that the majority harvest plants in addition to ranch animals stalk as of wild relatives. Natural compounds from animal, plants as well as microorganisms are the source designed for new-fangled drugs meant for treating human diseases. The beginning of biological scarcity decrease inside diversity of life forms is bound contain serious consequences intended for the whole livelihood earth.

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# 5

## Ecological Resources and Tribal Livelihood: An Odishan Overview

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— *Nilakantha Panigrahi and C.R. Das*

### ABSTRACT

The planners, academicians and implementers have witnessed a visible shift in the development planning during last decade of 20<sup>th</sup> Century. This includes production of goods and services, growth in per capita income and human wellbeing. The human well being is considered more broadly which has encompassed the consumption of goods and services. It also talked of accessibility of all people particularly of Scheduled Tribes (STs), Scheduled Castes (SCs), women and other deprived sections of the population to the welfare services. Such approaches in the development planning primarily aimed at removing those conditions of social deprivation and discriminations that restrict capabilities of, and deny opportunities for participating in normal economic and social activities. A few of them include attending school at the primary level, having access to quality health care, safe drinking water, sanitation, and gainful employment of an assured nature which connotes the processes of widening people's choices as well as various levels of their well being.

With this premise the present paper covers couple of objectives. The first section of the paper provides a theoretical understanding of the concept of ecological anthropology which deals with the ecological resources and the symbiotic relationships with the tribal communities and vice versa. The second section briefly explains the distribution of tribal people in Odisha and their changing life and livelihood. The third section gives an overview of Kenduleaf one of the most important ecological resources of Odisha with respect to the production and revenue potential. The fourth section from an empirical study finding first gives a profile of the scheduled tribe kenduleaf binder households, and secondly, the extent of their dependency on kenduleaf with respect to the extent of family labour engagement, creation of employment, income and expenditure of the KL binders and alternative livelihood they need to strengthen their economy. While concluding, the paper suggests couple of required development interventions for the livelihood improvement of the tribal KL binders and the maintenance of symbiotic relationships of the tribal people with their ecological resources.

**Keywords:** Livelihood, Health care, sanitation, gainful employment, discrimination

## **Introduction**

During last couple of decades one finds plethora of materials in social sciences relating to ethno-ecology, environmental economics, human ecology, and political ecology and ecological anthropology. Such areas of specialization describes a type of research that is interested in deepening our understanding of how human have been affected by their natural environment through time and conversely how they have influenced their natural environment (Worster, 1988a, 290-91). The term ecological anthropology which deals with the ecological resources came during 1960s by the thinkers like Alfred Kroeber and Julian Steward. The concept of cultural ecology influenced the concept of ecological anthropology, but one finds a shift from the concept of 'cultural population' to the 'ecological population'. The ecological anthropology is known for its functionalism and systems theory. For anthropologists role of cultural practices and beliefs in enabling human population to optimize their adaptations to their environments and in maintaining undegraded local and regional eco-systems are important. Rappaport (1971) used the word 'ecological population' as an 'aggregate of organisms having a common pattern of distinctive means by which they maintain a common set of material relations within the eco-system in which they participate'.

The native landscapes are created through human actions, including environmental features as legacies of past action both intended and unintended. Whether these are patches of highly fertile soil, islands of distinct vegetation types or areas of land degradation, an understanding of land use histories and the intersection of social, institutional, political, and economic processes over time are essential. Crumley (1994:6-7) defined landscapes as the material manifestation of the relations between humans and the environment, which 'represent another means of introducing geographical space into anthropological analysis, where it can serve as the laboratory of past human choice and response in which the effects of environmental changes can be palpably understood. An ecological understanding of landscapes involves analysis of the knowledge systems, productive practices, and religious rites that natives have developed over the course of centuries as a means of interacting with and gaining sustenance from their biophysical environments.

The 'cultural materialism' of Harris and the 'ethno-science' of Berlin ConKlin explained that the indigenous groups have traditional ways of categorizing resources, regulating their use and preserving the environment. Ethno-ecology is the traditional set of environmental perceptions i.e its cultural mode of the environment and its relation to people and society. Vayda and Walters (1999) maintain that ecological research should not make prior judgments concerning the causes of environmental change, but must be willing and able to assess all possible factors of biological and social origin. In anthropological and ecological research different kinds of generalizations are obtained from different levels of analysis (Bennett, 1976). In biological term the distinction are made between 'eco-system people' whose subsistence is tied with particular local eco-systems and 'bio-sphere people', who drew their support from resources obtained at a planetary level (Dasmann, 1988).



The changing scope of ecological anthropology finds that the earlier ecological anthropology was based on cultural relativism, while the new ecological or environmental anthropology blends theory and analysis with political awareness and policy concerns. This led to the new field of applied ecological anthropology and political ecology (Greenberg and Park, 1994). Orlove (1980) while reviewing the literature on ecological anthropology noted the processual ecological anthropology as a stage gradually supplementing neo-functional approach. Within the processual ecology human system ecology (Bennett, Ibid) emphasized on human ecology as human behavior. Anthropological political ecology established relation with geography and political economy in which concepts such as claims, rights, power and conflicts predominant. However, ecological anthropology many time face methodological difficulties to understand geological, biological and cultural temporalities developed over millions of years. In new ecological anthropology everything is on a larger scale. The focus is no longer the local eco-system. The outsiders are the key players in local ecology. With the changing scope of the subject ecological anthropologist need to pay attention to study the importance of external organizations and forces like government, NGO and the market that are now playing claims to local and in the regional eco-systems throughout the world.

The serious threats to natural resources in post-independent era came through the establishment of development projects basically in tribal inhabited inland areas. These development projects might be multi-purpose irrigation dams, mines, roads, railways, new townships, refugee settlements and big industries. A few such development projects so far established in tribal inhabited forest areas of Odisha which have tremendous impact on the natural resource base of the tribal people are Hydroelectric-cum-Irrigation projects like; Hirakud, Balimela, Machakund, Upper Kolab, Upper Indrabati, Mandira, Rengali; mineral based industries, like Rourkela Steel Plant, National Aluminum Company, Hindustan Aeronautics Limited; and mining projects on cement, iron, dolomite and limestone (Fernades,1994; Mohapatra,1999; Behura and Panigrahi, 2002). ).

The impact of massive deforestation has been observed in the life way processes of the rural people including tribal people in particular, which can be categorized as environment effects, social effects and economic effects. The social effects of deforestation restricted the access of tribal people into the forest and encroached the availability of forest produces (Mallik and Panigrahi, 1998; Roy Burmen, 1982). It affected the religious activities, life cycle rituals, customs, practices and the habits of the tribal people. Similarly, the economic effects of deforestation, due to development projects as observed, have drastically influenced the traditional livelihood resources of the tribal people, which were the produces of the forest. Tribal people for their survival largely depend on forest resources. Since the tribal people more or less live in the forest which are terrines with hills and mountains, under this situation for agricultural purpose they clean the land patches on the slopes of the hills and practice shifting cultivation, which of course is pernicious because it causes deforestation. Since tribal people do not have much alternative sources of livelihood and Government provisions for them to earn their

livelihood are inadequate, so they by and large depend on hill slopes, foothills and forest products to make their day to day survival.

### Study Design

The present study has covered 161 ST binder HHs of which 24.22 per cent are from Bolangir, 8.07 per cent are from Kalahandi, 37.27 per cent are from Rourkela and 30.44 per cent are from Sambalpur. Number of tribal KL binders from 161 households accounts for 290 persons which is highest in case of Sambalpur district (104), followed by Balangir (85), Rourkela (81) and Kalahandi (20). On an average 1.8 persons of KL binders are reported across the study regions, which is highest in Balangir (2.18), followed by Sambalpur (2.12), Kalahandi (1.53) and Rourkela (1.35). The gender wise composition of all the binders in four KL Divisions consists of 290 persons of which male accounts for 136 (46.90%) while females accounts 154 (53.10%). More female binders are observed in Rourkela (62.03%), followed by Balangir (51.76%), while in Kalahandi they tune to 40.91 per cent. The Study tools included structured interview schedule for KL binders to catch both qualitative and quantitative responses. In addition, case studies and photographs were also collected to enrich the data pool of the study. The data is analysed according to the KL Divisions.. The data was collected during the year 2009-10.

### Tribal Communities in Odisha: A Digression on their Regional Geography

The scheduled tribe communities of Odisha contribute substantially to the demographic structure and social fabric of the state. There are 62 tribal communities, with a total population of 8.14 million (Census of India 2001), who belong to Austro-Asiatic, Dravidian and Indo-Aryan language families. Out of them, 13 tribal groups have been identified as primitive who are recently known as particularly vulnerable groups. Almost 44.21 per cent of the total land area in Odisha has been constitutionally declared as scheduled area. Except for the coastal belt, most of the districts of the State are either partially or fully declared as scheduled area. The present scheduled area of the State includes six districts that are fully and five districts that are partially within it. The districts of Mayurbhanj and Sundargarh are the full scheduled districts while Keonjhar is the partially scheduled district in the northern zone of the state. Similarly, Koraput (undivided) is a full scheduled district, while Kandhamal and Kalahandi are partial scheduled districts in the southern zone of the state. Out of 314 Community Development Blocks of Odisha, 118 (37.3 per cent) blocks are covered under the Tribal Sub-Plan (TSP). The tribal population of Odisha constitutes 22.08 per cent of the total State population (2001). The major tribes in the northern zone of the state, based on their numerical strength, are, *Santhal, Munda, Ho, Juanga, Bhuyan, Bathudi, Kharia, Kolha, Kol Lahara, Kisan, Oraon, Gond, Lodha* and *Mirdha*. The major tribal communities of southern zone include *Khond, Koya, Gadaba, Paraja, Omatya, Pertia, Saora, Bonda, Didayi* and *Shabar*. There are 15 tribal groups distributed in different parts of Odisha

each having more than one lakh population. The tribal communities like *Santhal, Gond, Munda, Ho, Birhor, Bhumija, Kharia, Lodha, Oraons* and *Kissan* in the northern zone of the state cut across the State boundaries and are also found in the neighbouring States of Jharkhand, Chhatishgarh and West Bengal. Similarly, *Koya, Khond, Saora, Shabara, Paraja* and *Gadaba* tribal communities of the southern zone are also found in Andhra Pradesh and Chhatishgarh.

The tribal economies are still primitive from the point of view of resource utilization, technology adoption and diversification of cropping pattern. A study of the tribal economy requires an understanding of the concept of community, common property, meaning of land and the role of non-tribals, particularly scheduled caste groups, such as *Panas* and *Damos* who significantly influence the tribal economy. Land is the pivotal property and tribal people retain strong emotional attachment to it even though they do not enjoy legal rights over land. Apart from land based resources, Minor Forest Produce (MFP) popularly known as Non-Timber Forest Produces (NTFP) play a vital role in their economic life, sustenance and labour processes. The Roy Burman Committee (1982) pointed out the commercial viability of MFPs starting from family level to the national level. The Task Force on Development of Tribal Areas (1983) of the Planning Commission since then has also highlighted the importance of forest resources and the role of tribal communities for its management. More specifically, the tribal communities namely *Santhal, Munda, Ho, Bhuiyans* and *Oraons* of northern zone are more or less exposed to the mining and industrial operations in Mayurbhanj, Keonjhar, and Sundargarh districts. Quite a sizeable segment of them have been migrating from their native area to different urban and industrial pockets of Odisha and Jharkhand in search of wage labour. A look into the level of literacy among these tribal communities also reflects a distinct variation between these two zones. As per the 2001 Census the literacy rate among the *Kissan* was 50.19 per cent, while it was 50.88, 39.69, 54.20, 40.43 and 46.96 per cent among *Bhuyan, Munda, Oraon, Santhals* and *Gonds* of the northern zone respectively. The level of literacy among the major tribal communities of Southern zone is much less, namely, 11.73, 12.62, 14.69, 17.96, 21.21, 31.87 and 41.13 per cent respectively among *Koya, Didayi, Bondo, Paraja, Gadaba, Kondh* and *Saora* of the southern zone. The impact of these processes has been quite varied for the different tribal communities and the penetration of exogenous forces has generated aspirations among the tribal communities. In such a situation the influence of traditional institutions in the management of natural and social capital of these communities also varies. There is a need to understand the regional development and diversities and the overall framework of development intervention in these regions.

### **Tribal Livelihood and Natural Resources**

From time immemorial tribal communities eke out their livelihood from forest resources. The economic, social and cultural life of these communities is fully inter-twined with the natural resources. They are using forest resources as totems, which reflect their collective sentiments and solidarity. The use of these resources has been always guided by their

cultural practices, festive occasions and taboos. In pre-Independent period the Forest Act 1865, which came into force during the British period empowered the Government to declare any land covered with trees as forestland. As a result, rights of the tribal people were restricted in the name of 'national interest. Later on the Indian Forest Act 1878-divided forest into three categories, such as reserve forest, protected forest and village forest. This strengthened government control over forest and forest resources. This not only restricted tribal communities as regards free entry, but also accessing certain forest areas for the people in the name of forest classification. The National Forest Policy 1894 laid emphasis on the regulation of community rights and restrictions on the privileges previously enjoyed by the villagers in the immediate neighbouring forest, and brought out a formal relation of forest dwellers particularly tribals with that of Forest Department as a crucial issue in forest management by protecting hill slopes and imposing ban on shifting cultivation. The Indian Forest Act 1935 consolidated the power of the State on forest so as to meet the requirements of British industry, military and commerce.

In the post- independent period the first National Forest Policy of 1952 attempted to redefine the forest policy and the traditional rights of the forest dwelling tribes which converted certain concessions (enjoyed by tribals for long) by withdrawing the release of forest land for cultivation, controlling free grazing, discouraging tribals to do away with the practice of shifting cultivation. The National Commission on Agriculture (NCA) 1976 revised the National Forest Policy which recommended that forests be managed efficiently for commercial purposes and for the minimization of forest productivity but NCA remained silent about the traditional rights of the tribals. Gaining over experiences the Government of India under 42<sup>nd</sup> Amendment of the Indian Constitution deleted forest from State list and entered it under concurrent list in 1976. The Indian Forest Bill 1980 again vested powers with forest officers to arrest and for the seizure of goods. This policy also reflected the colonial legacy which did not treat *adivasis* as the friend of forest, rather, empowered State Government to declare any reserve forest as non-reserved and also allotted forest land for non- forest purposes. The National Forest Policy 1988 emphasized more on environmental stability through the preservation of forest by replacing contractors by tribal co-operatives, gave concessions to the ethnic minorities, provided suitable alternatives for the shifting cultivators. But, in practice the official draft did not follow the letter and spirit made in the resolution.

Much before the introduction of Joint Forest Management in Odisha it was seen that around 3 to 10 percent of all reserved and protected forest lands of Odisha were under informal community protection (Ghosh, 1996). Tribal people of Odisha seem to have shown remarkable performance in managing their land resources. Perhaps for this reason Government of Odisha has felt that for successful forest preservation the local community should be fully involved and made responsible for the prevention of illicit felling, theft of forest produces and encroachment in reserve forest (GOI, 1997).

Roy Burman Committee (1982) had pointed out the commercial viability of around 300 NTFPs, explained the close linkages between the tribals and forest; and the potential

of prosperity of different traders to trade forest produces at various levels. With the 73<sup>rd</sup> Amendment of Indian Constitution, which gave power and revitalized the Panchayati Raj Institutions, Government of India extended this special power through the Panchayats (Extension to the Scheduled Areas) Act 1996. Following this Government of Odisha has announced and formed the Odisha Panchayati Raj (Amendment) Act of 1997 and extended the Central Act 40 to the Scheduled Areas of the State. Recently (2000) GoO have considered these special provisions and involved the local communities as partners in the management of degraded forests and the members of the Vana Samrakshyan Samiti (VSS) are entitled to share the use of forests. Considering this GoO have handed over 68 NTFP items during 2000 to Gram Panchayats as regards its procurement and marketing at local level.

### **Factors of Chronic Poverty: Towards an Inclusive Explanation of the North-South divide in Odisha**

It can be argued that large differences in the density and extent of concentration of tribal population between the northern and southern regions lead to the observed differences in the extent of aggregate/chronic poverty between these regions of Odisha. On the contrary, while the density of tribal population is very nearly the same in the north and south NSS regions, there is much greater concentration of tribal population in the north as compared to the southern region. In fact, the northern region has more than a proportionate share of the state's tribal population (53.66 per cent) relative to the share of tribals in the state's total population (34.69 per cent). Thus the higher incidence of aggregate/ chronic poverty in the southern region cannot be explained in terms of a higher density and/or concentration of tribal population. This perhaps means that economic conditions of the tribal people vary from context to context. This needs to be studied to examine the efficacy of existing policies and programmes, and for drawing out implications for policy reforms and interventions.

A study of factors that contribute to a relatively stronger impact on aggregate/chronic poverty in the northern NSS region could be useful for understanding the presence of different kinds of constraints operating in the southern NSS region. Available evidences relating to some of these factors are discussed below. However, these factors are indicative and call for more detailed research as well as identification of other relevant variables. We present below an account of some of these differentiating factors.

#### ***Level of Wage Rates***

The available data suggests that wage rates are relatively higher in the northern as compared to the southern region of Odisha in all segments of the daily wage market. The most striking difference in wage rates is in the case of agricultural labourers. It may be seen that average weekly wages of tribal agricultural labourers in the north are about 34 per cent higher than they are in the south (and about equal to that in the coastal

NSS region of Odisha). It needs to be mentioned here that the observed difference in the incidence of chronic poverty between the northern and southern regions is not fully explained by labour market conditions, but perhaps more importantly, by the relatively lower ratio of prices received to prices paid by the small producers (who constitute a sizeable proportion of the poor) in the southern region (*World Bank, 'Odisha Policy Notes 2005*).

### ***Relatively Favourable Agro-ecological Conditions***

Relatively higher proportion of high land, and lower proportion of low land, in the southern as compared to the northern region, perhaps suggests the following: lower agricultural productivity in general in the south (because of lower moisture retention capacity of high land soil) in the short run and in the long run, possibly a higher rate of soil erosion in the southern region, in case there has been a greater extent of degradation of forest (*Directorate of Agriculture and Food Production, Bhubaneswar, 1997*).

The data on closed forest area as per cent of total forest area (which is the reciprocal of the extent of degradation of forests), and closed forest area as per cent of total geographical area (a measure of effective forest cover), for the northern and southern regions, show that the extent of degradation of forests is relatively less in the northern region and the effective forest cover is also relatively higher. In addition, there is a much greater concentration of closed forest area in the northern as compared to the southern region. In fact, it is more than proportionate to the share in total population of the state for the northern region (which is much larger than the south). There is some micro level evidence to the effect that JFM is functioning better in the northern region. A good indicator of this is the extent of institutional and community-based management of forests under JFM. We thus find that the extent of forest area protected by Vana Samrakhyana Samiti (VSS) is much higher in the north compared to the south relative to the total forest area in the two regions (*PCCF, Odisha, Aranya Bhawan, Bhubaneswar, 2005*).

### **Overview of Kenduleaf Resources in Odisha**

Kenduleaf (*Diospyros melanoxylon*) is one of the precious naturally renewable livelihood resources in the tribal dominated regions of the state used commercially. It is popularly known as "Green Gold". The quality of kenduleaf (Thus known as KL) in Odisha is known for its unmatched flavour, texture and workability (Forest and Environment Department, 2008). Due to its flavour, flexibility, feature, texture and resistance to early decay, KL is used as wrapper for preparation of *beedi*. *Beedi* is the popular cigarette for the Indians and for many Asian nations. The quality of KL in Odisha divides it into two types. The first one is little large, thinner, and more pliable with prominent nerves found in bushes, while the second type of KL is shorter, thicker and brittle collected from mature trees.

### Management of Kenduleaf

The management of KI in Odisha is divided into three administrative circles i.e. Conservator of Forest, Cuttack (KI) Circle which includes 5 KI Divisions and 44 KI Ranges; Conservator of Forest, Sambalpur (KI) Circle covers 6 KI Divisions and 50 KI Ranges; whereas, Conservator of Forest, Bolangir (KI) Circle covers 8 KI Divisions covering 59 KI Ranges. Thus, the KI organization in Odisha covers 153 KI Ranges distributed in 19 KI Divisions which are divided into 3 KI Circles. Looking at the revenue potential generated out of KI trading, the state government took a decision to nationalize kenduleaf in the year 1973. The Forest and Environment Department, Government of Odisha does the collection, processing, packaging and storage, of Kenduleafs while the Odisha Forest Development Corporations Ltd. (thus known as OFDC Ltd) sells them on behalf of the State Government on commission basis. The whole range of KI trade offers employment opportunities to the rural poor of Odisha. The KI organization includes 7,601 Collection Centre Popularly known as Phadis, spread over 23 western and central districts of the state. During the year 2006-07 (2006 KI crop year) the achievement of KI production was 3.84 lakhs quintals which have benefited 7,57,123 lakh pluckers (Forest and Environment Dept, 2006-07). The study of NCDS (Mallik, 1997) on the "Procurement and Marketing of Kenduleaves in Odisha: A study on economic deprivation and benefits to primary collectors" assessed the degree of dependency of KI pluckers on the collection of KI, employment opportunity of KI, and the impact of forest depletion on the KI pluckers.

### Registered Kenduleaf Binders and Binding Rates

Kenduleaf binding is another area of raising income for the tribal people of the state. Binding rate of the Kenduleaf is the only determinant of income benefit to the KI binder households. Attempt made to find out the status of KI binding parties distributed in different parts of Odisha, total number of *khuntis* in different KI divisions and number of KI binders who are engaged in binding operation in the state. The data indicate that there were a total of 962 number of binding parties, 10054 number of *khuntis* and 20108 number of binders engaged in KI binding in the state. Of the total binding parties operating in the state, only 5.50 per cent are functioning in Sambalpur KI FD, followed by 6.34 per cent in case of Rourkela KI FD, 6.30 per cent in case of Bolangir KI FD and 6.02 per cent in case of Bhawanipatana KI FD. Similarly, as regards the number of *khuntis* are concerned Sambalpur KI FD shares 6.53 per cent of the total *khuntis*, while Rourkela has 4.34 per cent of the *khuntis*, Bolangir has 8.06 per cent of *khuntis* and Bhawanipatana has 5.31 per cent *khuntis* for the binding of the KI. Out of 20108 number of KI binders, 6.53 percent of binders were functioning in Sambalpur KI FD, while 4.34 per cent binders were working in Rourkela KI FD, 8.06 per cent of binders were working in Bolangir KI FD, and 5.32 per cent binders were working in Bhawanipatana KI FD.

The payment of different rates per each KI bundles of different grades of KI, for the year 1990 to 2009 was assessed to find out the growth rate in KI binding rate per bundle. For the base year for all grades of KI the price was fixed at Rs.5.00 per bundle. However, this price was increased from Rs.3.00 per bundle. There were no variations in the rates as per the quality of the KI. Uniformity in the binding rate was found for all grades of the KI during the year 1999. When compared with the year 1990 one finds there is a growth of 70.00 per cent in the KI binding rate during the year 1999. Price variations in the payment of wage rates for different grades of KI were distinctly observed from the year 2005. During 2009 the growth in the KI binding rate when compared with 1999 observes 213.95 per cent for grade-1 kenduleraf, 179.01 per cent for grade-II kenduleaf, 173.26 per cent for all other grades. The rates of different grade of KIs are by and large influenced by the quality of the kenduleaves (Forest and Environment Department, 2010).

### **Production of Kenduleaf**

Production of KI is one of the important indicators of assessing its economic potentiality. Looking at various constraints of managing KI resources and for better economic return the state of Odisha in the year 1973 has nationalized KI and entrusted the Forest Department the task of procurement, while Odisha Forest Development Corporation Ltd has been entrusted with the responsibility of marketing the KI through periodic auction within state and at some place outside the state. All KIs are of not equal quality and thus have differential market value.

The quinquennial classification of data was made for the period 1973 to 2010 to assess the growth of production of KI in Odisha. The data on the average percentage of growth rate of the KI production in Odisha reflect that there was a fall in the production of KI during the period 1978-82 to the extent of -5.83, and -4.66 per cent during the period 2003-2007. In rest of the periods the average percentage growth rate of KI production in Odisha was always in upward trend. The above similar trends in the production of KI during the period were observed in case of Sambalpur and Rourkela KL FDs. In case of Bhawanipatana KL FD fluctuation in the net production of KI was observed since 1993, while in case of Bolangir KL FD the net production of KI was reported as constant from 1988 to 2002 which again receded in subsequent period (PCCF Office (KI), Bhubaneswar 2010).

### **Revenue Potential of Kenduleaf**

There are two types of KI produced in Odisha viz Processed and *Phal*. Processed KI is generally more in Odisha for which services of binders with skill and efficiency is required where as '*Phal*' leaves sold even before production without classification and processing. The average sale price per quintal of processed and *phal* leaves in Odisha effectively fixed and marketed by OFDC. Processing of KI in Odisha is undertaken by the



government headed by the PCCF (KI), which is not found in any other KI growing states in India. In Odisha, two KI Divisions namely Jeypur and Nawarangapur are harvesting KIs which are not processed, known as “*phal*” or unprocessed KI collected in a “*Kerry*” containing 40 leaves. The average sale price per quintal of processed leaves, therefore, fetched 2.29, 1.38, 1.98, 1.71 and 1.59 times more than the price of ‘*phal*’ leaves during the crop year of 2006, 2007, 2008, 2009 and 2010 respectively. It is basically due to the fact that the better and assured quality of processed leaves fetches more prices. Value addition by undertaking processing, binding and bagging not only contributes to state exchequer by way of royalty, but also generation of additional person days of employment and income ensure a group of people to sustain their livelihood.

An assessment of the decadal variations in the revenue generation from different major forest resources like timber, firewood, bamboo, kenduleaf, and other NTFPs was made by taking into account the achievements during last 57 financial years spread over the period 1953-54 to 2009-10. During the year 1953-54 to 1962-63, of the total revenue collected from different forest resources KI had contributed to the extent of 0.46 crores i.e 18.85 per cent, while during the decade 1963-64 to 1972-73 this contribution went to the extent of 1.72 crore and in next decade (1973-74 to 1982-83) the contribution of KI raised to 6.15 crores i.e 24.67 per cent of the total forest revenue. In subsequent decades the contribution of KI increased to the tune of 55.17 per cent (1983-84 to 1992-93), 70.90 percent (1993-94 to 2002-03) and 74.49 pe cent in the rest seven years periods (from 2003-04 2009-10). This shows that KI has been a major source of generating income for both government at higher level and households living in rural areas of the state at lower level who are engaged in KI related operations like bush cutting, plucking and binding of KIs. For the rural households in inland region of the state KI is of the very important naturally gifted source of livelihood.

Kenduleaf trading is a promising source for providing employment to the rural population of Odisha. Opportunities for employment are created during bush cutting, plucking, drying, storing, and processing of kenduleaves. All these activities have differential impact on rural household economies. In addition, the ‘*Beedi (Green cigarette) rolling*’ also creates a lot of employment opportunities for the rural villagers. However, the people engaged in all these arduous activities are exposed to various hazardous effects like underemployment, migration, deprivation from all social sector services like ration under PDS, education and health inputs provided by the line departments. Migration seems to have multiple effects on both adult and young generations of KI pluckers and the binders. One of the basic objectives of KI nationalization was to safeguard the welfare interest of the rural people engaged in various stages of KI trade. In order to achieve this, various organizational and operational strategies have been made for implementation at various stages of production, procurement and processing of kenduleaves. The distinct achievements of all these interventions are reflected in the increasing production of KI rise in the profit, increase of wage rates of the laborers engaged in various KI related activities. Sometime it is felt that these growths are not percolating down to the people

on a sustainable basis. As a result, very little change is observed in the socio-economic status and economic opportunities at local level, which leads to the continuation of their abject poverty of the KI binders households.

### **Livelihood Potential of Kenduleaf: An Empirical Finding**

#### ***Profile of the study***

The gender composition of the KI Binders indicates that of the total population of 619, females constitute 52.50 per cent and male constitute 47.50 per cent. Share of female among the KI Binder population is more in all the KI FDs. The age group composition of the KL Binders is analysed according to different age group categories. Among the KI Binders the data indicate that out of 619 people, around 11.07 and 17.97 per cent were belonging to the age group of 0-6 and 7-15 years respectively. Around 66.64 per cent people were belonging to the productive age group of 16 to 59 years. The marital status of the head of the KI Binder families shows that out of total 161 KI binders, 81.25 per cent were married, 13.44 per cent were widow/widower, and only 4.69 per cent were unmarried. The female shares only 12.50 per cent among the binders interviewed by the team. Similarly, a look into the marital population of all 619 members of the KI binder shows that around 48.04 per cent were married and 46.55 per cent were unmarried. The average family size per family among the KI binders was reported as 3.98 or say 4, which range from highest 4.17 per family in case of Sambalpur KI FD and minimum of 3.53 per family in case of Bolangir. The educational distribution of the head of the KI binders and their family members is separately calculated. The data indicate that out of total 161 KI binders family head, 57.81 per cent were illiterates, 15.00 per cent were just literates, 17.50 per cent were having education up to primary level and 2.81 per cent were having HSC pass. Most of the females (92.50%) were reported as illiterate. The educational achievements of all family members of the KI binders were also calculated. Out of 619 members of the KI binders, 44.13 per cent were reported as illiterates. This shows that low education might be another determinant of adopting KI binding as a source of living.

#### **Kenduleaf and Employment opportunity for Tribal Binders**

The person days generated by KI tribal binders were collected as per different activities like bush cutting, KI Plucking, and KI binding. More number of persons engaged in different activities are in the age group of 16 to 29 years (45.33%), followed by 30 to 45 years (33.92%). The field data collected with respect to employment generated in different KI operations, such as bush cutting, plucking, binding reveal that tribal binders employed in binding work for 95.31 percent, 4.03 percent of days in plucking and 0.67 percent days in bush cutting. Gender-wise distribution of KL work show that males are engaged in binding activities for 96.47 per cent of days, in plucking 2.36 percent and in

bush cutting 1.17 percent of total KI activities. So far as female are concerned they are engaged in binding activities for 94.30 per cent of days, in plucking 5.49 per cent of days and in bush cutting accounted for only 0.21 percent of days. It is obvious that women are engaged more in plucking of KI than males and in bush cutting males are engaged more number of days than female.

With respect to the number of days engaged in KI binding activity by each KI binder across the KI region is 135.74 days. Total number of days engaged in KI binding activity is highest per binder in Kalahandi (164.65 days), followed by Balangir (137.65 days), Sambalpur (134.66 days) and in Rourkela (128.08 days). So far as the number of KI bundles produced per binder it is reported to the tune of 563.32 in all regions, while it is highest in Kalahandi (725.25) and lowest in Sambalpur (527.88 bundles). As regards the income raised from KI binding the data explain that on an average a KI binder has generated Rs.12,956.53/-per one KI season. The highest income from KI binding is accrued by a binder in case of Kalahandi (Rs.16,692.25/-), while the lowest income is observed in case of Sambalpur (Rs 12,141.34/-).

Distribution of total days of employment, KI bundles produced, and income raised by tribal KI binder households the data show that on an average 244.50 days of work engaged by one household produced 1014.69 KI bundles which have generated an income of Rs.23337.86 during one KI season. The highest income generated per household out of KI binding is Rs27942.05 in case of Balangir KI Division and the lowest is in case of Rourkela (Rs.17851.83). The highest number of person days of employment generated in KI binding work is in Bolangir (300 Days) and the lowest number of days engaged in KI binding activities is in Rourkela i.e.172.91 days. Similarly, the data on producing number of KI bundles per tribal binder HH is highest in Bolangir i.e. 1214.87 and lowest in Rourkela i.e. 776.16 bundles.

### **Income and Expenditure of Kenduleaf Tribal Binder households**

Annual income of the tribal KI binder households was collected according to various sources, contribution of KI binding to the total household income, average income from KI binding per each household and per KI binder. The data with regards to the income of KI binders from various sources raised during the year 2009-10 observes that KI binding contributed to the extent of 61.05 per cent of the household income followed by wages and remittance (19.07%) and agriculture (10.10%). In case of Sambalpur KI FD it contributes to the extent of 65.88 per cent of the total income of the household, followed by agro-production to the tune of 16.53 per cent and wage and remittance (15.09%). In case of Balangir income from KI bindings constitute 62.58 per cent of total household income is the highest among the other sources of income. In case of Bhawanipatana KI binding work contributed 61.31 per cent of total household followed by wages and remittances (22.82%). The income from KI binding in Rourkela KI Division constitutes 59.77 per cent followed by wages and remittances (16.06%).

Generating income from various sources in order to meet the requirements of livelihood basket is the prime concern of the KI binder households. In addition to KI binding activity, binder households are also reported engaged in other livelihood sources. The study tried to find out the extent of engagement by a binder household for purposes other than KI binding and KI related activities during the year 2009-10. The collection and analysis of data was made with respect to the average number of days worked and earning made by each binder household. The study found out that on an average a KI binder household has worked 66.05 days during the period 2009-10 and earned an amount of Rs.4503.26. Number of days of engagement by a binder household varies from one KI FD to another, so also income from other sources. However, number of days engaged by a binder household seems to be highest in case of Bhawanipatana KI FD (81.71 days), followed by Rourkela KI FD (58.67 days), Bolangir KI FD (62.71 days) and Sambalpur KI FD (62.30 days).

### **Expenditure of Kenduleaf Tribal Binder households**

The data on monthly expenditure relating to the financial year 2009-10 was collected during primary survey. As per the National Sample Survey (NSS) data from Odisha estimated on the basis of poverty line of the Lakdawala Committee during the year 2009-10 at Rs. 505 & Rs. 804 for rural & urban areas respectively. But the Tendulkar Committee (Headed by Professor S.D. Tendulkar) expert committee appointed by Planning Commission revised methodology for poverty estimations. The Tendulkar Committee has recommended, among other things, two main departures from the previous methodologies. First, the Tendulkar Committee has enlarged the consumption basket and, thus increased the poverty lines for both rural and urban areas for which different consumption baskets have been suggested. For example, the poverty line of the Tendulkar Committee for the Year 2009-10 would be Rs.632 for rural Odisha in comparison to Rs.505 for rural Odisha as per the Lakdawala Committee methodology. This implies that the proportion of the rural poor estimated by using the poverty lines suggested by the Tendulkar Committee would be higher than those estimated by using the previous methodologies. Second, the Tendulkar Committee recommended the use of the "Mixed Recall Period (MRP)" methodology over the "Uniform Recall Period (URP)" methodology for estimation of poverty.

Based on the above estimation, it is an attempt to estimate the number of ST binder HHs below poverty line as per Tendulkar estimation of Rs. 632 per month per capita expenditure on consumption basket. In order to further analyse how many HHs are unable to afford even 50 per cent of prescribed amount i.e. Rs 316 are under distress condition. So it was attempted to find out to know how many HHs are spending below Rs. 316, Rs 317 to Rs632 and above Rs.632. The percentage of ST binder HHs under distress condition in Bolangir, Kalahandi, Rourkela and Sambalpur are 15.38, 40.00, 35.90 and 42.86 respectively. In all Divisions 37.89 percent ST binder HHs are unable to spend even 50 per cent of expenditure recommended for consumption basket to be above the poverty. The

percent of HHs who are in a position to spent Rs.317 to Rs.632 in Bolangir, Kalahandi, Rourkela and Sambalpur constitute 62.23, 45.00, 35.90 and 36.73 respectively. In case of total sample of ST binder HHs across all KI divisions, 42.24 per cent have afforded Rs. 317 to Rs. 632 and have crossed poverty line as per the Tendulkar Committee estimates and their per capita consumption basket constitutes 15.39, 15.00, 28.20 and 20.41 per cent in Bolangir, Kalahandi, Rourkela and Sambalpur KI divisions. It is revealed from the above estimation that only 19.87 percent of HHs crossed poverty line in all KI division, whereas, rest 80.13 per cent of tribal binder HHs is languishing under the clutches of poverty.

### **Conclusion**

During last three decades Odisha has witnessed repeated protest by poor tribal people against state encroachment on their age-old land rights. Incidences since 1990s in Maikanch in Koraput district, Raigardh and Mandrabaju in Kandhamal district and Kaling Nagar in Jajpur district may be linked to the impact of globalisation on the poor tribal people of Odisha. Yet incidents involving the subjugation of tribals in Odisha and the deprivation of their natural rights over resources are not new. In post-British India, as a result of deprivation, the tribal people of Odisha have taken part in many movements and revolts. These include uprisings of the Kondhs of Ghumasar (1835–37), the Gonds of Sambalpur (1857–64), and the Bhuiyans of Keonjhar (1867–68). These regional anti-feudal and anti-British agitations and movements gave birth to a class of regional leader, including women, in Odisha in general and in ethnic minority-dominated areas of the state in particular to fight against the British during India's independence struggle. (Bailey,1963) in his village study among the Kondhs of Odisha, rightly pointed out that land alienation, money lending, killing of marginalised groups, burning of crop fields and huts of the poor and imposition of collective fines were some of the major causes of such uprisings. Pathy (1987) opines that this milieu of underdevelopment, destitution and disunity seems to be being reproduced even after more than six decades of the formation of the state and more than five decades of independence.

From the above discussion one can say that the ethno-ecologies of the natives still plays a very important role in their livelihood basket and should not be challenged, transformed, and replaced. Imported values often conflict with native values. In the context of population growth, migration, commercial expansion, national and international incentives to degrade the environment, ethno-ecological systems that have preserved local and regional environments for centuries in many contexts are adversely affected. In such a situation anthropologists are to make use of various modern methodologies like satellites and other remote sensing devices, including geographic Information Systems (GIS) and a host of new possibilities for anthropological and ecological research particularly in the areas of land use patterns and ecological context. Anthropologists with the changing nature of global-local equations have to think globally and act locally. As new environments emerge and grow in importance, new types of ecological analysis will be needed to

understand the interrelations that human groups maintain with them. The establishment of new environmental problems that arises out of such situations results in new problem of environment that can and are to be studied ethnographically popularly dealt by anthropology of environmentalism. The combination of ecological and ethnographic approaches has expanded anthropological research resulting in new possibilities of contributing to solve the larger problems of the natives. This is an important issue with regards to the indigenous people since the paradigm shift in ecological anthropology incorporates new trends, priorities and audiences from both applied and advocacy point of view.

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# 6

## Natural Resource Management and Sustainable Development V/s Disaster Management

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— *Mamata Desai and Sandip Halder*

### ABSTRACT

The branch of physical geography deals with the science of natural resource management. The basis of this branch of science is the theory of the geographic landscape where primary element is earth. This also deals with the origin, structure, and dynamics of landscapes, the laws of the development and arrangement of landscapes, along with the transformation of landscapes for the economic activities of man.

The science of land resource management has always been basically an applied science. As it developed, its practical applications became considerably broader. Several special fields have developed in contemporary applied resource management science: agricultural production, land system engineering, land reclamation, land health use, architectural planning, recreation and also land disaster. The principal materials offered by the scientists for use in the various sectors of the national economy are applied/thematic maps, and charts with corresponding texts and in recent time's data base system along with digital maps.

**Keywords:** Physical geography, landscapes, economic, land health use

### Introduction

Natural Resource Management refers to the management of natural resources such as land, water, soil, plants and animals, with a particular focus on sustainable development of quality of life especially for future generations. Thus natural resource management, sustainable development and environmental governance are all co related. Natural resource management specifically focuses on a scientific and technical understanding of resources and ecology and the life-supporting capacity of those resources. In order to have a sustainable environment, understanding and using appropriate management



strategies is important in terms of conservation and development. Using appropriate and adapting management systems is dependent on local ecological situations and cooperation between scientists and local people who have knowledge and skill about the resources.

Land resource forms the most important wealth of any region. Its potential, proper utilization and management and role in the development are a matter of utmost concern to the people living in the region concerned. Improper use of land creates problems like land degradation, creation of waste land, decline in productivity due to soil erosion, encroachment on arable land and increase in the frequency of natural disaster.

Therefore, utilization and management of soil, natural vegetation and other land resources, according to their capability is very important. It should be ensured, that land resource must be utilized to the best advantage in an enduring manner. Land resources management, in a broader sense, is the implementation of land use planning, as agreed between and with the direct participation of the actual stakeholders.

### **Development & Management of Natural Resources in India**

The management of land and natural resources is one of the most critical challenges facing by the developing countries today. The exploitation of valuable natural resources, including oil, gas, minerals and timber has often been principal causes in triggering, natural and manmade disasters around the globe. Furthermore, increasing demand and conflict for diminishing renewable resources, such as land and water, is on the rise. This is being further aggravated by environmental degradation, population growth and climate change etc. The mismanagement of land and natural resources is responsible for various types of disasters in so many ways.

Inter-relationship and inter-dependence among water, land, vegetation and animal resources determine the nature and kind of livelihood support systems especially in the rural areas. Depletion of the natural resource-base and increasing biomass-demand of the humans and livestock population are also very much responsible for such types of imbalances. However, the degeneration of natural resources has assumed alarming proportions during last few decades. It is, therefore, pertinent to evolve strategies for sustainable natural resource management systems. It is also imperative to observe the changes taken place in the land-use pattern in general and in the agricultural sector in particular, which generally have implications on local bio-diversity and the ecosystem, which again determine the sustainable food and nutritional security of the local people and country as a whole.

India constitutes about 18 per cent of the world's population, 15 per cent of the live stock population and only 2 per cent of the geographic area; one per cent of the forest area and 0.5 per cent of pasture lands. The per capita availability of forests in India is only 0.08 per ha as against the world average of 0.8 per cent, which reflects the extent of

pressure on land and forests resources of the country. According to the National Remote Sensing Agency's (NRSA) there are 75.5 million ha of wastelands in the country. It has been estimated that out of these around 58 million ha may be regenerated and may be brought back to original productive levels through appropriate techniques and measures. But the percentage of such treated land is negligible only because of the absence of proper and scientific management planning.

Again due to lack of proper watershed management planning in India there are threats to the livelihood of millions of people which has become a major constraint to develop a healthy agricultural and natural resource base. Increasing population and livestock are rapidly depleting the existing natural resource base because the soil and vegetation system cannot support the present level of use. As population continues to rise, the pressure on forests, community lands and marginal agricultural lands leads to unscientific cultivation practices, depletion of forests. Also increasing grazing practices create more wastelands.

As a matter of fact a watershed is a complete geo-hydrological unit which drains at a common point. Rains falling on the mountain start flowing down into small rivulets. The small streams form bigger streams and then finally the bigger streams join to form a big channel to drain out of a village. The entire area that supplies water to a stream or river, i.e. the drainage basin or catchment area, is actually termed as the watershed of that particular stream or river. Thus, management of a watershed entails the rational utilization of land and water resources for optimum production but with minimum hazard to natural and human resources. The main objectives of watershed management are to protect the natural resources such as soil, water and vegetation from degradation. In general sense, it is an equilibrium between elements of natural resources on the one hand and man's activities on the other. In managing or developing a watershed it is very important to have people's participation. In this regard, the key issue is how far the people can be motivated, involved and organized to drive the movement. No significant improvement can be expected without the people being motivated or brought to the core of the project.

The Ministry of Rural Development, Government of India, has recently created a Department of Land Resources to act as a nodal department in the field of watershed management and development. This has the mandate of developing the valuable land resources of India, which are presently under degradation and it also endeavors to prevent further degradation of these resources through appropriate management and necessary measures. The Department of Land Resources, being the nodal department has taken up certain new initiatives to play a more active role in the Land Resource management in the country. At the conceptual level it has been realized that the management rather than the mere use of land is the central theme. There is no dearth of land; the real issue is management and utilization techniques which should also include the methods of conservation, sustainable development and equitable access to the benefits of intervention.

It is a known fact that man and his environment are interdependent. Any change in the surrounding environment directly affects the people living therein. A degraded environment results in a degraded quality of life for the people. Thus, any programme to reduce poverty and improve the standard of living of the people must be aimed at the sustainable improvement of the environment. But for this, people's participation is very necessary. There is a close relationship between the environment and the human community living within a certain ecological unit for its livelihood. When the economic condition of a community deteriorates, it leads to over all exploitation and degradation of natural resources. Thus, it is necessary for people to understand the relationship between their economy and the reasons behind their poverty and the degraded environment where they live in. Because the environmental regeneration is possible only when the concerned people realize a need for it and are empowered and trained to have control over the process of resource utilization, management and conservation.

To do so sustainable development of the resources is necessary. Promoting sustainable development is among the top priorities for every government. It is seen as one of the most crucial factors in governance in general, economic prosperity and improvement of quality-of-life for citizens, including improved health services, education, and shelter. Now it is an acceptable fact that everyone should be educated to realize the impacts of natural and manmade disasters, and the need for proper planning, preparation, response, recovery and ever-improved resilience.

India shares 18% of the world population, while its land is only 2% of the total geographical area of the world. Naturally, the pressure on the land is often beyond its carrying capacity. Therefore, the productive lands, especially the farmlands in the India are in the constant process of various degrees of degradation and are fast turning into wastelands. At present, approximately 75.5 million hectare area of the land is lying as wastelands in India. Out of these lands, approximately 50% lands are such non-forest lands, which can be made fertile again if treated properly. In the last 50 years it is India's lush green village forests and woodlots have been deforested to the maximum.

Government of India had created the Department of Wasteland Development during July, 1992 under the Ministry of Rural Development, which has been subsequently reorganized and renamed Department of Land Resources, with a broader mandate. National Wasteland Development Board was established in 1985 under the Ministry of Forests and Environment mainly to tackle the problem of degradation of lands, restoration of ecology and to meet the growing demands of fuel wood and fodder of the local people. During the Seventh Five Year Plan, the strategy adopted by the National Wasteland Development Board emphasized more on tree planting activities rather than Community Participation for wasteland development. In the year 1992, the new Department under the Ministry Of Rural Development (now Ministry of Rural Areas and Employment) was created and the National Wasteland Development Board was placed under it. The Board was reconstituted in August 1992 and was made responsible for mainly development of wastelands in non forest areas in totality by involving local people at every stage of development. It aims at creating a scenario where the Government acts as a facilitator

and the people at the grass root level become the real executioner of the programme. Major programme were implemented for improving the productivity of waste & degraded lands keeping in view the poverty, backwardness, gender & equity.

Sometimes many of the long-term development programmes is often disrupted and discontinued due to some unforeseen events. Many of them come in the form of natural or manmade disasters, which can put enormous stresses and set backs on social and political systems. Today, disasters are widely recognized as among the most disruptive forces impeding sustainable development, especially in developing nations, where disasters divert much-needed and scarce resources away from the strategic infrastructure development and toward response and recovery. Appropriate safeguards against these negative effects are needed, including promotion of national disaster management strategies and implementation of sound disaster management practices. However, the greatest emphasis of disaster management continues to be placed on response and recovery activities, while little attention is given to proactive measures that would reduce risk and prepare people, communities and economies to better withstand and survive disasters. In recent memory, for instance, the Indian Ocean Tsunami of December 2004 demonstrated the human cost of not having an early warning platform in place. Similarly, Hurricane Katrina in the United States Gulf Coast demonstrated the high price to be paid for not having a proper understanding of effective plans to counter the risks. Again due to proper warning system and timely evacuation human lives could be saved from cyclone Phailin in Orissa, India on 12<sup>th</sup> October 2013. On the other hand thousands of pilgrimages died in Uttarakhnad due to incessant rain and flash flood only because of lack of proper and timely information in August 2013.

### **Disaster Scenario in India and around the World**

India has been traditionally vulnerable to natural disasters on account of its unique geo-climatic conditions. Floods, droughts, cyclones, earthquake, landslides etc. are recurring features. About 60% of the landmass is prone to earthquake of various intensities, over 40 million hectares is prone to floods, about 8% of the total area is prone to cyclones and about 60% is susceptible to drought. The Disaster Management cell, Government of India has identified that 8 cities in India are situated in seismic zone V with very damage risk 14 cities are within seismic zone IV with high dame risk, another 24 cities neither seismic zone III, 17 cities are with seismic zone II. The Super cyclone in Orissa in October 1999, and Bhuj earth quake in January 2001, Aila in May 2009 and Phailin in 2013 or Uttarakhand disaster are the examples of such type of devastated natural disaster in India when environmental impact were felt for long time. 7 out of the 63 cities are located along the coastal belt and are vulnerable to cyclonic hazards. 10 out of total cities are located in severe to high landslide hazard prone areas in the hilly regions. Therefore, urban authorities are highly responsible for providing opportunity for the safety of the cities which includes, proper building planning, sewage clearing, and preservation of water bodies.

The picture of the other countries of the world does not have many differences to that of India. In recent past the summer heat waves are likely to become more common in Europe and by 2030. Most of the Europeans and Australians countries may have 10 – 15% more summer days over 35°C and 20 - 80% fewer frosts. Most climate models indicate that in many places global warming is likely to increase the frequency and duration of extreme events such as heavy rains, droughts and floods. It has been forecasted by the scientific communities of world that the summer heat waves are likely to become more common in Europe and by 2030, most of Australia may have 10-50% more summer days over 35°C, and 20-80% fewer frosts. Tropical cyclone frequency may change in some regions and peak winds and rainfall rates may increase.

Tropical cyclone rainfall rates may increase, but there is also uncertainty about location changes. Flooding at present is, overall, and costliest form of natural disaster with average losses estimated at \$400 million a year and it may increase in near future in many countries of world even heat waves may account for more deaths in Australia than any other climatic events. The average annual number of disasters reported during 2000-04 was 55% higher than during 1995-99. With 719 reported disasters, 2004 was the third worst year of the decade (1994-2004).

The occurrence of natural or manmade disaster is now a daily phenomena and the impact of it is huge in respect of economic and social point of view. In Southeast Asia that includes roughly 31 million people – 13.2 million in the Philippines; 4.9 million in Vietnam; 4.8 million in Thailand; 3.4 million in Indonesia; and 1.5 million in Cambodia. In South Asia, the numbers are even higher: 126.5 million people in India; 57.5 million in Pakistan and 20.9 million in Bangladesh. South and South East Asia have witnessed major disasters in recent times, including devastating earthquakes in China, the quake-triggered tsunami in Japan, the most recent Cyclone Phailin, in India, one of the largest cyclones to ever hit the region and above all the strongest ever typhoon Haiyan, that slams the Philippines island. Typhoon Haiyan, known locally as Yolanda, was historic in its scope, NASA concluding it may be the most powerful tropical cyclone to ever make landfall. According to Weather Channel lead meteorologist Michael Palmer “It is the most powerful storm ever to make landfall”.

That width of the Typhoon Haiyan was 370 miles. It surged through the Philippines with sustained winds of 195 mph, and gusts reaching 235 mph. According to the Philippines government, the typhoon made its first landfall over Guiuan in Eastern Samar before moving over Tolosa, Leyte at 7 a.m. local time and Daanbantayan, Cebu at 9:40 a.m. Haiyan then made its fourth landfall over Bantayan Island, Cebu and later made its last at Concepcion, Iloilo and Busuanga, Palawan. Apart from ferocious winds, storm surges up to 10 feet high that blown away coastal towns and deep inland destroying countless human lives and property. The Philippine government says 9.8 million have been affected in 44 provinces, 539 municipalities and 56 cities. Of those affected, 4.9 million are children; 1.5 million are children under the age of five who are at risk of Global Acute Malnutrition (GAM), a measurement of nutritional status used to assess the severity of a humanitarian crisis.

Again, Phailin a very severe cyclonic storm originated from a remnant cyclonic circulation from the South China Sea. From 8th-12th October the depression turned into a giant cyclonic storm and six satellites and 70 weather experts tracked its evolution and movement. By far it is one of the most disastrous cyclone after 1999 Super Cyclone. At the time of landfall on 12th Oct, maximum sustained surface wind speed in association with the cyclone was about 115 knots (215 kmph) Maximum rainfall occurred over northeast sector of the system centre at the time of landfall. Maximum 24 hr cumulative rainfall of 38 cm has been reported over Banki in Cuttack district of Odisha.

Although the nature of the Phailin was devastating but it could not able to use its paw over human being as compare to the super cyclone of 1999. One of the most important reasons behind it proactive pre-disaster management by the central and state Government, and awareness of the local people. In 1999 super cyclone, 460 people were died whereas 28 people lost their lives by Phailin. After the disaster telecommunication, transport system, water supply, medical assistance, food supply were taken care of and restored immediately. Effective decisions from all sectors, accurate weather monitoring, resource mobilization and community based participation were the key factor in reducing the impact of disaster.

To mitigate any type of disaster 'Natural disaster Management Authority' was formed by the Government of India. The authority is a multi disciplinary body which includes various departments like; health, relief, environment & forest, water resources, agriculture, railways, defense, science & technologies, Indian meteorological department. Such type of authority has also been formed in the state, district and block levels which are coordinated by the respective administrative chiefs.

The main objectives are; hazard mitigation, preparedness & capacity building, relief & rehabilitation. The Sustainable Mitigation Planning in some specified cases as adopted by the Government of India are;

- Construction of the buildings as per BSI rules, as has been done in Bhuj Gujarat, after January 2001 earth quake
- Various Government and non Government organizations like Indira Awas Yojana etc have various projects for construction of appropriate buildings to mitigate earth quake hazards
- The long coast line of India also falls under seismic zones III, some parts of Gujarat, entire Andaman, Nicobar islands are under active seismic zone
- Along with earthquake, landslide is another disaster in the hilly areas; October 8th 2005 earth quake with 7.4 Richter Magnitude in Jammu & Kashmir caused large scale destruction

### **Some Case Studies**

Landslides are major threats to life and property in the mountainous terrains around the world. Due to the growing urbanization and uncontrolled land use of the limitedly-

available mountainous areas, on global scale, there is an increasing trend of landslide hazard and associated risk. A recent global risk assessment study undertaken by Nadim indicates that the regions with the highest risk of such danger can be found in Colombia, Tajikistan, India, and Nepal. Historical record indicates that the greatest number of loss of life due to a single landslide event was the earthquake-triggered landslide disaster in Kansu Province, in China in 1920, where 100,000 people lost their life (Schuster and Fleming, 1986).

At present the prevention of loss of life and property due to natural calamities is being viewed very seriously by the Government of India. In the past, the main role played by the Government in the case of various disasters was confined mainly to post-disaster activities that included providing relief and organizing rehabilitation. The Uttarkashi Earthquake of 1991, Killari Earthquake of 1993 and the devastating Malpa landslide along the Kailash-Mansarovar route in 1998 acted as an eye-opener for the Government. The need was felt for a proactive approach rather than waiting for a disaster to occur. As a part of this strategy, the Government decided to institute task forces for landslide hazard zonation Mapping and geotechnical investigations along with land use zonation mapping and regulations. It was however the Bhuj Earthquake of 26 January 2001 that led to a paradigm shift in the policies of the Government of India.

Due to the 18th September 2011 Sikkim earthquake of 6.8 Richter scale, several new and a few reactivated landslides have occurred right from the Himalayan foot-hill region (e.g., Dudhia in Kurseong Sub-division, Darjeeling District, West Bengal) up to the higher Himalayan range in the higher reaches of Sikkim-Darjeeling Himalayas, parts of the country as well as in the relatively stable domains of the Meghalaya Plateau, Western Ghats and Nilgiri Hills. In all, 22 states and parts of the Union Territory of Pudducherry and Andaman & Nicobar Islands are affected by this hazard. The new landslides that occurred in the lower elevations are mostly concentrated within the terrace deposits of main streams like Tista, Rangit and Balason etc. 4 landslides reactivated within the old colluvial deposits on the lower reaches of slope adjacent to the streams near Jorethang-Rishi-Legship section along the right bank of Rangit River.

Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country—an area which exceeds 0.49 million km<sup>2</sup>. Landslides of different types are frequent in geodynamically active domains in the Himalayan and Arakan-Yoma belt of the North-Eastern of landslides is pronounced during the monsoon period. In order to reduce the enormous destructive potential of landslides and to minimize the consequential losses, the National Disaster Management Authority initiated a series of guidelines. The Guidelines include regulatory and non-regulatory frameworks with defined time schedules for all activities. Investigations of landslide risk assessment involve a multidisciplinary approach where engineering geologists and geotechnical engineers, geomorphologist are an integral part of the investigating team. The investigations include preliminary stage geological and geomorphological investigations, detailed and geotechnical investigations.

Building up and maintenance of the roadway linkages in the Sikkim & Darjeeling Himalayan regions have been a major problem for the engineers and Planners. During the incessant rains in monsoon period, these roadways sometimes get blocked due to landslides for indefinite period affecting the natural mobility of the hill people. Due to limited number of roadways in the region and absence of alternate route, people as well as essential commodities get stranded on the road during such natural calamities.

The main causes responsible for landslide hazards along the roads in the hill areas are;

- Large scale deforestation especially along the jhora banks and road stretch,
- Lack of proper and controlled drainage system,
- Jhora blocking due to non disposable garbage dumping, lack of proper building rules,
- Excessive heavy vehicular movements etc.
- Illegal mining & stone quarrying.

All these reasons have made this geologically unstable region to a vulnerable one. The roads in this region have never been examined with its carrying capacity in respect of geologic structure, soil profile and extent of erosion, geomorphologic analysis along with the evaluation of existing natural vegetation and their importance in the maintenance of the road. Also the steep slopes, heavy rainfall and high altitude characterize the Darjeeling Hill area. Here natural vegetation plays an important role in protecting the hill slopes from erosion. As is said earlier, the forest land in the hill areas are encroached upon for different purposes, as it is done in almost all hilly areas in the country and world as a whole. But, in Darjeeling Hill area, this has created some vulnerable patches, which have become susceptible to frequent landslide hazards. In Kurseong subdivision about 5 percent of the forest cover has been depleted in areas like Sukna, Bagdogra, Pankhabari ranges. In Kalimpong subdivision maximum deforestation is noticed, i.e., 26 percent. The most noted deforested areas are Kalimpong, Chel, Jaldhaka, etc. Due to increasing population pressure, agricultural land has been expanded since last few decades, as a result of which per capita forest coverage has been reduced considerably. The Table below explains the increase of arable land and depletion of forest coverage in the region since 1901.

**Table 1.** Changes in Arable and Forest Areas – 1901 – 1991

Year	Increase in Arable Land (%)	Decrease in Forest Area (%)
1901	19.76	51.54
1911	23.45	55.55
1921	21.3	49.14
1931	20.38	45.46



Year	Increase in Arable Land (%)	Decrease in Forest Area (%)
1941	24.50	45.01
1951	36.67	46.01
1961	31.92	46.07
1971	44.51	40.73
1981	53.61	38.23
1991	56.40	34.12

Source: Dept. of Forests, Government of West Bengal

Due to the 18th September 2011 Sikkim earthquake (M: 6.8), several new and a few reactivated landslides have occurred right from the Himalayan foot-hill region (e.g., Dudhia in Kurseong Sub-division, Darjeeling District, West Bengal) up to the higher Himalayan range in the higher reaches of Sikkim-Darjeeling Himalayas. The new landslides that occurred in the lower elevations are mostly concentrated within the terrace deposits of main streams like Tista, Rangit and Balason etc. 4 landslides reactivated within the old colluvial deposits on the lower reaches of slope adjacent to the streams near Jorethang-Rishi-Legship section along the right bank of Rangit River. Landslides are one of the natural hazards that affect at least 15 per cent of the land area of our country—an area which exceeds 0.49 million km<sup>2</sup>. Landslides of different types are frequent in geodynamically active domains in the Himalayan and Arakan-Yoma belt of the North-Eastern parts of the country as well as in the relatively stable domains of the Meghalaya Plateau, Western Ghats and Nilgiri Hills. In all, 22 states and parts of the Union Territory of Pudducherry and Andaman & Nicobar Islands are affected by this hazard. The phenomenon of landslides is pronounced during the monsoon period. In order to reduce the enormous destructive potential of landslides and to minimize the consequential losses, the National Disaster Management Authority initiated a series of guidelines. The Guidelines include regulatory and non-regulatory frameworks with defined time schedules for all activities.

Amongst them landslide zonation mapping is important. The major evaluating parameters for such mapping are;

- Soil magnitude & length,
- Soil thickness analysis,
- Relative Relief analysis,
- Land use mapping and analysis,
- Drainage pattern & density,
- Impact analysis of landslides,

The Table below will explain the major landslide occurrences in the Darjeeling-Sikkim Himalayas since 1897 till date.

**Table 2.** Major landslide occurrences in Darjeeling – Sikkim Himalayas Since 1897 to till date

Year	Area	Causes	Damages
1897	Tindharia and adjoining areas	Earthquake	Infrastructural failures
1899 (23rd & 25th Sept)	Darjeeling town and adjoining areas	Excessive Rainfall (1065.55mm)	Loss of properties and lives(about72 persons)
1934 (15th Jan)	Tindharia, Kalimpong, Darjeeling town, Kurseong	Bihar-Nepal earth quake	Heavy loss of properties
1950(14th June)	Kalimpong, Kurseong, Tindharia(Siliguri-Kalimpong railway line was closed forever)	Excessive rainfall (834.10mm)	Heavy loss of properties and lives(127 persons)
1968 (5th & 6th Oct)	Tindharia, Darjeeling, Kalimpong, Kurseong, NH 31 was severely damaged, Coronation bridge was washed away, Hill cart road especially near Giddah Pahar was badly damaged	Excessive rainfall (about 640mm in Kurseong)	Heavy loss of property and lives (677 persons) About 15% of total tea garden areas in Darjeeling was badly affected.
1980 (3rd & 4th Oct)	Darjeeling, Bijonbari, Sukhiapokhri, Tindharia, Kurseong	Excessive rainfall (about 300 mm in Kurseong)	Huge loss of properties and lives(250 persons)
1983	Darjeeling town and adjoining areas, Kueseong, Hill Cart road)	Heavy rainfall	Death:05, House damaged: 345, Heavy loss of property
1987	Darjeeling, Kurseong, Hill Cart Road	Heavy rainfall	Population affected:795, Death: 17, House damaged: 765
1997	Darjeeling, Kurseong, Hill Cart Road	Heavy rainfall	Heavy loss of property and lives(death:17)
1998 (7th July)	Darjeeling, Kurseong subdivision and municipality areas (Sherpa busy)	Heavy rainfall	Heavy loss of property and lives(21 persons, more than 3000 houses were damaged)
1999	Darjeeling-Pulbazar, Rangli Rangliot, Simbong division, Kurseong, NH 55, Kalimpong	Heavy rainfall	heavy loss of property and lives(11 in Sherpa busy, Kurseong)
2000	Darjeeling-Pulbazar, Kurseong, NH 55	Heavy rainfall	Heavy loss of property and lives but there was no such casualties were reported
2002	Darjeeling-Pulbazar, Kurseong, Tista Bazar areas	Heavy rainfall	Heavy loss of property. Total death 7

Year	Area	Causes	Damages
2003	Rangli-Rangliot, Tista Valley, Kalimpong-II, Kurseong, NH 55, Mirik (Gheyabari)	Heavy rainfall	NH 55 near Pagla Jhora was badly damaged, only Gheyabari (Mirik) 23 death was reported
2004	Rangli-Rangliot, Kalimpong II	Heavy rainfall	Heavy loss of property, more than 1,00,000 people were affected, total death 25
2006	Rangli-Rangliot, Kurseong, NH 55	Heavy rainfall	Heavy loss of property, More than 3000 people were affected and total death 13
2007	Darjeeling-Pulbazar Kalimpong-I, Kurseong, NH55	Heavy rainfall	Heavy loss of property especially in tea garden areas like Margaret Hope, Rangli Rangliot, Sukhiapokhri, Garubathan
2008	Darjeeling-Pulbazar, Rangli-Rangliot, Kalimpong-I, Singringtam, Rangli, Bagogra, Mirik- Karshing municipal areas	Heavy rainfall	More than 1,00,000 population were affected but total death reported were 3
2009	Sukhiapokri, Kalimpong-I Kalimpong Municipality	Heavy rainfall	About 555 villages were affected, near about 1,50,000 population affected , total death reported were about 40
2010	Bijonbari, Sukhiapokhri, Darjeeling, Takdah Kurseong, Mirik, Kalimpong – I & II, NH55	Heavy rainfall	Total failure of road & rail link in between Siliguri – Darjeeling due to massive landslides near Pagla jhora and 14 <sup>th</sup> Mile
2011	Darjeeling, Kurseong, NH55, Kalimpong	Earth quake and heavy rainfall	Population affected more than 3,50,000; Death reported Over 90 and houses damaged more than 4, 50,000, Massive landslides occurred on NH 55 near Tindharia

### Uttarakhand Disaster in August 2013

Cloudbursts, landslides and flash floods are an annual affair in Uttarakhand. The monsoon of 2010 brought with it such massive losses of lives, property, crops and infrastructure that the state said its development clock had been set back by a decade. Things are much, much worse this year in August 2013, when due to incessant rain fall

many highways damaged, bridges washed away, electricity and phone networks down, several ravaged places continue to be marooned. The horrifying picture came after the disaster. After all, the speediest monsoon in over 50 years has just dumped over 400% more than average rainfall over Uttarakhand and neighboring Himachal Pradesh.

Himachal chief minister Virbhadra Singh blames nature's fury against which all disaster management must, presumably, fail. India's premier disaster management body neither has implemented any project successfully nor has much information over progress at the state level. Even if local administration had understood the implications of meteorological data, it didn't have much time to put out effective warnings across a state where 65% of the area is under forests.

The Reason Behind Kedarnath Flood as has been said that on GLOF (Glacial Lake Outburst Flood) could be one of the reason behind the flash flood in Kedarnath township, that washed away almost 200 houses and affected thousands of local inhabitants and tourists. The Gandhi Sarovar lake, also known as Chorabari lake, is one of the well known Glacial lake in the higher Himalayan region of India. The Chorabari glacier lies between latitudes 30°44'50"N and 30°45'30"N, and longitudes 79°1'16"E and 79°5'20"E, from an altitude of approximately 6,000 metres (20,000 ft) at the slopes of Kedarnath peak, to 3,800 metres (12,500 ft).

The glacier is around 7 kilometres (4.3 mi) in length, while the basin area of the glacier is approximately 38 square kilometres (15 sq mi) and the glacier ice cover is 5.9 square kilometres (2.3 sq mi). The glacier slope is around 11 degrees and faces south. The glacier has two snouts. It is said that an original single glacier covered the area, which while receding, split into two snouts. One of the snouts is the source of the Mandakini River at 3,865 metres (12,680 ft). The other snout, at 3,835 metres (12,582 ft), drains into the Chorabari Tal.

On 17th morning between 7.30 a huge flash flood that originated from Chorabari lake devastated the Hindu pilgrimage city Kedarnath, that was housed by over 3000 people. The debris flow was such that it had huge boulders and mud that washed away almost 150-200 houses and other were under rubble of 10-12 feet high.

During last flood in 2012 many scientists from various organizations warned about the possibilities of such calamities in future, but, things were not taken seriously by planners and policy makers at state and central government. No early warning systems were placed in this highly sensitive state Uttarakhand. The situation seems not in control of the government in terms of rescue operation and covering huge number of affected people.

## **Conclusion**

The Himalaya is vast mountain system extending in to eight developing countries in south Asia: Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan. The fact that India is recognized as a mega diversity country and as one of the 10 most

extensively forested areas in the world is due mainly to the Himalayas. Although it covers only 18% of the India's geographical area and accounts for more than 50% of the country's forest cover and 40% of the species endemic to the Indian subcontinent. Losses of forest cover, biodiversity, agricultural productivity and ecosystem services are interlinked problems in the region that threaten the sustainable livelihoods of not only millions of mountain people but also much larger population inhabiting the adjoining Indo-gangetic plains.

Owing to its relatively recent geological origin, the Himalayan ecosystem once rich in biodiversity of elusive plant and animal species is under threat of destruction, expanding agricultural land and rural population resulted in diminishing forest area. Expanding economic activity and population growth are the two basic factors behind increases in energy consumption.

In a state like J&K, where economic growth is necessary and population growth is increasing, energy demand will continue to rise in the years to come. Again, energy consumption patterns and the rise in demand, their sources, and ways in which they are harnessed and utilized have implications for the environment and natural resources, which ultimately affect overall development. Progress in environmental management has been slow and natural resource degradation remains at the core of many problems. Climate change will add a new stress to ecosystems and socio-economic systems already affected by poverty and natural resources depletion and unsustainable management practices needs an immediate attention of the scientific community.

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# 7

## Status of *Saraca asoca*: An Endangered Medicinal Plant Species of Conservation Concern from Northern Western Ghats Biodiversity Hotspot

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— Patwardhan Ankur, Pimputkar Makarand, Mhaskar Monali, Agarwal Prerna, Barve Narayani and Vasudeva R.

### ABSTRACT

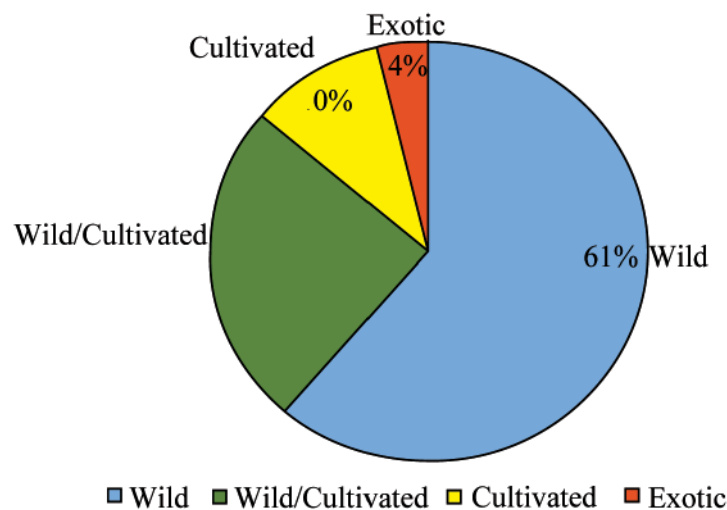
*Saraca asoca* (Roxb.) de Wilde is an economically important medicinal tree species that has been identified as one of the flagship species for conservation and cultivation in India. Scanty information regarding its population structure is available as the demand from pharmaceutical industry is catered by substitute species. Natural populations from northern Western Ghats have been studied at various protection levels ranging from informally protected areas (Sacred groves) to Wild Life Sanctuary. Data on spatial distribution and age structure including regeneration status of this species were presented and discussed.

**Key Words:** *Saraca asoca*, Sita-ashok, Trade, Population, Regeneration, Distribution map, northern Western Ghats.

### Introduction

Biological resources are viewed as ‘resource capital’ of a nation (Ganeshaiyah et al. 2012). Among the 34 global biodiversity hot spots, Western Ghats of India occupies the fifth position according to the economic potential of its biological resources (Natesh, 2000). It is also one of the eco regions of the world with high levels of endemism and houses over 4000 plant species that have medicinal uses. Of the 960 traded medicinal plant species from India, 178 species are consumed in volumes exceeding 100 Metric Tons per year, with their consolidated consumption accounting for about 80% of the total industrial

demand of all botanicals in the country (Ved and Goraya, 2007). From the Western Ghats in particular, in the last decade, there is a 50% population decline of medicinal plants in RET (Rare, Endangered and Threatened) category. Modern medicine is dependent on several high-value metabolite-yielding plant resources as major raw material. For instance, natural populations of *Salaciachinensis* L., are being exploited for salacinol and kotalanol to be used against diabetes (Muraoka et al. 2010), *Nothapodytes nimmoniana* (J. Graham) Mabb. for campothecin for the cancer cure (Lorence and Nessler, 2004) and *Saraca asoca* (Roxb.) de Wilde for epicatechin and procyanidin treatment of uterine and menstrual disorders (Pradhan et al. 2009). Unsustainable, unscientific harvesting of these resources in large volumes by forest contractors through local tribal people was found to be one of the reasons for the rapid depletion of natural populations. Recent estimates suggest that only a minuscule of the supply of Medicinal and Aromatic Plants (MAPs) to the pharmaceutical industry is originated from the cultivation, rest sourced directly from the natural populations (Figure 1).



**Figure 1.** Share of Wild collected and Cultivated origin of MAPs in trade

*S. asoca*, an evergreen tree species (family: Fabaceae), is one such species that immediately needs conservation attention. It is one of the 32 prioritised medicinal plant species by the Planning Commission, Government of India and National Medicinal Plant Board for the need of research and development (Haridasan et al. 2003). It is native to Indian subcontinent and is distributed in the Indo-Malaysian region and in Sri Lanka. The wild presence of this species has been recorded along moist zones of Western and Eastern Ghats (Peninsular India), sub-Himalayan tracts (Uttar Pradesh to Arunachal

Pradesh) and Eastern India, mainly up to 750 m altitude. Though widely distributed, the distribution of *S. asoca* is highly clumped (Kumar et al. 2006). From the Western Ghats it is restricted to only a few scattered patches in the low land humid evergreen forests along gently flowing perennial streams.

With more than half of the natural habitat from NWG being cleared (WWF, 2007), highly fragmented, scattered natural populations of medicinally important species (such as *S. asoca*, *N. nimmoniana*, *Symplocos racemosa* Roxb, *Dysoxylum binectariferum* (Roxb.) Hook. f. ex Bedd., etc.) exist in remnant forest patches or informally protected forest landscapes such as 'Sacred Groves' (SG) (Mhaskar et al. 2011).

It has been observed that *S. asoca* has been extensively wild-harvested, sometimes even from forested areas. The population is declining due to harvest of a part (bark) that damages the plant. Habitat destruction, habitat encroachment, narrow niche of the species and other factors has led to decrease in population size. Considering the conservation need of this species, it has been listed under the threat category of 'Vulnerable' by IUCN, (2013) and 'Endangered' by CAMP, (2001). With this background it has become essential (i) to assess the current population and regeneration status of *S. asoca* from NWG of Maharashtra, and (ii) to identify and spatially map the existing populations of the species. Thus the present study was carried out to understand the population structure at various protection levels.

### Trade Potential of the Species

'Ashok-chhal' in Ayurveda, is the bark of *S. asoca* tree, constitutes a popular botanical raw drug used by India's herbal industry in the preparation of well-known Ayurvedic formulations. Every part of *S. asoca* has medicinal properties; more than 150 pharmaceutical formulations and traditional medicines are prepared from different parts of this plant. It yields many high value secondary metabolites which have wide range of clinical applications (Table 1). A number of leading pharmaceutical companies manufacture tonics, tablets, syrups made from *S. asoca* under different brand names like 'Ashokarishtha', 'Ashotone', 'M2 Tone', 'Ashonil', 'Mensta' to name a few. It is speculated that natural populations are the primary source of dry bark for the manufacturers. According to FRLHT survey, the cost of *S. asoca* bark ranged around Rs.20-25/kg for the year 2005-2006 and it is estimated that about 2000 to 5000 tons of bark of *S. asoca* is required by the pharmacy industry annually in India suggesting a very high level of threat to the plant species (Ved and Goraya, 2007). Due to scarcity of authentic *S. asoca* bark, barks of *Polyalthia longifolia* Benth. & Hook. f., *Aphanamixis polystachya* (Wall.) R. Parker, *Caesalpinia pulcherrima* (L.) Sw., *Shorea robusta* Gaertn, *Mesua ferrea* L., *Brownea ariza* Benth, *Bauhinia variegata* L., *Trema orientalis* (L.) Blume and *Rhododendron arboreum* Sm. are used as adulterants (Pradhan et al. 2009).



**Table 1.** Chemical constituents and activities reported from *Saraca asoca*

Plant part Used	Phyto-constituents	Activity
Bark	Catechin, Epicatechin	<ol style="list-style-type: none"> <li>1. Antibacterial activity against <i>Salmonella typhi</i>, <i>Pseudomonas aeruginosa</i>, <i>Staphylococcus aureus</i>, <i>Bacillus cereus</i>, <i>Klebsiella aerogenes</i>, <i>Escherichia coli</i>, <i>Proteus vulgaris</i> and <i>Klebsiella pneumoniae</i> (Rajan et al. 2008), <i>Shigella sonnei</i>, <i>Salmonella enteritis</i> (Annapurna et al. 1999)</li> <li>2. Chloroform extract effective against early IV instar larvae of the vector mosquitoes viz., <i>Colletotrichum quinquefasciatus</i> (Verghese et al. 1992) Anti menorrhagia activity, in treatment of menstrual and uterine disorder (Middelkoop and Labadie, 1983, 1985; Bhandary et al. 1995)</li> <li>3. Radical scavenging activity (Pandey et al. 2011)</li> <li>4. Anti-oxidant property (Panchawat and Sissodia, 2010)</li> </ol>
Whole plant	Ketosterol	<ol style="list-style-type: none"> <li>1. Androgenic in nature, Antibacterial activity against <i>Bacillus subtilis</i>, <i>Escherichia coli</i>, <i>Salmonella typhosa</i>, <i>Staphylococcus aureus</i> (Pal et al. 1985)</li> <li>2. Antifungal activity against <i>Alternaria cajani</i> (Dabur et al. 2007)</li> <li>3. Active in treatments against uterine disorders, piles, dysentery and even against diabetes (<a href="http://indianmedicine.nic.in">http://indianmedicine.nic.in</a>, 2012)</li> </ol>
Flowers		<ol style="list-style-type: none"> <li>1. Antibacterial activity against <i>Salmonella viballerup</i>, <i>Shigella boydii</i>, <i>Escherichia coli</i>, <i>Vibrio cholerae</i>, <i>Shigella flexneri</i> and <i>Shigella dysenteriae</i> (Jain and Sharma, 1967)</li> <li>2. Anti-cancer activity against Dalton's lymphoma ascites and Sarcoma-180 tumour cells (Verghese et al. 1992)</li> <li>3. Anti-menorrhagic activity (Middelkoop and Labadie, 1985)</li> </ol>
Leaves		<ol style="list-style-type: none"> <li>1. Antibacterial activity against <i>Escherichia coli</i> (Singh et al. 2009), <i>Bacillus subtilis</i>, <i>Pseudomonas aeruginosa</i>, <i>Salmonella typhimurium</i> (Seetharam et al. 2003)</li> <li>2. Antifungal activity against <i>Alternaria alternate</i>, <i>Colletotrichum gloesporioides</i> and <i>Drechlera specifera</i> (Seetharam et al. 2003)</li> <li>3. Petroleum ether extract effective against early IV instar larvae of the vector mosquitoes viz., <i>Colletotrichum quinquefasciatus</i> (Verghese et al. 1992)</li> <li>4. Anti-helminthic property of ethanol extract. (Nayak et al. 2011) Combination of <i>S. asoca</i> leaf extract with Piperonyl butoxide and MGK 264 (ENT 8184) has a strong synergistic molluscicidal activity (Singh et al. 2010) Anti-pyretic activity (Varaprasad et al. 2012)</li> </ol>
Roots		In treatment against paralysis, hemiplegia and visceral numbness, itching in eczema, psoriasis, dermatitis, and herpes- kushta / visarpa, Pruritis, scabies and Tineapedis (Nadakarni, 1957)

## Materials and Methods

### *a) Study Area*

The northern ranges of the Western Ghats, referred as northern Western Ghats (NWG) (**15° 30'- 20° 30' N Latitude, 73°-74° E Longitude**), lie in the states of Maharashtra, Gujarat and Goa. NWG make about one third of the total length of Western Ghats. Forests in this region are generally stunted, species poor and are fragmented as compared to the southern parts of Western Ghats. The study area covers Western Ghats part of Pune, Raigad, Kolhapur, Ratnagiri and Sindhudurg district. The localities sampled were denoted as ST 1 to ST 8. This encompasses five SG, one Private Forest (PrF) and two Protected Areas (PA) including one Wildlife Sanctuary (WLS) and one Reserve Forest (RF).

### *b) Sampling and Data Analysis*

Transect of 5 m width with a length of 100 m was laid at each site totalling 8 transects. Adult (GBH  $\geq$  15cm) and regenerating individuals of the species were recorded along the transects. The observations regarding disturbance were made for each site such as canopy cover, presence of path, cut stump, lopping, soil removal and fire. The adult individuals were categorised into GBH classes of 15 cm interval and regenerating individuals were categorised based on height and GBH (Table 2) to assess the demographic profile. Kolmogorov-Smirnov (KS) test was performed for comparison of populations from study areas.

**Table 2.** Regeneration classes

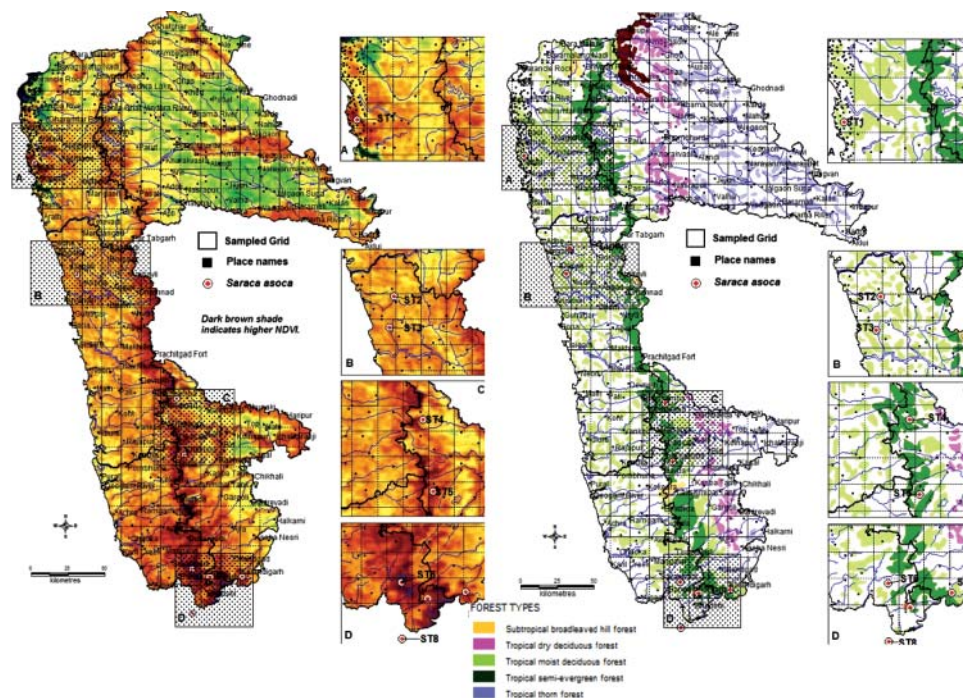
<b>Class 1</b>	< 40 cm height
<b>Class 2</b>	40-100 cm height
<b>Class 3</b>	>100 cm height, <10 cm Girth at Breast Height
<b>Class 4</b>	>130 cm height, <15 cm Girth at Breast Height

### *(c) Preparation of Distribution Maps*

The exact geo co-ordinates and elevations of all populations were recorded using a GPS receiver. Using this, spatially explicit distribution maps were prepared on a GIS platform (MapInfo 7.5). We used two different thematic maps for overlay analysis. The land-use map of India was digitized from Forest Survey of India Atlas (1973) and NDVI images from AVHRR satellite were downloaded from the internet. These images were from the year 2000 and the resolution was 250 m. These images were geo-referenced to geographic projection.

### Major Findings

All the eight natural populations of *S. asoca* identified from NWG of Maharashtra occurred over a wide range of elevation ranging from 200 to 1250 m above mean sea level with slope varying from 0° to 40°. Floristically the habitats ranged from disturbed evergreen to moist deciduous forests. Table 3 gives details and other relevant ecological parameters of sampling sites. Among the eight localities sampled, a total of 258 adult and 449 regenerating individuals were encountered. The density of adult individuals in these populations varied from 15 to 57 individuals per 500 sq m per site. The populations were highly fragmented and showed signs of disturbances. The data generated had enabled us to come up with distribution map of the species (Figure 2). Maps revealed the sparse distribution of *S. asoca*. Preferred habitats were found to be semi evergreen and moist deciduous forests. Commonly associated species consisted of both evergreen nature such as *Caryotaurens* L., *Mangifera indica* L., *Syzygium cumini* (L.) Skeels and deciduous one such as *Terminalia tomentosa* (Roxb.) Wight & Arn. *Mallotus philippensis* (Lam.) Müll.

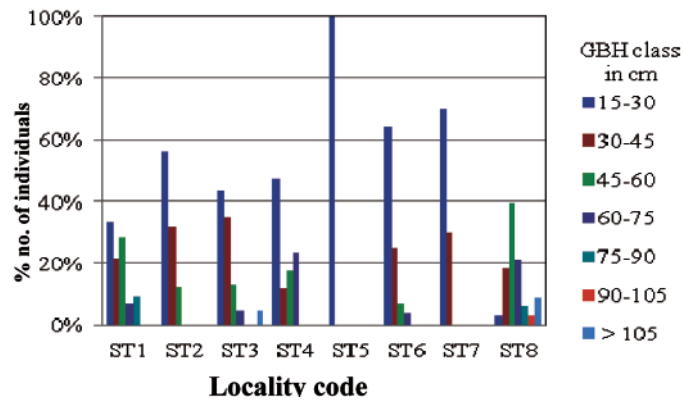


**Figure 2.** Distribution of *S. asoca* overlaid on NDVI and Forest cover maps of NWG region

Demographic profile (Figure 3) of *S. asoca* from (PA) (ST1 and ST7) showed reverse J-shaped curve with good representation of recruitment and large sized adults. It showed a healthy and mildly disturbed population structure. The population among the sampled

Table 3. Ecological parameters assessed for locations sampled

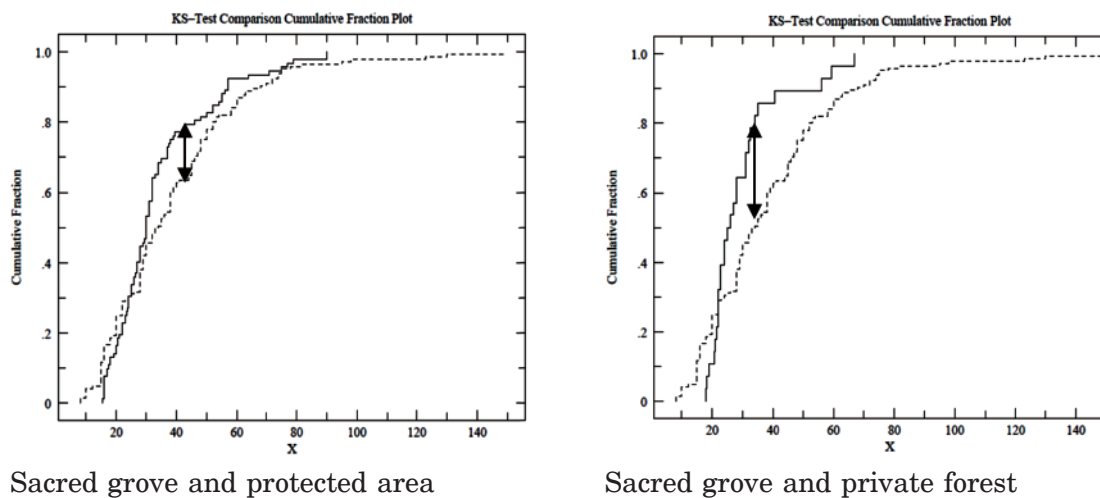
Code	Protection level	Latitude (Degree)	Longitude (Degree)	Altitude (m)	Canopy (%)	Slope (Degree)	Density (no. of individuals / 500 sq. m.)	Min GBH (cm)	Max GBH (cm)	Period of onset of flowering	Fauna	Associated Plant species	Remarks
ST1	WLS	18.420	72.949	185	80-100	20-40	42	16	90	February end	Blue mormon Paradise fly catcher, Giant squirrel	<i>Dimocarpuslongan</i> , <i>Caryotaurens</i> , <i>Garciniatalbotii</i> , <i>Holigarnagrahamii</i> , <i>Mammeasauriga</i>	Cattle grazing, collection of seeds
ST2	SG	17.863	73.243	670	60-80	20-40	57	15	60	February end	Giant squirrel, Blue mormon	<i>Symplocosracemosa</i> , <i>Antiaristoxicaria</i> , <i>Dimocarpuslongan</i> , <i>Leeaindica</i>	Cattle grazing
ST3	SG	17.708	73.221	258	60-80	20-40	23	15	98	February end	Blue mormon, common crow	<i>Antiaristoxicaria</i> , <i>Syzygiumcumini</i> , <i>Caryotaurens</i> , <i>Mangiferaindica</i>	Cattle grazing
ST4	SG	16.931	73.848	1248	40-60	20-40	17	15	74	Late December	Blue mormon, Paradise fly catcher	<i>Dysoxylumnectoriferum</i> , <i>Meynaxiflora</i> , <i>Nothapodytesinmoniana</i> , <i>Terminaliatomentosa</i>	Tourism, predation of seeds by Bonnet macaques
ST5	SG	16.578	73.898	618	20-40	20-40	15	8	30	February end	Blue mormon, Paradise fly catcher	<i>Grewiamicrocos</i> , <i>Lagerstroemia parviflora</i> , <i>Terminaliatomentosa</i>	Tourism and fuelwood removal
ST6	PrF	15.853	73.947	200	20-40	20-40	28	12	67	February end	Blue mormon, Paradise fly catcher	<i>Terminaliabelitrica</i> , <i>Terminaliatomentosa</i> , <i>Chukrasiatabularis</i> , <i>Sterculiaurens</i> , <i>Flacourtiamountana</i> , <i>Mangiferaindica</i> , <i>Syzygiumcumini</i>	Cattle grazing, fuelwood removal
ST7	RF	15.806	74.261	178	40-60	40-60	50	15	39.5	January end	Blue mormon, common cerulean, angled pierrot, common crow, grey count	<i>Caryotaurens</i> , <i>Hydnocarpuspentandra</i> , <i>Chionanthus malacengi</i> , <i>Brideliaretusa</i> , <i>Mangiferaindica</i>	Fuel wood removal
ST8	SG	15.575	73.950	290	60-80	0-20	33	15	149	February start	Blue mormon, crimson rose, common mormon, common crow	<i>Hydnocarpuspentandra</i> , <i>Macarangapeltata</i> , <i>Mallotusphilitipensis</i> , <i>Nothopogonacastanaefolia</i> , <i>Stereospermumchelenoides</i>	Cattle grazing, mining, tourism, fuel wood removal and collection of seeds



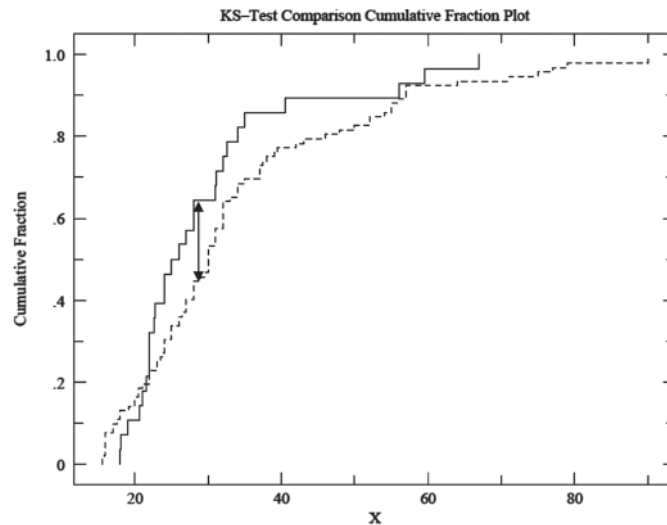
**Figure 3.** Demographic profile of adult individuals

SGs (ST2, ST3, ST4, ST5 and ST8) showed large variation. High proportion of medium aged trees was found in ST8 while, ST2, ST4 showed maximum number of individuals in lower GBH classes indicating a very high level of disturbance and illicit felling of the adult trees. Private forest (ST6) also showed similar demographic profile.

As per KS test results, size class distribution of the adult populations from the sacred groves differs both from formally protected sites and private forest. The statistically significant differences calculated were ( $D = 0.19, p = 0.024 > 0.05$ ) and ( $D = 0.33, p = 0.008 < 0.05$ ) respectively (Figure 4). But there was no statistical difference observed between size class distribution of adult populations from the protected areas and private forest ( $D = 0.1972, p = 0.337 > 0.05$ ) (Figure 5).

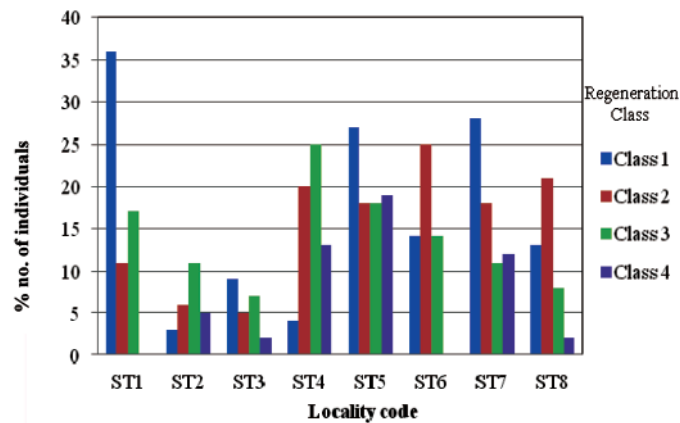


**Figure 4.** KS test comparison cumulative fraction plot for adult individuals



**Figure 5.** KS test comparison cumulative fraction plot adult private forest vs. protected area

High proportions of individuals were observed in lower regenerating classes in forest patches like ST7 (RF) and ST 3 (SG) (Figure 6). Compared to other populations, highest per cent of regenerating individuals in Class 1 was seen in PA- ST1, while SGs (ST2, ST3, ST4, ST5 and ST8) showed highest per cent of regenerating individuals in recruitment classes 3 and 4. No recruiting individuals were observed in private forest (ST6) owing to their cutting for fuel wood.

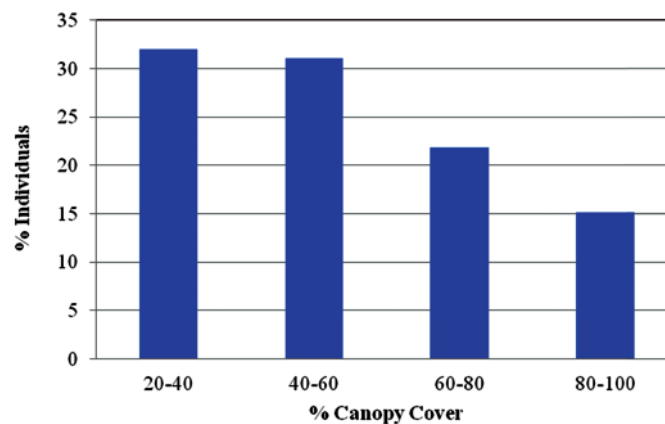


**Figure 6.** Regeneration status

The population structural change is the function of regeneration pattern of individuals within the community (Cunningham, 2001). The lack of knowledge on distribution or population status may make the species vulnerable to extinction, especially when the population is small or has restricted distribution. The constraints to reproduction have resulted in poor natural regeneration, threatening the very survival of the species.

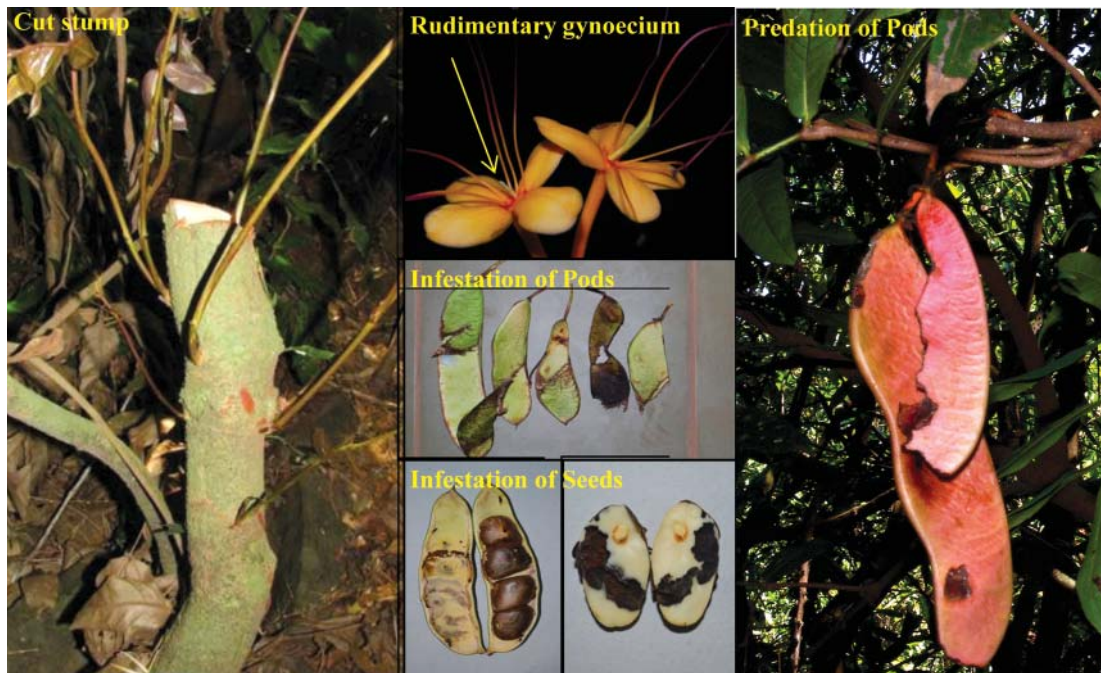
The distribution map showed that this is typically a species of low land evergreen forest patches, that too riparian one. This species strictly remains confined to edges of gentle flowing streams in its natural habitat.

The size class distribution had reverse J-shaped pattern with many individuals in low size classes and a few in high size classes, implying that their populations are expanding through active recruitment. KS test provided a more comprehensive measure of community distinctness and change in nature of size class distribution. Recruitment of viable seeds, germination, seedling establishment and their growth are indicators of the regeneration potential of a plant community. In tropical forests, many tree species are dependent on canopy openings for germination and seedling growth (Richards 1952, Hartshorn 1978). In this case, it was found that canopy openings favour regeneration of *S. asoca* (Figure 7). ST6 is a private forest in close proximity to human settlement and witnesses' high exploitation pressure. As a result, few stunted impoverished individuals were left behind after selective exploitation affecting natural regeneration. This is an indication of poor recruitment and the plant populations are likely to compress if intensive disturbance continued. Similar observations were recorded by Lyaruet *al.* 2000 while working on floristic structural and seed bank diversity of a dry Afromontane forest of Tanzania.



**Figure 7.** Regeneration status at various canopy levels

Lack of individuals at lower size classes and mature reproductive individuals in ST4 and ST2; may be related to their regeneration failure in combination with over exploitation for poles, fuel wood and timber. In ST4, the population is not easily accessible due to steep



**Figure 8.** Factors that delimit population build-up of the species

slope. Bonnet Macaques were observed damaging the inflorescence and eating young leaves. They were major hindrance in development of seed pods because of the physical damage and predation of the unripe pods (Figure 8). Besides, ST4 being a pilgrimage site, dumping of polythene bags, garbage had negative impact on the regeneration both in terms of seeds getting trapped in the polythene and attracting macaques. Site ST8 (a sacred grove) is easily accessible to humans. Because of construction of a road leading to bauxite mine had resulted in chopping of *S. asoca* individuals that existed along the periphery of the grove. A gentle flowing stream runs through ST7 and ST8. Regeneration through seeds was less in these sites as compared to the re-sprouting from rootstocks as seeds were dispersed because of the water. This ensured the survival of plants after being cut, a phenomenon especially evident at site ST8. The recruitment of the regenerated individuals was also seen to be affected.

### Conclusions

Though presence of the species was observed throughout the study area, regenerating populations were less. A significant number of individuals are found on privately owned lands, where farming and fuel wood extraction is a primary land use activity. In such cases, the trees are lopped and regenerating saplings uprooted. However, under such conditions, small populations of the species still thrive in these areas. Though reducing



harvest pressure on wild population and promoting viable commercial cultivation with the community and government participation is a good option, it offers a huge challenge. Effective conservation of *S. asoca* in NWG can be achieved by high levels of protection to natural population, creation of forest gene banks and more extensive, scientific studies of the species.

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# 8

## Impact of Degradation of Forest on the Livelihood of Inhabitants in Sariska Tiger Reserve, India

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— *Utpal Kumar De and Krishna Chauhan*

### ABSTRACT

Degradation of forest resources and biodiversity of Sariska tiger reserve has become an important issue due to its severe impact on the economy of century old forest dwellers. Due to extensive pressure from the villagers for grazing and other forest products for their survival, rising man animal conflict there has been an increase in the degradation of forest and its bio-diversity leading to decline in resource base. People living in this forest depends extensively on their pastoral activities and thus on the quality of the forest directly and indirectly. Also their economy is partly dependent on the growth of tourism which is based on the flora and fauna of the reserve. This paper tries to examine the degradation of forest in Sariska Tiger Reserve and its impact on the economy of the villagers inside the reserve. Analysis of primary data and other secondary information reveals that the percentage of earning of the villagers varies from 85 to 100 per cent depending upon the level of degradation and available alternative opportunities. Their economy and sustenance has been highly affected owing to the unsustainable extraction practice and thus degradation directly and indirectly. It thus calls for suitable population relocation with appropriate compensation in the form of opportunity creation and promotion of nature based tourism to take off further pressure on this forest. Steps are necessary to regenerate the carrying capacity through improvement of resource base by participatory management.

**Keywords:** Degradation of Forest, Economy of Forest Dwellers, Wildlife Tourism, Sariska Tiger Reserve

### Introduction

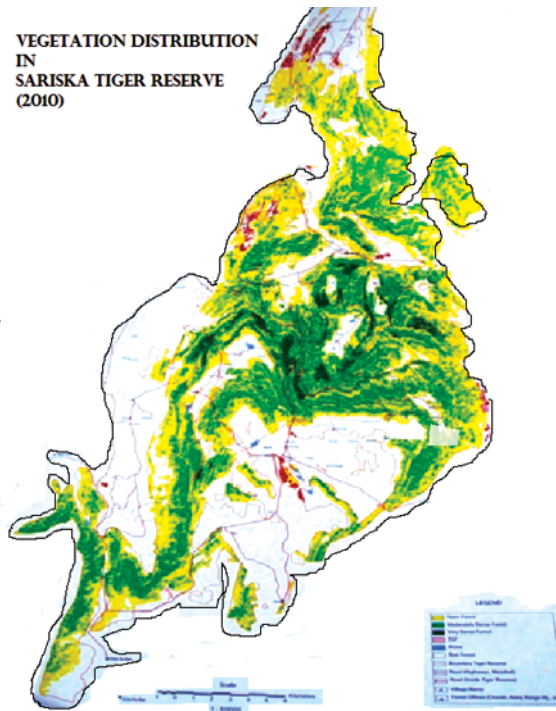
Forests currently cover about 4 billion hectares all over the world (31 per cent of the earth's land surface) and contributes about 1.0 per cent of global GDP engaging around

0.4 per cent of the total labour force directly and indirectly (FAO, 2012). At least ten million people were employed in the management of forest and conservation and an estimated 1 billion people depend on forests for their subsistence directly or indirectly (Scherr et al., 2004). Besides providing food, timber and non-wood produces, forests also provide important services as preservation of biodiversity, protection of watershed by reducing surface run off of water, checking floods and soil erosion and safeguard against draught, atmosphere regulation as well as promotion of tourism (through its scenic beauty that generate income and employment), agriculture, overall ecosystem services and maintenance of environmental balance (Poffenberger et al. 1996; Olander et al., 2008). All these benefits drawn from the forests are not only very difficult to estimate but almost impossible. Thus, every attempt to estimate the contribution of forest would capture only a part of the total contribution.

About 350 million of the world's poorest people including 60 million indigenous people use forest intensively for their subsistence. Hundreds of millions of people rely on traditional medicines harvested from forests. In 60 developing countries, hunting and fishing on forested land supply more than 20 per cent of protein requirement to its population; and more than 2 billion people depend on fuelwood energy for cooking, heating and food preservation that is harvested from the forest around (FAO, 2012). Forest is thus an integral part of life of the forest dwellers and a key source of their livelihood. Large number of people living in forest depends on it for generations. They collect wood and non-wood forest products and use for self-consumption as well as for marketing. Commercially extracted timber from forest at a large scale for the production of various consumer goods like paper pulp, furniture, housing etc along with growing population and growth of trade in wood, illegal trade practice like poaching of wildlife etc. forest has been endangered (World Bank, 1987, 1988; Sharma, 2006; IUCN, 2012).

Dependence on Forest resources for fodder, fuel wood, timber and minor forest produce has been an accepted way of life for the rural people and accounts for nearly 74 per cent of India's population (Govt. of India, 2012). With critical demographic changes, the land to man ratio and per capita forest area has rapidly declined over time leading to relentless pressure of encroachment for cultivation, and unsustainable resource extraction, rendering the very resource base unproductive and in turn depletion of its biodiversity. Along with these incongruities and aberrations in land use, unsound development strategies have led to increasing threats to biodiversity by way of illegal encroachment of 0.07 Mn Hect of forest, cultivation of 4.37 Mn Hect and diversion of 0.52, 0.14 and 0.06 Mn Hect of forest for river valley projects, industries and townships, and for transmission lines and roads respectively with an additional 1.5 Mn Hect for miscellaneous purposes (TERI, 1999).

Though recorded forest area of Rajasthan is 32639 Sq Km (9.54 per cent of the state's geographical area), merely 72 Sq Km area is very dense forest, 4448 Sq Km is moderately dense and 11567 Sq Km is open forest and virtually no tree cover in the remaining areas (FSI, 2011, State of the Forest, 2012). Sariska Tiger Reserve (STR) represents only 0.027



Source: Forest Survey of India, 2010

**Figure 1:** Range Map of Sariska Tiger Reserve

per cent of the total geographical area of Rajasthan and 3.4 per cent of total forest area (32639 Sq Km) of the state.<sup>1</sup> Only 14 Sq Km of very dense forest has been ascertained in Sariska (Forest Survey of India Report, 2003). Total area of STR is however 866 Sq Km including 492 Sq Km of the notified Sariska Wildlife Sanctuary and 374 Sq Km of adjoining area of Alwar, Rajgarh and Sariska Forest Ranges (Figure-1). The forest of STR falls within group V and VI of Champion and Seth classification of Tropical Dry Deciduous and Tropical Thorn forest (Champion and Seth, 1969). Total Reserve Forest area in the sanctuary is 39705 hect., while protected Forest Area is 9494.54 hect making a grand total of 49199.54 hec or 492 Sq Km.

Though area of the reserve kept same (Table-1), Sariska Tiger Reserve recorded a significant degradation over the years in terms of density of forest (State of Forest Report, 2004). Not only that, there has been a significant change in biodiversity in the park and that was the major attraction of large number of tourists (Rodgers, 1990; Ross and Srivastava, 1994; WII, 2009; Sankar et al., 2009). Forest cover of its outer surround also declined marginally.

<sup>1</sup> This forest cover is estimated on the basis of the satellite data of Oct.-Dec. 2008.

**Table 1.** Change in Forest Cover in Sariska Tiger Reserve and its Outer Surround (Sq km)

	Geographical Area	Forest cover within Tiger Reserve			Change in Absolute Area		
		1997	2000	2002	1997-2000	2000-2002	1997-2002
Within Reserve	881	674	674	674	0	0	0
Outer Surround	2499	464	463	463	-1	0	-1

Source: State of Forest Report 2004.

### Description of Study Area and Objective

After independence and formation of Rajasthan state in 1947, all forest areas were leased out to the private contractors for manufacturing of charcoal and firewood. Systematic felling was continued till 1967 even after the formation of sanctuary and they lacked in principles of forestry. Unrelenting extraction of other forest produce like fuel-wood, foliage, tubers, fruits, etc and grazing or pastoral activities have been continued and control mechanism remained inadequate.

Unplanned mining of marble, limestone and dolomite on the periphery of the reserve forest along with pumping of underground water and pollution also caused degradation of the Sariska Tiger Reserve and leading to broken periphery where water aquifers and other sources of water were substantially damaged. About 500 mines were functional in and around the STR during late 1970s, which were closed down in early 1980s with the initiative of local NGO, Tarun Bharat Sangh (TBS) that also started conservation work in the villages since 1985 (Govt. of Rajasthan, 2000).

Rodgers (1990), Shahabuddin *et al.* (2004), Govt. of India (2005), paid attention primarily to the degradation of Core-1 area where proposed national park has been carved out. But the other Core areas, adjacent to the buffer (core-2 and core-3), are also accessible to the villagers living in the surrounding buffer zone and under severe degradation. It has been observed that, not only the core zones but also the buffer, where the high anthropogenic interference in the periphery has been causing irreparable damage to the park. Cattle rearing are still a major economic activity in the STR and its vicinity, where grazing, lopping pressure combined with the villagers living in and around the reserve, and most of the inhabitants are living in a primitive condition.

Wildlife Institute of India (2005) through household survey in 11 villages of core-1 reported that the livelihood opportunity of majority of Gujjar Tribes pursuing cattle grazing has not improved, rather went down over the years and degraded forest leading to more intensive resource harvesting by those families in wider areas and caused degradation of resource availability and impoverishing themselves over time. Reduction in resource base for the livelihood of families living in and around the park and rising pressure on the reserve has also been described by the Tiger Task Force (2005), Shahabuddin, *et al.* (2006), Shahabuddin and Kumar (2007), Torri (2011).

Therefore, degradation of Sariska National Park has led to the increase in hardship of the dwellers that can be an appropriate revelation of the degradation as well as changing socio-economic conditions of those inhabitants. This paper tries to unearth the impact of degradation of Sariska Tiger Reserve (STR) and its biodiversity on the economy of the villagers inside the park.

### **A Brief Outline of the Economy of Forest Dwellers around STR:**

The STR occupies an important place in the economy of the people living in and around it. The inhabitants (mostly Gujjar by caste)<sup>2</sup> draw their livelihood primarily from cattle rearing within the park. Also they extract the forest derivatives like timber, non timber forest products like fodder, fuel etc. for their survival (not for commercial purpose) since a long period of time. As per record, ancestors of the present population there settled during 1905 when the area was under the local ruler Maharaja J. Singh (Saini, 1983). In those early days, they were mainly hunters and nomads, but later on adopted pastoral activities. Villagers in the reserve rear a large number of cattle, produce milk, mawa (milk derivatives used for the preparation of various Indian sweets and dishes), butter, ghee (purified butter) etc. Along with that they also earn some amount from the sale of livestock.

Secondly, households outside the core-1 (buffer and its adjacent core-2, core-3) also used to earn a part of their income from the cropping activities though in small proportion that has been allowed under the provision of revenue village status. It has however been forfeited due to withdrawal of that provision in recent time and imposition of the forest act in the pretext of conflicting issues of degradation of forest and biodiversity.<sup>3</sup> Several issues of encroachment and poaching have come up in the past and many villagers have been suspected of killing animals in order to protect their crops as well. This often led to the damage of wildlife, which has compelled the authority to take such decision (Nagothu, 1998). A few people of core-2 and core-3 adjacent to the buffer areas on periphery (having almost identical characteristics of buffer) yet practice agriculture despite the harassment and illegal status accorded to such activity.

Some family members of core-2 and core-3 also earn a little as daily wage labourer (apart from their income generated from forest) within the region or in many cases outside the region, working in the factories or industries located in Delhi, Jaipur, Gujrat, Punjab etc. Many families from the park also avail some gainful employment in MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) that provide 100 days guaranteed employment to the rural people for livelihood and other employment schemes available from time to time in the outer surround of the park. A

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2 However, they have been trying to get the recognition of tribe and agitations have been observed.

3 his information has been collected by the author from the focussed group discussion in the area at the time of field survey.

very few villagers are however employed in the forest department and hotels within the STR, but in very low scale and earning a gainful employment as petty workers. Their numbers are very negligible due to the lack of skill and education required for the jobs. While some are working as a tourist guide in the park and earn fairly well because of their rich knowledge about the park.

Produced milk and mawa are sold in open market in the nearby villages or town, which is further supplied to various parts like Tehla, Thanagazi, Narayanpur, Akbarpur, Alwar city and also further to some big cities surrounding the Alwar region like Behror, Bharatpur, Bhiwadi, Jaipur, Gurgaon and Delhi. Rajasthan Dairy co-operative limited makes arrangement to regularly channelize milk from the villagers inside the park, that saves their time and energy and raise net earnings. Due to the high quality of milk products and relatively cheap, there is a high demand for those products. For its rich mawa (a popular milk product) production Alwar is known as the mawa capital of India.

However, over time due to the degradation of forest and pressure from the forest department in terms of restriction on harvesting forest resources; income of the families has been declining. They find it increasingly difficult to maintain livelihood owing to decline in the production of milk and sale of livestock (as opined by the villagers during the survey in 2010-11). Household study related to the socio-economic condition of the eleven villages in Core-1 by Shahabuddin and Kumar (2006) also stated the intensity of poverty and hardship of the inhabited villagers due to degradation of the vegetation caused by varying level of anthropogenic disturbances that over the years pushed the park dwellers towards impoverishment. Also report of Tiger Task Force (TTF, 2005) highlighted that degradation of forest has been associated with reckless poaching and further degradation of fauna in the reserve. The poachers are also supported sometimes by the villagers, who are affected by the loss of cattle or crops due to some wild species.

### **Materials and Method of Analysis**

Nature and extent of degradation of forest and biodiversity of Sariska National Park is described in brief.<sup>4</sup> It is examined on the basis of primary data collected from the villagers by direct interview using a suitable interview schedule as well as through time to time organized focus group discussion. Over time quantitative and qualitative changes in forest cover or say level of degradation and its temporal effect on sustenance of villagers is examined by the changes in difficulty and quantum of resource collection by the inhabitants.<sup>5</sup> Degradation leads to decline in availability of required materials and quality of grazing field in the nearby surrounding areas. Hence, the villagers have to

4 Here many a time reserve and national park are used interchangeably.

5 As the forest dwellers here are not commercial and they use it only for their survival the degradation would force them to use more manpower, more time for survival. It would lead to decline in children's enrolment or increase drop out (if they are used for the purpose). So, that information can be used as indirect information for the degradation across the areas.



travel longer distance and more manpower or labour time would be required for meeting their same needs as earlier. Overall, the effort used would be more.

Villagers within STR collect minor wood and largely non-wood forest products for self consumption. Grazing of cattle or harvested fodder is used to feed buffalos, cows, goats etc. Thus value of all the collected products is not observed directly. As the harvesting of forest resources is not practised on a commercial basis, it is very difficult to suitably estimate and compare the generation of income and employment across different core zones. Moreover, impact of over time changes in forest resource base on the economy of villagers is very difficult to examine as the villagers receives benefit from such resources directly and indirectly and the exact relation is very difficult to establish. Only the major impacts are captured here. The earning or revenue generated from the forest resources (like fuelwood, grass and tree fodder, timber poles and thatching grasses) are estimated first and then compared across the zones with varied level of degradation. A part of the products like milk, sales proceeds of cattle is generated from grazing or collected fodder, whose equivalent market value is however considered in the direct contribution of forest and hence is deducted from the sales proceeds of milk in order to avoid double counting. Only net earnings from milk are considered. As the major products (tree fodder, timber pole etc) collected from the forest are consumed at home and not marketed, its equivalent value at the going market rate in the outside areas, if available, are considered for estimation. Also, in case of some of the collected materials like thatched grass, fuelwood, fodder grass, which are also not sold in the surrounding market, the opportunity cost of daily labourer (at the going wage rate) is considered along with the per capita average daily collection to compute the imputed price of those items. Then, the proportional contribution of various components of income from forest is computed and compared across the zones.

Per capita monthly and annual income from all sources and average earning from the respective sources across the zones with different level of degradation are compared to find out the impact of degradation on their livelihood. Variation in tourist arrival over time is also examined to understand the degradation of forest and its biodiversity on the tourist inflow in the reserve. Thereafter, the impact of changing tourist arrivals on the employment in hotels and restaurants or rest houses is examined by looking at the temporal changes of those parameters. By this way the indirect impact of changes in forest biodiversity of STR (through tourism) on the economy of hospitality sector and the villagers if any is examined.

Primary data is collected from a random sample drawn from 16 villages selected by simple random sampling without replacement from all the 28 villages (all belonging to different core zones within the park). The whole core area has been officially divided into three zones namely Core-1 (having 10 villages at present with 318 families), Core-2 (having 11 villages with 364 families) and Core-3 (with 6 villages 52 families) respectively making a total of 734 families in all the core areas. 9, 5 and 2 villages have been chosen from three core areas respectively by simple random sampling without replacement.

A total of 294 families from the 16 STR villages (core I, II and III) are selected as final sample units, and household heads are chosen as the respondents. Here samples are distributed over core-1, core-2 and core-3 in order to have an idea of variation in degradation level in the prime forest area of core-1 and adjacent to buffer area of core-2 and core-3. Also we tried to understand the dependence of villagers on forest, nature of degradation across the zones, and reasons for it.

Moreover, primary data are collected from the 305 visiting tourists and secondary information on temporal variation in tourist is used in order to understand the impact of degradation of biodiversity on tourism and thereby on the villagers' economy.

Information is collected by direct interview on the socio-economic conditions, extraction of resources from the park as well as their involvement in cattle grazing and harvesting of forest resources (timber and non-timber) in the SNP.

### **Observation and Analysis:**

The average involvement of family members, requirements of time and distance travelled for the purpose of grazing and collection of wood and non-wood forest products and their changes over time give an indirect indication of the changing dependence and livelihood opportunities. Table-2 reveals that in the earlier days like 1980-81 most of the forest dwellers used to get their required forest products in their close vicinity and respondents across the villages stated that it was available within 1 Km radius of their living places. However, over the years, with the growth of population and degradation of sources in the adjacent areas they have to travel more in order to collect such products. Though, scarcity in the neighbourhood has increased and also the requirement of growing population, the substitutes has not been adopted significantly by those poor people. Still now they are dependent on those forest products due to their unchanged livelihood pattern (food, cooking, housing, cattle rearing etc) and hence now they have to travel from 3 to 4 Km from their residences.

In the same way, from every family on an average 6 to 8 labour hours used to be spent per day for the purpose of collection of minor timber and non-timber forest products during 1980s. This information is gathered from the elder family members in case the main respondents could not supply the information. The daily labour time used for the purpose has increased to 30-32 hours across the zone during 2010-11, which is also an indication that more labourer from each family are now used for longer hours in this occupation. However, the rise in distance travelled and time used for the collection of forest products for their survival vary across the zones depending upon the extent of degradation of forest and pasture in the vicinity.

In core-1 distance travelled and man-hour required for collecting fodder and fuel wood has increased by 249.79 per cent and 435.90 per cent respectively during past three decades. The rise in distance covered is comparatively high considering the earlier vegetation cover in the core-1. The growth in labour hour required is even

**Table 2.** Variation and Average Distance Travelled by an Average Household for Grazing and Fodder Collection in the Surveyed Villages of Various Core Zones

Zone	Village	Dist. Travelled (km)		Labour Hour/Day		Fuelwood (kg)/day	Grass/Tree fodder (kg)/day	Timber Pole (per yr)	Thatching grass (per yr)	Change in Percentage	
		1980-81	2010-11	1980-81	2010-11					Distance Travelled	Labour Hour/Day
<b>Core-1</b>	Umri, Deori	1.00	3.00	7.00	29.86	89.05	73.10	48.33	53.33	200.00	326.53
	Kraska	1.00	2.91	7.00	22.57	87.71	75.29	43.86	49.00	191.43	222.45
	Rotkayala	1.00	3.00	6.00	36.05	106.32	93.16	61.58	64.74	200.00	500.88
	Sukola	1.00	3.67	6.00	44.00	124.44	111.11	74.33	85.00	266.67	633.33
	Kankwari	1.00	3.00	5.00	33.29	105.00	83.57	60.71	70.24	200.00	565.71
	Haripura	1.00	2.82	5.00	24.27	80.45	74.77	54.77	59.32	181.82	385.45
	Leelunda	1.00	4.00	7.00	31.60	53.25	45.75	40.00	45.00	300.00	351.43
	Dabli	1.00	3.96	6.00	34.87	92.61	74.13	49.78	53.91	295.65	481.16
	Raikamala	1.00	5.13	5.00	32.88	70.63	68.13	40.63	47.50	412.50	557.50
	<b>Average</b>	<b>1.00</b>	<b>3.50</b>	<b>6.00</b>	<b>32.15</b>	<b>89.94</b>	<b>77.67</b>	<b>52.67</b>	<b>58.67</b>	<b>249.79</b>	<b>435.90</b>
<b>Core-2</b>	Raika	1.00	3.80	8.00	24.00	79.00	65.00	40.00	44.00	280.00	200.00
	Panidhal	1.00	3.89	8.00	26.44	63.00	59.00	38.00	41.00	288.89	230.56
	Kali Khol	1.00	4.94	8.00	24.00	60.00	51.00	38.00	44.00	394.44	200.00
	Kalachara	1.00	4.67	8.00	22.86	63.00	47.00	36.00	41.00	366.67	185.71
	Bairawas	1.00	4.25	7.00	20.00	59	53.00	42.00	46.00	325.00	185.71
	<b>Average</b>	<b>1.00</b>	<b>4.31</b>	<b>8.00</b>	<b>23.46</b>	<b>67.46</b>	<b>58.44</b>	<b>38.59</b>	<b>42.72</b>	<b>331.00</b>	<b>193.25</b>
<b>Core-3</b>	Kanyawas	1.00	3.56	8.00	20.00	70.00	70.00	35.00	44.00	256.00	150.00
	Mandalwas	1.00	4.00	8.00	20.00	60.00	54.00	39.00	43.00	300.00	150.00
<b>Average</b>	<b>1.00</b>	<b>3.78</b>	<b>8.00</b>	<b>20.00</b>	<b>65.00</b>	<b>61.88</b>	<b>37.08</b>	<b>43.36</b>	<b>278.00</b>	<b>150.00</b>	
<b>Over All</b>	<b>1.00</b>	<b>3.79</b>	<b>7.00</b>	<b>25.20</b>	<b>74.00</b>	<b>66.00</b>	<b>43.00</b>	<b>48.00</b>	<b>278.69</b>	<b>260.00</b>	

Source: Calculated from Field Survey Data of STR during 2010-11

significantly higher than the other core areas and after so much of awareness even today the degradation has been continuing. The growth in distance travelled is however lower in core-1 as compared to the other zones. Distance travelled in core-2 and core-3 for the similar activities has increased during the same period by 321.11 per cent and 278 per cent respectively. Whereas, the labour hour used for the purpose has increased respectively by 303.98 and 327.81 per cent. Though because of relatively more vegetation in the core-1 the growth of distance travelled is comparatively lower than the other two zones the labour hour used increased at a rapid rate. The primary reason is that the people of core-1 are more dependent on the forest for their livelihood and there is less monitoring by the forest officials leading to longer use of time for extraction and grazing. Hence, more labour time is devoted to collect as much as possible and to feed their larger cattle groups in order to maintain its productivity. Whereas, the other zones are closer to the buffer zones where pressure of grazing over the years have been from both inside and outside the reserve and hence degradation has already been widened and people have to travel more. Despite that the growth in labour hour required is less because of the diversion of activities though not significantly. Due to availability of alternative job and income in the surrounding (in agriculture though on a small scale due to the restriction from the forest management) they devote less labour hours and compensate the fuel-wood and grazing by purchased fodders, as is clear from Table-3.

So the rising stress due to degradation of forest in STR is found to have direct bearing on the earning for survival. The stress is more in areas of more degradation as measured in terms of rising distance to be covered for the collection as well as grazing and rising requirement of labour for the same purpose. The rising engagement of total daily labour from a family and daily time of an average individual labour in core-1 despite comparatively less rise in distance would be in contradiction with the previously mentioned lower degradation of core-1 as compared to core-2 and core-3. Actually, the rising distance is in parity with the rising actual degradation that happens to be more in core-2 and core-3 (nearer to buffer zone and where the accessibility of outside villagers is also more). The more rise in timing<sup>6</sup> in core-1 is an indication of unchanged or rising dependence on forest by the people of core-1 than that of other areas, where people also earn a part of their livelihood from other occupations outside and proportionately more than the families of core-1 (shown later). So, they devote a part of their effort in outside activities which the core-1 families hardly do.

However, the rising time coupled with rising distance covered (as effort is positively related to the collection or grazing and productivity of cattle, while distance is inversely related to the collection or grazing) does not guarantee the rising or falling contribution of forest. The income generated from the forest directly or indirectly across the villages should be checked to find out the variation in impact of degradation on the economy (at least a major part) of villagers of different core zones.

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6 It is assumed that the average family size remains more or less same, which is understood from the discussion with the respondents.

**Table 3.** Collection of Forest products, Distance Travelled and Labour-Hours Per Day in Surveyed Villages of Sariska Tiger Reserve during 2011

Zone	Village	Sample Families (No)	Sample Individuals (No)	Cattle (No)	Milk (Lit.) Per day	Family Members Involved (No)	Avg. Dist. covered (Km)	Total Lab. hrs per day	Avg. Lab. Hrs per Capita per day	Total Fuelwood (Kg/day)	Total Grass/ Tree fodder (Kg/day)	Total Timber Pole (No/yr)	Total Thatching Grass (kg/yr)
Core-1	Umri, Deori	21	117	577	417	4	3.00	29.86	7.04	1870	1535	1015	1120
	Kraska	35	164	456	423	3	2.91	22.57	7.25	3070	1095	1535	1715
	Rotkayala	19	133	445	438	5	3.00	36.05	6.99	2020	1770	1170	1230
	Sukola	9	76	382	182	6	3.67	44.00	7.20	1120	828	669	765
	Kankwari	21	142	547	414	5	3.00	33.29	7.13	2205	1755	1275	1475
	Haripura	22	116	260	278	4	2.82	24.27	6.94	1770	746	1205	1305
	Leelunda	20	146	198	202	4	4.00	31.60	7.10	1065	915	800	900
	Dabli	23	164	1049	747	5	3.96	34.87	6.97	2130	1705	1145	1240
	Raikamala	8	52	342	211	5	5.13	32.88	6.74	565	545	325	380
	<b>Sub-Total</b>	<b>178</b>	<b>1110</b>	<b>4256</b>	<b>3311</b>	<b>5</b>	<b>3.50</b>	<b>32.15</b>	<b>7.04</b>	<b>15815</b>	<b>10894</b>	<b>9139</b>	<b>10130</b>
Core-2	Raika	15	123	333	304	6	3.80	24.00	4.19	1190	980	595	660
	Panidhal	9	53	236	146	4	3.89	26.44	6.10	570	530	345	365
	Kali Khol	18	149	811	334	6	4.94	24.00	4.04	1075	920	680	785
	Kalachara	21	131	365	339	4	4.67	22.86	6.00	1330	995	760	865
	Bairawas	16	113	457	253	5	4.25	20.00	4.38	950	850	670	735
	<b>Sub-Total</b>	<b>79</b>	<b>569</b>	<b>2202</b>	<b>1375</b>	<b>4</b>	<b>4.31</b>	<b>23.46</b>	<b>5.87</b>	<b>5115</b>	<b>4275</b>	<b>3050</b>	<b>3410</b>
Core-3	Kanyawas	25	171	568	525	4	3.56	20.00	5.00	1750	1740	885	1095
	Mandalwas	12	97	233	237	5	4.00	20.00	4.00	720	650	465	515
	<b>Sub-Total</b>	<b>37</b>	<b>268</b>	<b>801</b>	<b>762</b>	<b>4</b>	<b>3.78</b>	<b>20.00</b>	<b>4.50</b>	<b>2470</b>	<b>2390</b>	<b>1350</b>	<b>1610</b>
	<b>Grand Total</b>	<b>294</b>	<b>1947</b>	<b>7259</b>	<b>5447</b>	<b>4</b>	<b>3.79</b>	<b>25.20</b>	<b>5.29</b>	<b>23400</b>	<b>17559</b>	<b>13539</b>	<b>15150</b>

Source: Field Survey 2010-11.

Over-all average family income of those living in and around the park derived from various forest based items has declined due to the depletion of forest resources and restriction on grazing that resulted in decline of per capita cattle population in last few years and milk production per unit of cattle as well. As per the estimate on the basis of the response of sample households, a total of 750-1000 head loads (each measuring about 40-50 Kg each in weight, that makes about 23.4 thousand kg (Table-3) of fuelwood in total is extracted on an average day together by all the 734 families surveyed in 16 sample villages across the three core zones of the Tiger Reserve.<sup>7</sup> The quantity sometimes increased to 30.0 thousand Kg per day. Also, those people regularly collect grass fodder, thatching grasses etc. and in total daily collection of the non-timber forest products are estimated to be about 35.32-40.0 thousand kg.

Per capita per day fodder (grass and leaves) collection by the sample families in core zone-1 is estimated to be 9.81 kg. For the households in core-2 and core-3, daily per capita collection of the same is however estimated to be about 7.51 kg and 8.91 Kg. respectively (Table-6), which is relatively lower than that of core-1 villages. At the same time per capita per day timber pole collection are about 8 units in core-1, whereas it is almost half in core-2 and core-3 with 5 poles per person on an average.

The thatching grass collection in core-1 is also the highest among all the cores with 9 kg per capita, followed by 6 kg each in core-2 and core-3 (Table-7). These are in parity with the argument of perceived more degradation of forest in the outer surrounding and the adjacent core-2 and core-3 as compared to core-1. Not only that, degradation at local level is also not uniform across the villages and thus though the family members of core-1 travel less in comparison to the members of core-2 and core-3, there is wide variation in that across the villages within core-1 and that is true for other core areas as well.

**Table 4.** Pearson Correlations

	Table-4	Milk per Cattle	FW per Lab hr	Fodd. Per Lab hr	Tim Per Lab hr	Th-Grass Per Lab hr	Dist	Per Cap Lab hr
Milk per Cattle	-.801*	1						
FW per Lab hr	-.307	.407	1					
Fodder per Lab hr	-.149	.283	.659*	1				
Timber per Lab hr	-.397	.448***	.967*	.603**	1			
Th Grass Per Lab hr	-.391	.434***	.972*	.651*	.995*	1		
Dist.	<b>.384</b>	<b>-.458***</b>	<b>-.578**</b>	<b>-.356</b>	<b>-.597**</b>	<b>-.570**</b>	<b>1</b>	
Per Cap Lab hr	.426	-.297	-.351	-.334	-.390	-.409	-.130	1
Fodder per Cattle	-.761*	.751*	.108	.208	.157	.154	-.493**	.091

\*, \*\* and \*\*\* indicate that Correlation is significant at 1, 5 and 10 per cent level of significance by 2-tailed test.

<sup>7</sup> The value is estimated by multiplying the number of sample families with the average collection per day.

Bivariate correlations (Table-4) reveal significant inverse relationship between the distances travelled by the families across villages of core areas and collection of fuelwood, fodder, timber and thatching grass etc per unit of labour time used. It indicates the lower productivity of labour of more degraded areas as measured in terms of changing distance travelled over time for the collection of forest products. However, a positive relation is observed among the collection of fodder, fuelwood, timber and thatching grass per unit of labour, which is an indication of coexistence of these materials (means where one is available in good amount others are also available and vice versa). Again, milk productivity of cattle is more in the villages where per unit of labour collection of fodder is also more. Availability per cattle has significantly negative correlation with per capita holding of cattle. Also, milk productivity of cattle has significantly positive association with the availability of fodder per cattle.

$$\text{Milk Productivity} = 444.65^* - 40.47^* \text{ Cattle per Capita} \dots (1)$$

(33.346) (8.086),  
F = 25.053\*,  $\bar{R}^2 = 0.62$

$$\text{Milk Productivity} = 472^* - 48.41^{***} \text{ Distance Covered} \dots (2)$$

(96.6) (25.07),  
F = 3.73\*,  $\bar{R}^2 = 0.25$

$$\text{Milk Productivity} = 119.19^* + 64.731^* \text{ Fodder per Cattle} \dots (3)$$

(41.946) (15.222),  
F = 18.085\*,  $\bar{R}^2 = 0.532$

Notes: (1) Figures in the parentheses represent standard error of the corresponding coefficients.

(2) Here \*, \*\* and \*\*\* indicate that the coefficient is significant at 1, 5 and 10 per cent level of significance by two tailed test.

The simple regressions of milk productivity of cattle across the villages in the core areas on the per capita holding of cattle, distance covered for the collection of forest products and collection of fodder per cattle are presented below. Equation-1 shows significant negative impact of per capita rearing of cattle on its productivity. It indicates that with more cattle holding and identical effort availability of fodder per cattle declines and leading to fall in output of milk. Equation-2 also indicates inverse impact of rising distance for collection of fodder. With same manpower and available total time, more distance travelled leads to fall in availability of fodder or time for grazing that caused decline in productivity. Equation-3 however indicates that more availability of fodder per cattle significantly increase milk productivity.

### **Variation in Value of Materials Collected from the Forest of STR and Share in Total Earning of the Inhabited Villagers across Different Core Areas**

Though collected fuelwood and fodder is generally not sold by the villagers themselves, it possesses a very high value when collected in such large quantity. The Final Report of Ecological Studies in Sariska Tiger Reserve, Rajasthan, 2009 recorded the value of quantity of fuelwood exploited annually worth Rs 8084750 for the entire Tiger Reserve

and Rs 985500/- for the villages outside the Reserve, considering a minimum price of Rs 20 per head load of fuelwood collection at that time. Similarly, for annual fodder exploitation the estimated value is Rs 5105944/- and Rs 186556/- for the villages of entire Tiger Reserve and villages located outside its periphery respectively (WII, 2009). At present the value of each kg of fuelwood and fodder is estimated on the basis of the opportunity cost of labour i.e., by using the daily wage of agricultural labour and quantity of collection by an average person, which comes to about Rs 4 per kg. Also, income from cattle i.e., milk and sell of cattle/ livestock is considered to be the indirect contribution of forest. Then all these are used to estimate the total earning from their collection of forest resources and cattle raising and adding with the income from other sources if any (agriculture, wage labour etc), total monthly and then annual income is estimated. Thereafter, proportion of income contributed by forest directly or indirectly is computed in order to examine the variation across the villages in zones with different levels of degradation.

Table-7 indicates that per capita annual value of resources collected from forest in core-1 in the form of fuelwood is Rs. 20517. Whereas in case of core-2 and core-3 it is Rs. 12945 and Rs. 13272 respectively, which are much lower than that of core-1. Also, villagers of core-1 generate the highest per capita from grass and tree fodder collection (Rs. 17763 per annum) and it is followed by core-3 and core-2 with about Rs. 13020 and Rs. 10969 per capita earned from such resources. Annual per capita income from timber and thatching grass in core-1 is Rs. 988 and Rs. 37 respectively, which is also comparatively higher as compared to the other core areas. These values in core-2 are Rs. 643 and Rs. 24 and in core-3 are Rs. 604 and Rs. 24 respectively.

Collection of thatching grass per family may vary depending upon the size of house or hut, which is again dependent upon the family size (as the livelihood pattern is same for all those villagers and as the family size is more or less identical across the villages) and thus worth of per capita collection of such material should have been same whatever be the labour and time required across the zones. Here the differences in requirement may however vary due to the size of the cattle.

However, in core-1, per capita cattle holding is not more than the other areas (as shown earlier) and thus maintenance of them does not require more shed or more of such materials. Here one point may be noted is that the people in core-2 and core-3 also collect such shedding materials (like plastic sheets) from the nearby market and thus the per capita collection of such material and its worth is found to be much lower than that of core-1. Per capita annual income generated from milk and livestock sale in core-1 is about Rs. 3712 and Rs. 3209 respectively (Table-7). Also average per capita cattle reared in core-1 is 3.83, which is more or less same as that of core-2 (3.86). But the production of milk and earning from it is relatively more in core-1 due to relatively higher availability of grasses and tree fodder for cattle despite continued degradation in core-1 as well. However the income from agriculture and other off-farm activities is not accrued to the people of core-1.



**Table 5.** Aggregate Annual Earning of the Respective Villages and Percentage Share of Various Sources in STR

Zone	Village	Annual Income from various Sources by all the Families Together (Rs)						Share of different Sources (%)						
		Direct Forest		Indirectly from Forest		Non-Forest		Total Income	Direct Forest	Indirect from Forest		Indirect		Non-Forest
		Milk net of Fodder	L/Stock	Agri.	Off-Farm	Milk net of Fodder	Live-stock			Total	Agri.	Off-Farm		
Core-1	Umri, Deori	5029480	759500	580667	Nil	Nil	6369647	78.96	11.92	9.12	21.04	0.00	0.00	
	Kraska	8406260	1448700	345000	Nil	Nil	10199960	82.41	14.20	3.38	17.59	0.00	0.00	
	Rotkayala	5602920	565800	306667	Nil	Nil	6475387	86.53	8.74	4.74	13.47	0.00	0.00	
	Sukola	3136140	97920	231667	Nil	Nil	3465727	90.49	2.83	6.68	9.51	0.00	0.00	
	Kankwari	5861300	418500	463333	Nil	Nil	6743133	86.92	6.21	6.87	13.08	0.00	0.00	
	Haripura	5067420	914240	175000	Nil	Nil	6156660	82.31	14.85	2.84	17.69	0.00	0.00	
	Leelunda	2950800	116700	251667	Nil	Nil	3319167	88.90	3.52	7.58	11.10	0.00	0.00	
	Dabli	5664760	2890900	965000	Nil	Nil	9520660	59.50	30.36	10.14	40.50	0.00	0.00	
	Raikamala	1638920	719900	243333	Nil	Nil	2602153	62.98	27.67	9.35	37.02	0.00	0.00	
	<b>Average</b>	<b>43358000</b>	<b>7932160</b>	<b>3562333</b>	<b>Nil</b>	<b>Nil</b>	<b>54852493</b>	<b>79.04</b>	<b>14.46</b>	<b>6.49</b>	<b>20.96</b>	<b>0.00</b>	<b>0.00</b>	
Core-2	Raika	3198840	756200	355000	39000	223333	4572373	69.96	16.54	7.76	24.30	0.85	4.88	
	Panidhal	1626860	273800	250000	24000	0	2174660	74.81	12.59	11.50	24.09	1.10	0.00	
	Kali Khol	2957540	1063400	450000	0	0	4470940	66.15	23.78	10.06	33.85	0.00	0.00	
	Kalachara	3442660	984500	168333	438500	12000	5045993	68.23	19.51	3.34	22.85	8.69	0.24	
	Bairawas	2675340	580600	420000	116500	501667	4294107	62.30	13.52	9.78	23.30	2.71	11.68	
	<b>Average</b>	<b>13901240</b>	<b>3658500</b>	<b>1643333</b>	<b>618000</b>	<b>737000</b>	<b>20558073</b>	<b>67.62</b>	<b>17.80</b>	<b>7.99</b>	<b>25.79</b>	<b>3.01</b>	<b>3.58</b>	
Core-3	Kanyawas	5136180	1239600	518333	450000	6000	7350113	69.88	16.87	7.05	23.92	6.12	0.08	
	Mandalwas	2030660	753800	250000	575000	246667	3856127	52.66	19.55	6.48	26.03	14.91	6.40	
	<b>Average</b>	<b>7166840</b>	<b>1993400</b>	<b>768333</b>	<b>1025000</b>	<b>252667</b>	<b>11206240</b>	<b>63.95</b>	<b>17.79</b>	<b>6.86</b>	<b>24.64</b>	<b>9.15</b>	<b>2.25</b>	
<b>Grand Total</b>	<b>64426080</b>	<b>13584060</b>	<b>5974000</b>	<b>1643000</b>	<b>989667</b>	<b>86616806</b>	<b>74.38</b>	<b>15.68</b>	<b>6.90</b>	<b>22.58</b>	<b>1.90</b>	<b>1.14</b>		

Source: Field Survey 2010-11.

**Note:** Here, the fodder is the input in milk production and thus a part of earning from milk includes value of fodder that the family would have to spend for buying from the market, if it was not collected from the forest. Again there is opportunity cost of family labour who could earn from other activities as a labourer and thus its contribution has to be included. As it is directly collected from the forest, it forms a part of the income from forest directly. Despite a small investment in buying cattle and tools for the collection of materials it does not make much difference in the net earnings. Similarly, a part of the fuelwood collected from the forest is used for boiling milk and mawa production. But it is included in the contribution of forest as a direct source.

Since core-1 is in the heart of the reserve and every possible attempt has been made to minimise the pressure to protect the habitat from degradation, agriculture has been banned in the area. In core-3 however, per capita earning from milk and sale of livestock is Rs. 7438 and Rs. 2867 respectively, which are even higher than that of core-2 with figures registered at Rs 6430 and Rs 2888 respectively. Annual per capita earning from off-farm activities is about Rs 1295 and Rs. 943 in core-2 and core-3 respectively. It thus, reveals that forest resources extracted in STR has been contributing to total income more in core-1 directly and indirectly than in core-2 and core-3. It is due to the relatively less degradation in core-1 than the other areas. It also shows a relatively higher dependency of the families living in core-1 with no other alternative opportunities as in core-2 and core-3 (Tables-6 and 7).

On an average, milk production per cattle per day in core-1 is found to be 0.8 litre, while core-2 ranks last with 0.6 litre and in core-3 production of milk per cattle is the highest with about 1.0 litre per day per cattle (as there supplementary fodder from outside is also provided to the cattle) (Table-6). However, despite low productivity of cattle and its low proportional contribution; share of income from extracted forest products, milk as well as sale of cattle together is the highest (100 per cent) in core-1, (Table-8). Here, families extract more resources to increase the total milk production in the absence of agriculture and other opportunities of income and thereby expediting the process of degradation though the area is still in a comparatively better-off position in terms of quality of forest.

In sample villages of core-2, combined earning from forest and milk is about 85.42 per cent of the total family earning and they also generate a small portion of their annual income from agriculture (3.01 per cent) and from off-forest activities (3.58 per cent). Average contribution of agriculture to the earning of sample villagers in core-3 is 9.15 per cent and that of off-forest sources is merely 2.25 per cent. In Core-3, forest and milk production contribute about 81.74 per cent of the family earning. So, directly or indirectly forest in STR contributes significantly to the income and livelihood opportunities across the villages of various core areas though some agriculture and other than forest sources contribute in meagre proportion in the areas adjacent to buffer. In actual buffer areas those proportions could be more due to more degradation of forest resources and rising difficulty in collecting such materials, but some alternative opportunities are available outside those villages and nearby towns. But due to paucity of information (as survey could not be conducted due to some prohibitions there) it was not possible to check with facts and figures here.

Table-9 reveals that collection of various forest resources by an average family in core-1 is significantly higher than that of core-2 and core-3. On an average, a family in core-1 collects fuel-wood 42.36 and 33.32 per cent higher than that of a family of core-2 and core-3 respectively. In other cases like grass, tree fodder, timber or thatching grass also core-1 families collect significantly more than those of core-2 and core-3.

**Table 6.** Per Capita Milk Production, Forest Products Collected, Distance Travelled and Labour-Hours Per Day in STR

Zone	Popul.	Milk Production Per Unit of Cattle (Litres)	Avg, Family Member Involved	Distance Covered (Km)	Labour-Hours (Per day)	Fuelwood (Kg/day)	Grass/T fodder (Kg/day)	Timber/ Pole (Per yr)	Thatching Grass (Kg. Per yr)
Core-1	1110	0.8	5.0	5.0	32	14	9.81	8	9
Core-2	569	0.6	4.0	4.3	23	9	7.51	5	6
Core-3	268	1.0	4.0	3.8	20	9	8.91	5	6

Source: Field Survey 2010-11.

**Table 7.** Per Capita Annual Value of Resource Collected and Income from all Sources in STR

Annual Value of Resource Collected (Rs)							Annual Income from all Sources (Rs)					
1	2	3	4	5	6	7	8	9	10	11	12	13
Zone	Population	Avg, Fam. Member Involved	Fuel-wood	Grass/ Tree Fodder	Timber/ Pole	Thatching Grass	Direct Forest Collection (4+5+6+7)	Milk Net	Live-stock	Agri.	Off-Farm	Dir. & Ind. from Forest (8+9+10)
Core-1	1110	5	20517	17763	988	37	39305	3712	3209	0	0	46226
Core-2	569	4	12945	10969	643	24	24581	6430	2888	1086	1295	33899
Core-3	268	4	13272	13020	604	24	26920	7438	2867	3825	943	37225

Source: Field Survey 2010-11.

**Table 8.** Average Share of Income of the Village Households from Different Sources in STR (in %)

Zone	Forest	Milk	L/stock	Agri.	Off-Farm	Total
Core-1	84.95	8.07	6.98	0.00	0.00	100.00
Core-2	67.62	17.80	7.99	3.01	3.58	100.00
Core-3	63.95	17.79	6.86	9.15	2.25	100.00
Over All	77.80	11.80	7.21	1.98	1.20	100.00

Source: Field Survey 2010-11.

**Table 9.** Comparative Difference of Core-1 from Core-2 and Core-3 in terms of Collection of Some Items by an Average Family (%)

	Fuelwood (Kg Per Day)	Grass/Tree fodder (Kg Per Day)	Timber Pole (No. Per Yr)	Thatching grass (kg Per Yr)
Compared to Core-2	42.36	38.52	38.42	35.00
Compared to Core-3	33.32	32.91	36.49	37.34

Source: Computed by author from primary data.

### **Impact of Degradation of Forest and Biodiversity on Tourism in STR**

Tourism activity in the form of visitors to the park and pilgrimage are regular feature of the Sariska National Park (core-1) due to its rich flora and fauna and unique sacred heritage of Pandupole Hanuman temple (Lord Hanuman is a Hindu God whose reference is also available in the great Epic of Mahabharata)<sup>8</sup>. However, despite rising inflow of tourists in Rajasthan as a whole over the years, tourist inflow in Sariska is reported to have been decreasing (Table-10) and profit generated from hospitality businesses has also been declining due to falling tourists' inflow and longer lean period, which is attributed to the deteriorating condition of both flora and fauna. Tourist arrival in Sariska as percentage of visitors to the state of Rajasthan has declined drastically from 1.05 in 1991 to 0.13 in 2008 (Table-10). In absolute sense, the percentage growth rate in the tourist arrival during 1991 to 2008 was -23.58 per cent, where as the growth rate for the state as a whole during the same period was 522.24 per cent. This decline in attraction of tourists can be associated with the degradation of biodiversity in the park over time, especially of tiger as shown in Table-11. Also, opinion given by the 94 per cent of the repeated visitors in the park during last 5 to 10 years confirms severe degradation of the forest and deteriorating condition of the park (Table-12) and only 6 per cent of them responded to minor degradation; however no one asserted the improvement of the park.

Activities like tourist guide and hospitality workers in tourism sector have very low direct significance on the total income and employment generation of the villagers within the park. It is mainly due to low skill and education of the people that prevent them from entering in such activities. Numbers of such people from the sample is found to be negligible. Only a few nature guides, drivers and petty staffs in the hotels come from the families living in the reserve. Of course, some people from the adjoining areas around the park would be benefitted from such activities as some of them are involved in tourism and hospitality sector prevalent outside the park. Only three hotels and a few guest houses are there within the park. The only possibility of direct income for them is the sale of milk and milk products to the nearby road-side restaurants and Dhabas (road side eatery with modest arrangements) and hotels. But their share in the total demand for such products is very insignificant due to which villagers mostly supply their items to the nearby markets in town. So if there is any impact on the employment and income of the owners of hotel or restaurant, their employees and the related people who supply their products in these hotels and restaurants would be reflected from the changes in tourist arrival over time and that may be linked with the changing forest bio-diversity.

Table-13 reveals an overall negative growth of staffs and very less increase in staff salary of a prominent hotel (Tiger Heaven) where majority of nature loving tourist in Sariska stay. Whatever rise in salary is noticed from 2000 to 2010 was actually negative

8 Pandavas during their Gupta Baas or concealed exile (exile in unknown place), met lord Hanuman on their journey to the present day Delhi (Hastinapur) in core-1 at Pandupole, which is about 22 Km. from the reception centre of the Sariska Tiger Reserve.

**Table 10.** Percentage Growth in Tourist Arrival in Sariska Tiger Reserve during 1991-92 to 2008-09

Year	1991-2 to 96-97	1996-97 to 2001-02	2001-02 to 2006-07	2006-07 to 2008-09	1991-92 to 2008-09
Sariska	44.47	-19.54	-47.86	26.08	-23.58
Rajasthan	31.12	33.05	195.30	20.78	522.24

Source: Field Survey 2011-2012.

**Table-11.** Changes in Wild Animal Population during 1987 to 2009 in STR

Sl. No	Species/Zoological Name	No				Change in Percentage				
		1972	1988	1999	2009	1972-88	1988-99	1999-2009	1988-2009	1972-2009
1	Tiger/Panthera Tigris	14	45	27	3	221.4	-40.0	-88.9	-93.3	-78.6
2	Leopard/Panthera Pardus	35	47	55	47	34.3	17.0	-14.5	0.0	34.3
3	Jungle Cat/Fellis Cnaus	NA	749	125	168	NA	-83.3	34.4	-77.6	NA
4	Caracal/Fellis Caracal	NA	NA	7	NA	NA	NA	NA	NA	NA
5	Hyaena/Hyaena Hyaena	NA	284	115	296	NA	-59.5	157.4	4.2	NA
6	Jackal/ Canis Aureus	NA	2264	363	1521	NA	-84.0	319.0	-32.8	NA
7	Sambhar/ Cervus Unicolor	800	12336	6150	7196	1442.0	-50.1	17.0	-41.7	799.5
8	Chital/ Axis Axis	540	7979	3600	4021	1377.6	-54.9	11.7	-49.6	644.6
9	Neelgai/ Boselaphus Tragocamelus	300	11022	5200	6018	3574.0	-52.8	15.7	-45.4	1906.0
10	Chowsinga/ Tetracerus Quadricomis	30	489	13	NA	1530.0	-97.3	NA	NA	NA
11	Chinkara/ Gazella Gazella	NA	12	NA	NA	NA	NA	NA	NA	NA
12	Wild Boar/ Sus Scrofa	NA	4895	3450	5033	NA	-29.5	45.9	2.8	NA
13	Rhesus Monkey/ Mecaca Mulatta	NA	6803	E	P	P	P	P	P	P
14	Common Langor/ Presbyts Entellus	NA	12797	VC	8136	NA	NA	NA	-36.4	NA
15	Indian Porcupine/ Hystrix Indica	NA	653	368	512	NA	-43.6	39.1	-21.6	NA
16	Civet Cat	NA	NA	E	165	NA	NA	NA	NA	NA

Source: Management Plan 1978-79 to 2004-14 and Relocation document 2008, Sariska Tiger Reserve, Govt. of Rajasthan.

Note: VC = Very common, E= Present, P = Plenty, NA= Not Available.

**Table 12.** Previous Visits and their Opinion on STR during 2010-11

Time of Previous Visit	Severely	minor	No Change	Improved	Total
10-15 yrs	0 (0)	2 (6)	0 (0)	0 (0)	2 (6)
5-10 yrs	31 (94)	0 (0)	0 (0)	0 (0)	31 (94)
0-5 yrs	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Total	31 (94)	2 (6)	0 (0)	0 (0)	33 (100)

Source: Field Survey 2010-2011.

Note: Figure in Parentheses represents percentage to total.

if the rise in price level during the period is considered i.e., discounted income of 2010 is compared. There is a comparable fall in tourist visited the same hotel in a year, which is clear from Table-14. Though during 2000 tourists visited the hotel was 151 and increased to 345 during 2003, it then declined continuously to 131 in 2008. Thus though tourism does not contribute much directly to the economy of insiders, it has also been adversely affected due to recession in tourism activities during last few years on account of degradation of forest and biodiversity

**Table 13.** Number of Staffs and their Average Monthly Salary in Tiger Heaven Hotel during 2000 to 2010

S. No.	Designation	Staff		Salary		Percentage Change	
		2000	2009	2000	2009	Staff	Salary
1	Manager	1	1	5000	6000	0.00	20.00
2	Chefs	1	1	5000	6000	0.00	20.00
3	Asst. Chefs	1	1	3500	4500	0.00	28.57
4	Service Boys	2	1	3000	4000	-50.00	33.33
5	Guard	1	1	2500	3500	0.00	40.00
6	Gardener	2	1	3000	4000	-50.00	33.33
7	Cleaner	1	1	3000	4000	0.00	33.33
	Total	9	7	25000	32000	-22.22	28.00

Source: Field Survey 2010-11

**Table 14.** Tourist Arrival in Tiger Heaven Hotel in STR during 2000-08

	Number of Tourists					Percentage Changes			
	2000	2003	2005	2007	2008	2000-03	2003-05	2005-07	2007-08
Indian	101	205	170	112	106	103	-17.1	-34.1	-5.36
Foreign	50	140	80	50	25	180	-42.9	-37.5	-50
Total	151	345	250	162	131	128	-27.5	-35.2	-19.1

Source: Field Survey 2010-11

## Conclusion

This paper provided an analysis of how degradation of forest and its biodiversity affects the economy of the villagers living within the Sariska national park. Direct and indirect employment and earning of the families living in various core areas have been computed and compared to understand its relation with the variation in degradation. Despite absence of time series data, it could clearly show how the primary cattle rearing activity and earning from forest resource collection is seriously affected due to the process of degradation.

Moreover, the focus group discussion (as reported during field survey) reveals that today villagers experience longer dry and resource scarce months due to the degradation of forest and habitat. During the rainy season as villagers call it Chowmasa (July-September, Monsoon season when sufficient rain occurs and thus more fodder is available), members who are engaged outside, come back to their respective village to participate in their family (cattle rearing) activities. Due to availability of sufficient fodder in the park during this period pastoral activity, milk processing etc increase.

Along with that the tourism is also found to be affected due to the degradation, though it does not contribute much to the earning of villagers inside the park. But, it affects the tourism and hospitality sector and its related people.

Overall, it can be argued that heavy dependence on forest beyond its carrying capacity that led to the degradation of STR and its bio-diversity, in turn affected villagers' economy and that further intensified the extraction activities over extended areas and leading to further degradation. Therefore in order to shift the focus from high dependence on forest and forest derivatives, it is necessary to generate the off-forest based activities along with successful relocation of villagers from core areas as has been undertaken to take the pressure off the forest.

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# 9

## A Vision of Forest Resource Management Through Lense of Community Strength in an Ethnic Belt of Southern Rajasthan

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— *Dr. Lalit Choudhary and Dr. Seema Bharadwaj*

### ABSTRACT

Tropical forests are home for two thirds of all plant species of the world, and play a vital role in maintaining global biodiversity and ecosystem functioning therefore the main objective for all forest actors should be integrated in order to safeguard the values that forest resources intended to achieve. Community based forest resource management (CBFRM) still stands as a logical instrument and a tool for management of community forest activities. CBFRM system frequently includes religious beliefs, traditional knowledge and ethics full with forest management. In this paper we present the results of an analysis of the role of JFM, ethno practices, sacredness, religion and traditions in CBFRM. India has been at the forefront of devolving natural resource management to the local community, particularly in the forestry sector. The findings of the study in the context of CBFRM are achieving their primary objectives of afforestation, regeneration, eco-development of degraded forests and increase in the availability of fodder grasses and biodiversity conservation in the form of basic pillars of CBFRM in this area.

**Key words:** CBFRM, JFM, PRA, Traditional knowledge, Sacredness

### Introduction

Country's social, cultural, and ecological multiplicity requires specific tailored local forest management in meeting the local needs yet conserving the forest wealth in perpetuity. Joint forest management system was a helpful tool for devolving everyday forest use and management rights to the community with the help of community with some conflicts. Management and conservation of forest resources are big current challenges of this

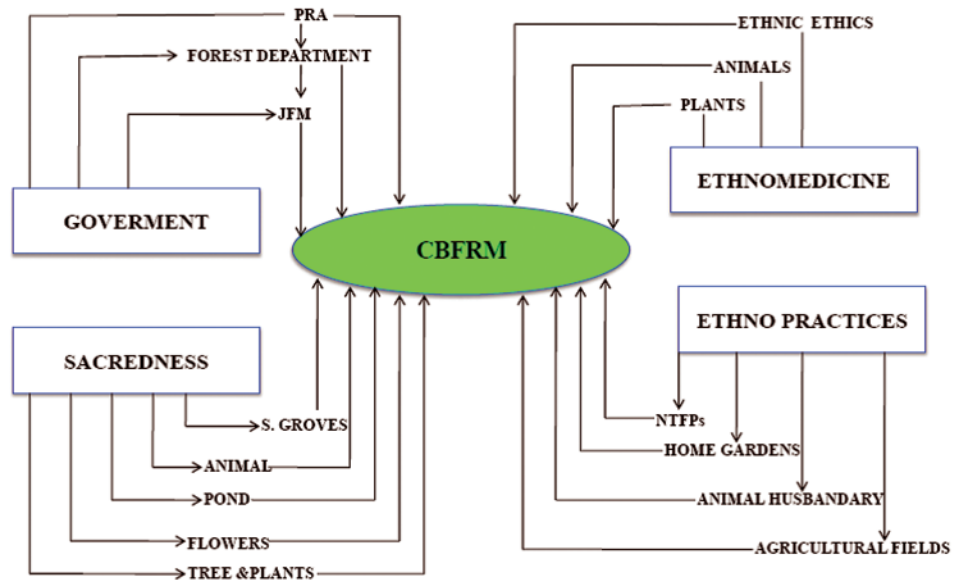
age of globalization, privatization and industrialization. Combination of participatory management approach and forest policy is a pertinent strategy to face this challenge. Religious governance can positively affect natural resource conditions. Such religious systems should be accounted for as new policy interventions are implemented (Hartberg, Y., 2014). An understanding of the ways in which forest resources are perceived by the forest dwellers on the one hand and by the forest managers on the other is critical for designing strategies for sustainable forestry in the Asian context. There is an increasing realization that today there is need to move beyond formal knowledge based on silvicultural issues, and find appropriate linkages with traditional forest knowledge generated over generations by forest inhabitants through an experiential process of trial and error. Strengthening linkages between knowledge systems using community participatory management an approach is now seen as critical for sustainable forestry (Ramakrishnan, P.S. 2007).

Community forests called Orans and Gauchars in the western arid part of India constitute a significant proportion of the total geographical area of the region. Given the economic importance of these areas from time immemorial, the local people took special care to protect and sustainably utilize these common property resources (Chaudhry, P. et al. 2011). Through their traditional wisdom and experience, people have developed strategies to face and manage these vagaries of nature. However, increasing pressure from livestock and human population along with socio-economic development in the region has caused severe land degradation and desertification (Narayan et al., 2003). Orans are unique examples of gene pool conservation based on the socio-cultural value system of Rajasthan. However, traditional biodiversity conservation methods have not appealed much to scientists, foresters, academicians and policy makers; therefore, there is an urgent need to systematically survey, demarcate and conduct research in all of the existing Orans in Rajasthan (Singh and Bahl, 2006). Climate change poses a great threat to the fragile desert ecosystem. It includes changes in rainfall, temperature and atmospheric carbon dioxide concentrations. Knowledge of climate variability can assist in adapting to climate change (White, 2000). The important issue is the capacity of the local inhabitants to adapt the management of rangeland ecosystems to changing circumstances, without incurring adverse environmental consequences (Chaudhry, P. et al. 2011). An ethnoforestry element is an example of traditional biophilia of ancient human cultures which express a tendency to love and respect of nature and mother earth. The conservation of biodiversity through local realities of people of traditional societies in the Banswara dates back to millennia (Bharadwaj, Choudhary and Bhatt 2012). The customary practices of home garden of tribal communities are not only to provide daily food needs but also well and good sustainable use and conservation of biodiversity and gene pool (Kala, C.P. 2010). Forest community-based monitoring movements for biodiversity conservation are today assuming increasingly important roles in environmental governance in the world's forests. These forest community stewards promote local resource access and management (Taylor, P.L., 2012). Incentives are key to attracting and maintaining participation in community based natural

resource management (CBNRM) initiatives. In southern African CBNRM initiatives, many incentives are offered, particularly jobs and community income from hunting and photographic tourism activities. There is a need to assess jointly resident’s knowledge and perceptions of these incentives and their actual delivery to determine whether they are likely to be effective in sustaining participation in CBNRM activities over the long run (Suich, H., 2013).

The paper retrace to foster interdisciplinary research that is required to fully understand a component of community based forest resource management that is common, widespread, and that serves both community and forest resources.

**Conceptual Framework**



**Figure 1.** Conceptual Framework of Community based resource management (CBFRM) in ethnic belt of Southern Rajasthan.

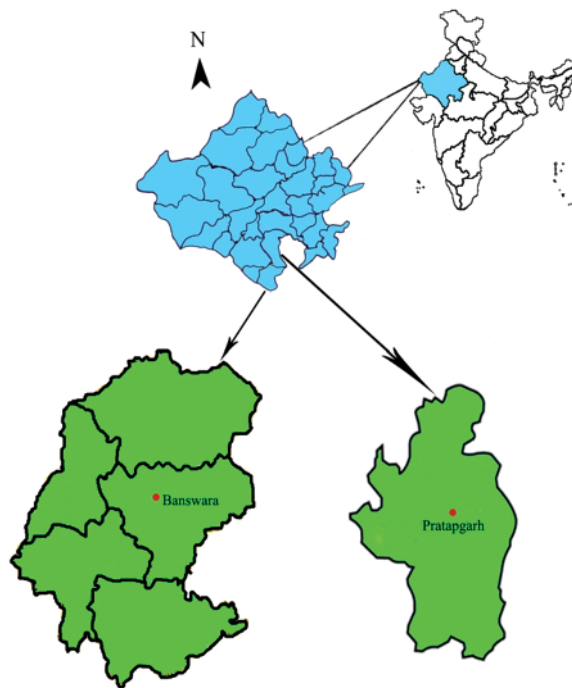
**Methodology**

**Study Site:** Banswara and Pratapgarh districts are come in tribal belt of southern most part of Rajasthan. Communities of this remote area have traditionally derived their subsistence from forest in the form of livelihood goods, such as food, fuel wood, fodder, fiber and timber for construction. Present work is centralized at Bagidora and Pipalkhunt forest ranges of Banswara forest division. Target villages of present study were Sobania, Jathalia, Narukheda, Borapada and Bagidura. The present study is a kind

of social science research and it basically qualitative which requires primary data with the gathering of data from field survey, direct observation and interviews based on the role of indigenous knowledge and how it is applied in the community forest management and secondary information from related research and documents.

### Findings

Following findings of this study are in favour of CBFMR in this ethnic belt of southern Rajasthan:



**Figure 2.** Location of study area.

**Conservation of forest resources:** Biodiversity in habitat corridors on the hills of Pipalkhunt and Bagidora forest ranges indicates oracularity of CBFMR. This is due to the results of promising practices of conservation strategies of regional sustainable development, afforestation, regeneration, eco-development of degraded forests, increase in the availability of fodder and grasses. Rehabilitation, reclamation, soil and moisture conservation, ecological restoration, environmental conservation through peoples partaking are some other conformity impacts with the objectives of CBFMR. VFPMCs, sacred groves and sacred ponds have been successful in achievement of management of forest resources and sustainability. This paper also focuses on the role of home gardens in management of forest resources. We found that home gardens are good sites for

protection of genepool of trees, plants, flowers, fruits, vegetables and herbs and that fauna which is related with these floras.

**Community efforts for Forest resource management:** Forests have a strategic role in management of environment and better sustainable management of common property resources, for this participation of ethnic community is very important. JFM was spread fastly in this area because of its mutual aid attitude between forest department and community. Once the people of the area were very much associated with depletion of forest resources but now they are protecting the forest resources and finding out way to preserve the forests through JFM. Participatory Rural Appraisal [PRA] and Micro planning exercises also identified other developmental (non-forestry) priorities which are also related with forest resource management and basic needs of local community. 68 VFPMCs constituted in the last nine years which are actively engaged in development, protection and management of 14823 ha forest land. Because of this participatory protection VFPMCs were able to produce 4,217 Qts. of fodder grasses worth Rs 8.43 lacs from these production 3995 families were benefited. 82 SHGs were formed during last nine years of working periods. Out of these, 38 SHGs are of feminine group with 305 women members. In these groups 711 members were from Schedule tribe.

**Soil and moisture conservation:** The mission mode approach of this work is to accomplish the goals of saving every drop of rain, providing adequate water for agriculture and conservation of life support system. The treatment measures for soil and moisture conservation and afforestation were planned in a synchronized manner. RCC check dam, Earthenbund and Loose stone masonry check dam, Ponds, Gabion bund, Percolation tanks, Contour trenches, Contour dykes, V-ditches and Anicuts were main treatment measures to achieve the goal. These structures were extensively constructed in and around forest areas.

**Afforestation:** Existing forests of Bagidora and Pipalkhunt range were established and managed in afforestation work of the period 2003 - 2009 in Pipalkhunt and 1996 – 1998, 2009- 2011 in Bagidora. Sustainability of plantation works was an important issue of special interest and concern. The animal biodiversity of the mixed forest community also increased progressively due to ecosystem development. 750 ha area has been planted with 2.44 lacs plants during the year 2003 – 2007 in Pipalkhunt range and the total area of plantation in Bagidora range during 1996 to 1998 and 2009 to 2011 was 1130 ha with 7.06 lacs plants.

## **Conclusion**

VFPMCs and sacred groves have been successful in protection of their forests from threat of illicit grazing, and forest fires. As a result, these forests are regenerating with vigor therefore the community through implementation of JFM has played catalytic role in development of ethnic villages with increased production through improved irrigation, soil and moisture conservation, value addition in collection and processing of NTFPs and enhanced biomass production. Afforestation areas of present work offer

an excellent platform for enhancement of socioeconomic status, management for forest resources and conservation of biodiversity. Above concluding findings also through light on environmental impact assessment of study area.

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# 10

## Application of Bioinformatics in Management, Analysis and Conservation of Biodiversity Data

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— A.K. Roy, A. Dixit and R. Ranjan

### ABSTRACT

Biodiversity is variation between and among organisms at organism, ecological and molecular level. In this study, an attempt has been made to review the role of bioinformatics in managing, organising, analysing biodiversity data and make it public accessible.

**Keywords:** Biodiversity informatics, DNA Barcoding, Conservation.

### Introduction

Biodiversity is a fascinating multifaceted subject, worthy of deep exploration, investigation and analysis. This subject has been intensely studied by many eminent biologists during the last century and masterly presentations have appeared in the literature. However, there are still unseen faces and parameters hidden inside this vast subject, which are yet to be analyzed and exposed. The term Biodiversity was introduced recently as a new concept to portray the multiplicity of all biota including animals and plants together interacting in an ecosystem. It can be plant diversity, animal diversity, family diversity, species diversity, population diversity, ecological diversity or genetic diversity, all intergrading into one another. In 1982 an explicit definition was first given in a paper by Bruce A. Wilcox commissioned by the International Union for the Conservation of Nature and Natural Resources (IUCN). Subsequently, in 1992 **United Nations Earth Summit in Rio de Janeiro defined** “biological diversity” as “the variability among living organisms from all ecological complexes”. In simple way it may be defined as the sum total of species richness, i.e. the number of species of plants, animals, fungi,

bacteria, viruses and other micro-organisms occurring in a habitat. Thus, biological diversity/biodiversity could be identified at four levels i.e. Species diversity, Ecosystem diversity, Molecular Diversity and Genetic diversity.

World economy and needs of human being directly depend on biological resources. The biological diversity increases the survival chance of an organism and ensures the continuance of life on earth. It provides fundamental requirement for adaptation, better survivability and evolution of an organism. A significant proportion of drugs are derived, directly or indirectly, from biological sources as at least 50% of the pharmaceutical compounds on the US market are derived from plants, animals, and micro-organisms, while about 80% of the world population depends on medicines from nature (used in either modern or traditional medical practice) for primary healthcare (Chivian *et al.*, 2008).

Bioinformatics is an interdisciplinary field evolved to organize and analyse the biological data through computational tools, technique and database. Recently due to rapid development in techniques and research technology, tremendous data has been generated in the field of biological sciences which also plays important role in understanding biodiversity. Bioinformatics combined with biodiversity to form the Biodiversity informatics, is applied to study biodiversity research by managing and analysing biodiversity data including its conservation around the world.

## **Application of bioinformatics in biodiversity knowledge discovery**

### **1. Digitization**

Without bioinformatics, biodiversity data means basic information about occurrence and variation in species. Such information may be in the form of retained specimens that assembled in the natural history collections of museums and herbaria. Bioinformatics convert this relevant primary biodiversity information to more sophisticated information. Bioinformatics involved in large scale digitization of data related to biodiversity, so that more information regarding diversity available to public access and advanced research and analysis on this topic possible. Many databases regarding biodiversity were generated.

### **Some of the global biodiversity databases:**

**Species 2000-** It is a “Federation” of database organizations working closely with users, taxonomist and sponsoring agencies. Ambitious undertaking with the aim of “enumerating all known species of plants, animals, fungi and microbes on Earth,” in a comprehensive resource that ties together a variety of smaller online taxonomic indexes. Users will be able to access the data through one of two search engines: An “annual



checklist” that’s reviewed and updated every 12 months, and a “dynamic checklist” that provides more current information. [<http://www.sp2000.org/>]

**Species Analyst-** Provides access to a variety of natural history databases through a Web interface. Data (principally museum collection information such as date specimen was collected, latitude and longitude of collection site, and the collector’s name) can be downloaded in a variety of formats. Site will also generate a global distribution map of the collection sites for a given query, and can link users to online tools for further analysis and modelling of the data at the San Diego Supercomputer Center. [<http://speciesanalyst.net/>]

**Global Biodiversity Information Facility-** It is responsible for digitisation and global dissemination of primary biodiversity data, so that people from all countries can benefit from this information. This establishes a standard method for exchange about specimens for researcher. GBIF, a long-term project of the international Organisation for Economic Cooperation and Development, is building “an interoperable network of biodiversity databases and information technology tools,” the structure of which is summarized in the project’s business plan. [<http://www.gbif.org>]

**Tree of life (ToL) -** It contains more than 3000 world wide web pages, provide information about the diversity of organism on earth, their evolutionary history (phylogeny) and characteristics. Each page contains information about particular group of organisms. ToL pages are linked to one another hierarchically, in the form of evolutionary tree of life. Starting from the root of all life on earth and moving out along diverging branches to individual species, the structure of the ToL project thus, illustrates the genetic connection between all living things. [<http://www.tolweb.org/tree/phylogeny.html>]

**Deep Green-** Comprehensive databases presenting phylogenetic and biodiversity data from published papers in interactive phylogenetic-tree form [<http://ucjeps.berkeley.edu/bryolab/GPphylo/>].

**CONABIO-** Mexican-government site with primary aim of establishing a continuously updatable national biodiversity information system. [<http://www.conabio.gob.mx/>]

**Belize Biodiversity Information System-** Site providing nomenclature, taxonomic, distribution, and life history data for a variety of bird, mammalian, reptilian, amphibian, and fish species in Belize. [<http://gcmd.nasa.gov/index.html>]

**Nature Serve-** An “online encyclopaedia of life” sponsored by the Association for Biodiversity Information which provides data on nomenclature, conservation, geographic distribution, and life history of more than 50,000 U.S. and Canadian plant and animal species and ecological communities. Users can search by common or scientific species name, species association, and other criteria. [<http://www.natureserve.org/>]

**Biological Collection Information Service in Europe (BioCISE)-** Project to identify and publish a Web-based catalogue of European biological collections and collection information systems. [<http://www.bgbm.fu-berlin.de/BioCise/>]

**Barcode of Life Data Systems (BOLD)** - The Barcode of Life Data Systems (BOLD) is an informatics work bench aiding the acquisition, storage, analysis, and publication of DNA barcode records. By assembling molecular, morphological, and distributional data, it bridges a traditional bioinformatics chasm. BOLD is freely available to any researcher with interests in DNA barcoding. [<http://www.boldsystems.org>]

## **2. DNA Barcoding & Biodiversity**

DNA Barcode plays important role in biodiversity analysis. DNA barcode is standardized species specific 650 bp fragment of cytochrome c oxidase I (COI) gene of mitochondria. DNA barcodes used as a global standard for species identification and biodiversity studies. DNA sequence can be used to identify different species specially in mammals, birds, arthropods, fishes and many other animal groups in the same way a supermarket scanner uses the familiar black stripes of the UPC barcode to identify our purchases. When the barcode sequence has been obtained, it is placed in the Barcode of Life Data Systems (BOLD) database as reference library of DNA barcodes that can be used to assign identities to unknown specimens. Four articles focus on DNA barcoding analytical approach in biodiversity; i) the first of these articles, from Bertolazzi *et al.*, (2009) presents a machine learning approach for classifying species according to DNA Barcode derived information. Chu *et al.* (2009) have described a 'composition vector' approach for making use of large data sets of DNA Barcodes for classification. In light of molecular sequence alignment as an often rate limiting step in many classification approaches, Kuksa and Pavlovic (2009) have presented an alignment-free approach for DNA Barcode data. In light of the range of approaches associated with DNA Barcode based classification, Austerlitz *et al.* (2009) have also presented an overview of common phylogenetic and statistical methods most commonly considered. DNA barcodes generated by laboratories that have an expertise in DNA sequencing, to facilitate efficient use of barcode information in biodiversity studies, bioinformatics developed web based tool available at *iBarcode.org*. This tool is developed for visualization and analysis of DNA barcode data at sequence, genetic distance and phylogenetic tree levels (Gregory AC Singer *et al.*, 2009). In DNA barcoding generally 650 bp sequence used for analysis, but with the help of bioinformatics sequence analysis it was observed that 90% identification success is obtained with 100 bp regions of COI gene and 95% success with 250 bp Barcodes. In another words, in 90% of the species tested a DNA barcode of only 100 bp contains nucleotide substitution(s) specific to members of a particular species. These are mini-barcodes to identify unknown specimens (Isabelle Meusnier *et al.*, 2008).

## **3. Tools and software for Biodiversity data integrating-**

**Alice Software- Software** used for creation, management and publication of biodiversity data. [<http://www.alicesoftware.com>]

**Spice for species 2000-** It creates and maintained autonomous Global Species Database (GSDs). It investigates authority and wide taxonomy coverage through accurate mapping quality GSDs from many organisations. [<http://www.systematics.reading.ac.uk/spice>]

**Biodiversity Pro Software-** It has following feature:

**Alpha calculation-** Abundance Plot-Dominance, Rank, Abundance Model-Log-series, Broken Stick, Rarefaction, Diversity Indices-Shannon, Alpha Caswell, Berger-Parker, Simpson, Hill, Margalef, McIntosh.

**Beta calculation-** SHE analysis, Species Richness, Species Distribution.

**Multivariate Calculation-** Principal Component, Correspondence Analysis, Cluster Analysis Non-Metric MDS

**Comparisons-** Descriptive Statistics, Kulczynski, Mann-whitney, Rank Correlation, Correlation, Variance-Correlation, ANOSIM.

**Tools-** Send Data, Transform Data, Standardise Data, Add-Ins Options

**PHYLIP (the Phylogeny Inference Package)** - It is package of programmes for phylogenetic analysis. It uses parsimony, distance matrix and likelihood method with bootstrapping and consensus trees.

[<http://evolution.genetics.washington.edu/phylip.html>]

**World Map-** Used for exploring geographical patterns in diversity, rarity and conservation priorities from large biological datasets.

[<http://www.nhm.ac.uk/science/projects/worldmap/>]

**LOCKSS (Lots of Copies Keep Stuff Safe)** - It is an international community program, based at Stanford University Libraries, that uses open source software and P2P networking technology to map a large, decentralized and replicated digital repository. LOCKSS box collects content from the target sites using a web crawler similar to the ones that search engines use to discover content. It then watches those sites for changes, allows the content to be cached on the box so as to facilitate a web proxy or cache of the content in case the target system is ever down and has a web-based administration panel to control what is being audited, how often and who has access to the material (Anthony Goddard et al, 2011).

#### **4. Phylogenetic Diversity**

It states how much evolutionary history is represented by a group of species or how variation in taxa of one locality increases the variation in another locality (Daniel *et al.*, 2006). To analyse the phylogenetic diversity data, Phylogenetic Diversity Analyzer software developed. It provides a wide range of biodiversity analysis using Phylogenetic Diversity (PD), Split Diversity (SD) and related measures based on both phylogenetic trees and networks. This provides conservation biologists with an objective decision-making process.

### **5. Databases developed for Biodiversity Conservation**

Databases increase knowledge of Earth's taxonomic diversity and provide public access to vast resources available in the world's scientific collections, and these are goals of the Global Biodiversity Information Facility (GBIF). Involvement of historical biodiversity data to biodiversity conservation database increase it's important as historical data reflecting long-lost landscapes that play important role in biodiversity in past and its role in future biodiversity. In response to this need, the Species Survival Commission (SSC) of the IUCN-World Conservation Union recently announced the development of its Species Information Service (SIS), which will link the SSC's network of more than 7000 species specialists in a distributed data management system, integrating modern principles of data custodianship. The most powerful feature of SIS is that its data will be continuously updated and managed by species experts. This mechanism will link policymakers with scientists who have first-hand knowledge of the current status of Biodiversity (anonymous, 2004).

An attempt has been made to develop database of pathogenic fungi causing the diseases of medicinal plants of Bihar & Jharkhand state by following the bioinformatics tools known as mediPDB in which descriptions of 185 medicinal plants available with respect to their uses, name of pathogenic fungi and disease symptoms providing useful information in biodiversity conservation. The known medicinal plants alongwith their uses and diseases caused by fungi stored in database are taken from the Report on "Diseases of Medicinal plants" authored by Roy & Pandey(2012).

#### **The interface of mediPDB**

Various query interfaces and graphical visualization pages were implemented to facilitate access to data and further analysis to support research on medicinal plants. The mediPdb provides three modes for browsing the plants information—the botanical name of plant browser, common name of plants browser and fungi name browser. As presented in Figure 1, the plant view shows the Botanical names of particular plant, their common name, distribution, uses of those medicinal plants, diseases symptoms of the plants developed by fungal pathogen, place and date of collection of samples.

#### **Conclusion**

Application of bioinformatics in biodiversity is to collect information regarding diversification of plants, animals and microbes and provide public access by creating biodiversity databases, software and tools for their analysis so that useful information can be derived.

Plant\_Info

Plant Name: Azadirachta indica Juss

Family: Meliaceae

Common Name: Neem

Distribution: Throughout India

Uses: It is used in malarial fever, Ulcers, blood purification, skin conditions, eczema, and dandruff, warts, Heart diseases, Hypertension, Blood clots, excess cholesterol, kidney problems, digestive and nervous disorders and STD (Sexual Transmitted Diseases) Oil is used to be effective in treatment of leprosy and skin diseases. Leaves in poultice are used for healing of wounds. Oil cake is used as a fertilizer and manure. Nimbidin is used for making several pharmaceutical preparations including emulsions, liquors, ointments, and medicinal cosmetics.  
Symptom (i): Light brown irregular spot on the leaves. PDI: 60%.  
Place & date of collection: Bhagalpur, Feb. 2004.  
Fungus isolated: Fusarium solani. Moreau.  
Culture Deposited: UDB No - 302

Buttons: Clear, Close, Fungi

**Figure 1.** Interface of Plant information in mediPdb

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