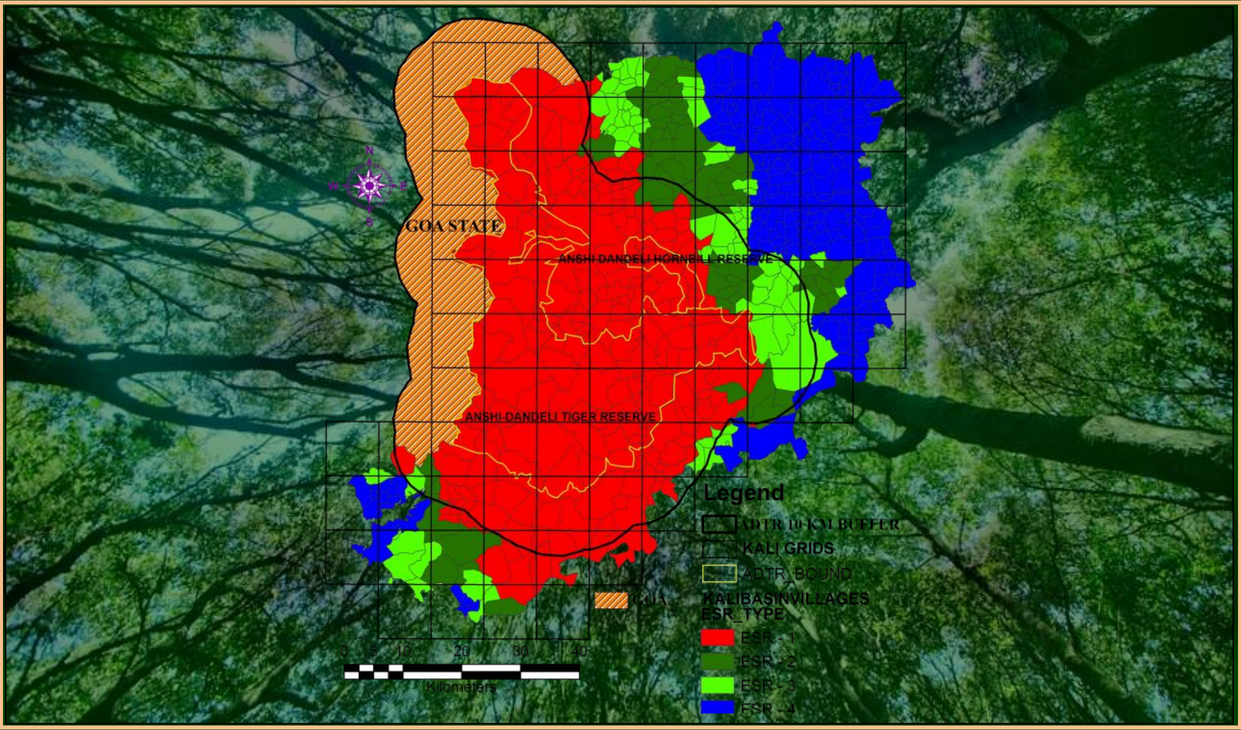
Sahyadri Conservation Series: 68, ETR 125

Ecologically Sensitive Regions in the Kali River Basin, Karnataka:

Delineation based on Ecological Principles and People's Livelihood



ESR: KTR with 10 km buffer - Conserve for Posterity

RAMACHANDRA T V	BHARATH SETTURU	SUBASH CHANDRAN M D
RAO G R	VISHNU D MUKRI	JOSHI N V

NRDMS Division, The Ministry of Science and Technology (DST), GoI
ENVIS, The Ministry of Environment, Forests and Cliamate Change, GoI

ENVIS Technical Report 125

September 2017

Energy & Wetlands Research Group [CES TE15]
Centre for Ecological Sciences,
Indian Institute of Science, Bangalore - 560012, INDIA
Web: http://ces.iisc.ernet.in/energy/, http://ces.iisc.ernet.in/biodiversity
Email: tvr@iisc.ac.in, energy.ces@iisc.ac.in

Ecologically Sensitive Regions in the Kali River Basin, Karnataka: Delineation based on Ecological Principles and People's Livelihood

RAMACHANDRA T V	BHARATH SETTURU	SUBASH CHANDRAN M D
RAO G R	VISHNU D MUKRI	JOSHI N V

Citation: Ramachandra T V, Bharath Setturu, Subash Chandran M D, Rao G R, Vishnu D. Mukri, Joshi N V. 2017. Ecologically Sensitive Regions in the Kali River Basin, Karnataka: Delineation based on Ecological Principles and People's Livelihood, ENVIS Technical Report 125, Sahyadri Conservation Series 68, Energy & Wetlands Research Group, CES, Indian Institute of Science, Bangalore 560012

Financial Support

NRDMS Division, The Ministry of Science and Technology (DST), GoI

ENVIS, The Ministry of Environment, Forests and Cliamate Change, GoI

ENVIS Technical Report 125

September 2017

Energy & Wetlands Research Group,
Centre for Ecological Sciences, TE 15
New Bioscience Building, Third Floor, E Wing
[Near D-Gate] **Indian Institute of Science**
Bangalore 560012, India
http://ces.iisc.ernet.in/energy
http://ces.iisc.ernet.in/biodiversity

Email: tvr@iisc.ac.in,
energy.ces@iisc.ac.in
sahyadri@ces.iisc.ernet.in

Ecologically Sensitive Regions in the Kali River Basin, Karnataka: Delineation based on Ecological Principles and People's Livelihood

RAMACHANDRA T V	**BHARATH SETTURU**	**SUBASH CHANDRAN M D**
RAO G R	**VISHNU D MUKRI**	**JOSHI N V**

Citation: Ramachandra T V, Bharath Setturu, Subash Chandran M D, Rao G R, Vishnu D. Mukri, Joshi N V. 2017. Ecologically Sensitive Regions in the Kali River Basin, Karnataka: Delineation based on Ecological Principles and People's Livelihood, ENVIS Technical Report 125, Sahyadri Conservation Series 68, Energy & Wetlands Research Group, CES, Indian Institute of Science, Bangalore 560012

Financial Support

NRDMS Division, The Ministry of Science and Technology (DST), GoI

ENVIS, The Ministry of Environment, Forests and Cliamate Change, GoI

Energy & Wetlands Research Group,
Centre for Ecological Sciences, TE 15
New Bioscience Building, Third Floor, E Wing
[Near D-Gate] **Indian Institute of Science**
Bangalore 560012, India
http://ces.iisc.ernet.in/energy
http://ces.iisc.ernet.in/biodiversity

Email: tvr@iisc.ac.in,
energy.ces@iisc.ac.in
sahyadri@ces.iisc.ernet.in

Ecologically Sensitive Regions in the Kali River Basin, Karnataka:
Delineation based on Ecological Principles and People's Livelihood

RESEARCH HIGHLIGHTS:

- Ecologically Sensitive Regions (ESRs) are the 'ecological units' with exceptional biotic and abiotic elements. Identification of ESRs considering spatially both ecological and social dimensions of environmental variables, helps in ecological and conservation planning as per Biodiversity Act, 2002, Government of India.
- Ecologically Sensitive Regions (ESR) **should be prioritized based on conservation values and threat levels and not under 'political pressure'** or 'threats from the economically influential section of the society' under the guise of 'public pressure'.
- The worth of forests in the district is evident from the revenue of Rs. 9707 to 15,171 crores per year from the provisioning goods and services. This amounts to about Rs. 2 lakh per hectare per year (Details in the Annexure).
- The land use analysis highlights the decline of evergreen forest cover from 61.79 to 38.5 % (1973-2016);
- The Kali River basin has rich biodiversity with endemic flora and fauna;
- Vital habitat for tiger (*Panthera tigris*), leopard, wild dog (dhole) and sloth bear;
- Constitute an important elephant corridor between Karnataka and Maharashtra;
- Important birds are Malabar Trogon, Malabar Pied Hornbill, Malabar Grey Hornbill, Indian Grey Hornbill, Great Indian Hornbill, Emerald Dove, Ceylon Frog mouth, Pompador Pigeon etc.;
- ESR provide scope for habitat improvement, enhance the environmental services, reduce edge effects, connectivity, reducing fragmentation of forests and also provides a physical barrier from human encroachment.
- Ecological importance is evident from the occurrence of perennial streams with catchment having more than 65% native species of vegetation, while the streams are seasonal in the catchment dominated by monoculture plantations (6-8 months) and agriculture (water retention in streams is only for four months of monsoon).
- The current move of de-notifying Kali tiger reserve area of 75% Eco Sensitive Zone will have more adverse effect on ecology, hydrology and sustainability of natural resources. This senseless action would enhance the instances of human animal conflicts, while eroding the water security and people's livelihood.
- In this backdrop, Delineated ESRs outside PAs (Protected areas) in Kali river basin requiring urgent protection from rising threat levels.
- **ESR delineations are to be on ecological principles with the vigorous scientific analyses than shortsighted political strategies**

❖ ESRs at village levels are identified considering the integrated ecological framework with bio-geo climatic variables.

- ESR 1: highly sensitive regions requiring stringent conservation measures involving all stakeholders including VFCs (Village forest committees).
- ESR 2 represents a zone of higher conservation and forms a transition for highest conservation and moderate conservation regions.
- ESR 3 represents moderate conservation region and only regulated development is allowed in these areas.
- ESR 4 represents least diversity areas and the developments are allowed as per the requirement by strict vigilance from regulatory authorities. It is recommended that these regions are also has a lot of scope for further enrichment of environment by stakeholders and forest department intervention.

SNO	ESR TYPE	AREA (Ha)
1	**ESR-1**	1,13,018.23
2	**ESR-2**	25,729.16
3	**ESR-3**	32,668.15
4	**ESR-4**	618.09
TOTAL AREA		**1,72,033.6**

❖ ESR analyses reveal that 10 km buffer region is ecologicallyfragile zone and to be protected as Eco-sensitive regions as per the norms of Environmental (Protection) Act, 1986.

❖ Kali river basin covers a total of 524 villages spread across three districts (uttara Kannada, Belgaum and Dharwad).

❖ 203 villages are in ESR 1, 73 villages in ESR-2, 77 villages in ESR-3, and 181 villages are in ESR 4.

❖ The Kali river basin spread across the Uttara Kannada district has 331 villages and 190 villages are in ESR-1.

❖ Proritisation of ESRs helps in the implementation of sustainable developmental framework with the appropriate conservation strategies through the involvement of local stakeholders.

❖ The Community-based Conservation (CBC) of ESR 2 & 3 by invloving local communities, in the conservation decision-making and sustainable management would help in the conservation of biological diversity (or wildlife) as well as addressing the needs of people's livelihood.

❖ Proposed de-notification of eco-sensitive regions in the Kali River basin would create large-scale environmental disturbances that have the potential of adversely changing the character of the natural landscapes. This would spell ecological and economic catastrophe with the impending threat to water security and people's livelihood. Decision makers in the democratic India need to ensure the sustenance of natural resources and prosperity of the local people than eroding the resource base through unplanned senseless developmental activities.

DISTRICT NAME	ESR-1	ESR-2	ESR-3	ESR-4	TOTAL
UTTARA KANNADA	190	45	48	48	331
BELGAUM	13	25	27	20	85
DHARWAD	0	3	2	103	108
KALI RIVER BASIN	203	73	77	171	**524**

Ecologically Sensitive Regions in the Kali River Basin, Karnataka:
Delineation based on Ecological Principles and People's Livelihood

Executive Summary:

Ecologically Sensitive Regions (ESRs) are the 'ecological units' with exceptional biotic and abiotic elements. Identification of ESRs considering spatially both ecological and social dimensions of environmental variables, helps in ecological and conservation planning as per Biodiversity Act, 2002, Government of India. The current research attempts to integrate ecological and environmental considerations into administration, and prioritizes regions at Panchayat levels (local administrative unit) in Uttara Kannada district, Central Western Ghats, Karnataka state considering attributes (biological, Geo climatic, Social, etc.) as ESR (1-4) through weightage score metrics.

The Western Ghats one among 35 global hotspots of biodiversity. The Ghats are a range of hills which were once covered with extensive forest all along the length from Gujarat to Kerala, constitutes 5% of India's landmass with 30% of plants and animals. The high level of fragility of the Western Ghats ecosystems is due to its inherent geomorphological, climatic and biological characteristics. The region consists of evergreen and semi evergreen forest with the exceptional biodiversity of endemic flora and fauna: 4,600 species of flowering plants with 38% endemics, 330 butterflies with 11% endemics, 197 reptiles with 52% endemics, 529 birds with 4% endemics, 161 mammals with 9% endemics, 343 fishes with 31% endemics and 248 amphibians with 62% endemics. The Western Ghats with increasing dry period northwards, exhibit a progressive decline in tree endemics from south to the north. Of the 320 tree species considered endemic, 85% occur at 8-10° N, which receive maximum of 8-10 months of rainfall. At 10-12 °N, the region has 71% endemics, 43% in 12-14 °N, 22% in 14-16 °N, 17% in 16-18 °N and only 9% tree endemics north of 18° (the locality with only 3-4 rainy months). The rich biodiversity coupled with higher endemism is due to the humid tropical climate, topographical and geological characteristics, and geographical isolation (Arabian Sea to the west and the semiarid Deccan Plateau to the east). The Western Ghats is a thin north- south aligned strip of narrow forested hills with specific geographical, climatological, geological, hydrological and biological aspects. Maintaining ecological integrity by designating as Ecologically Sensitive Areas would aid in the long-term

preservation of biodiversity. The Western Ghats are the sources of all the rivers of the Deccan and the coast. The protection of forests in the river catchment are essential for water and food security with the sustained supply of water to the peninsular India and conservation of key species.

Protected areas (PA), national parks (NP), sanctuaries, nature reserves, wildlife refuges, wilderness areas have been created through policy initiatives in order to protect the native habitat of endemic species. Thus, PA system has evolved strategically to protect and maintain biological diversity, cultural resources at local to global scales. Subsequently, the concept of ecologically sensitive areas and community conserved areas has led to newer and wider frameworks for conservation at the landscape level, with an appropriate legal sanctity through the Environment Protection Act 1986. Section 3(2)(v) of the Act empowers the central government to take all such measures that it deems necessary to protect and improve the quality of the environment and prevent environmental degradation. It allows for the restriction of areas in which certain developmental activities can be prohibited. Further, section 5(1) of the Environment (Protection) Rules (EPR), 1986, specifies certain criteria like topographic and climatic features of an area, biological diversity of the area, environmentally compatible land use, extensive cultivation, proximity to the protected areas, etc. that can be considered while prohibiting or restricting certain operations in different areas. Maintaining ecological integrity in the protected area with buffer region is essential as most of protected landscapes are open systems that face anthropogenic and other biotic threats from adjacent areas. Alterations in landscape structure with a reduction in contiguous forests would increase the likelihood of invasive plants and animal range expansions, alter hydrologic regime (water availability), which leads to the erosion of integrity of the protected ecosystems.This necessitates identification and demarcation of effective ESRs considering the existing level of impacts and their future spatial spread.

The river basin consists of prime protected areas namely the Kali Tiger Reserve and Hornbill conservation reserve. Earlier, Anshi National Park and Dandeli Wildlife Sanctuary were together granted the status of Project Tiger Reserve, and declared as 'Anshi Dandeli Tiger Reserve' (2007) and subsequently renamed as Kali Tiger Reserve (December 2015). The Kali Tiger Reserve (KTR) is a part of 8,800 Sq Km of tiger conservation landscape comprising Protected Areas and reserved forests of Dandeli Wildlife Sanctuary towards north of KTR abutting Bhimghad Wildlife Sanctuary and further connects Radhanagari and Koyna Wildlife Sanctuaries in Maharashtra and Protected Areas in Goa State. Similarly reserve forests on the northeast of KTR forms permeable landscapes for tigers. The reserved forests in the south, connects KTR with Bedthi and Aghanashini Conservation Reserves and further down to Mookambika and Sharavathi Valley Wildlife Sanctuaries.

The unplanned developmental activities and ad-hoc policy measures in PAs are altering forest landscape structure, affecting the biodiversity, soil retention capacity, hydrologic regime, loss of carbon sequestration potential, etc. Deforestation has been considered as one of the drivers of global warming and consequent changes in the climate. Forests of Karnataka are experiencing landscape dynamics from post-independence period due to the implementation of large-scale developmental projects and deceitful policy measures. The Kali river basin is acting as a lifeline for Uttara Kannada, parts of Belgaum and Dharwad districts through sustained hydrological and other services. In this regard, spatiotemporal land use analyses and ecological sensitive regions (ESR) of Kali river basin has been prepared. The land use analysis highlights the decline of evergreen forest cover from 61.79 to 38.5 % (1973-2016). The natural forest cover has been replaced with exotic species such as Acacia, Eucalyptus and Teak etc.. This has led to change in major forest cover of Dandeli, Haliyal, and parts of Supa regions. The construction of series of dams and reservoirs have submerged large-scale forest land by affecting ecology.

ESRs are demarcated at the village level in the Kali River basin considering bio-geo climatic variables. The Kali river basin covers total 524 villages of across three districts – Uttara Kannada, Belgaum and Dharwad (Table 3). Among these, 203 villages are in ESR-1, 73 villages are in ESR-2 shows, 77 villages in ESR-3, and 181 villages in ESR-4. The Uttara Kannada district has 331 villages out of which 190 villages are in ESR-1. Forests of these villages need to be protected and further degradation should not be allowed. The ESR 1 & ESR 2 is referred as '***no go area'*** with respect to developments and ESR 4 is referred as a least possible eco-sensitive region. The Community-based Conservation (CBC) of ESR 2 & 3 is anticipated as conservation of biological diversity (or wildlife) based on the involvement of local communities, in decision-making. This approach will help in improving local ecology by their inputs.

Keyword: Ecologically Sensitive Region (ESR), Biodiversity, Ecology, sustainability,

Ecologically Sensitive Regions in the Kali River Basin, Karnataka

1.0 Introduction

Ecosystems are the distinct biological entities that sustain the biosphere and characterised by a range of functions: nutrient cycling, bio-geo chemical cycle, hydrologic cycling, etc. Ecological sensitivity of ecosystems refers to their ability to cope with various kinds of environmental disturbances that have the potential of adversely changing the character of the natural landscapes. The conservation and sustainable management of ecosystems are the vital components in the pursuit of development goals that are ecologically, economically and socially sustainable. Sustainable development of a region requires a synoptic ecosystem approach that relates to the dynamics of natural variability and the effects of human interventions on key indicators of biodiversity and productivity (Ramachandra et al. 2007). This requires an understanding of the complex functioning of ecosystems, diversity of resources, values, ecological services and their significant ability in influencing climate at local as well as global scale.

Landscape with a mosaic of interconnected forest and non-forest patches constitute a complex ecological, economic and socio-cultural systems. Forests are playing a crucial role in sustaining life on the earth through maintaining ecological diversity, regulating climate, carbon sequestration, protecting soil and hydrology etc., They provide abundant resources and livelihoods for the world's population (Gibson et al., 2011; Hansen et al., 2013). Forest ecosystems offer numerous resources such as timber and non-timber forest products (NTFP), medicinal resources, fuelwood and as well provide recreational values (Kindstrand et al. 2008). They act as prime biodiversity repositories (Li et al., 2009) and mitigate global warming (Cabral et al., 2010) by absorbing 30 % of fossil fuel CO_2 emissions (Pan et al., 2011). The goods and services provided by forested landscapes are vital to the socioeconomic development of human populations (DeFries et al., 2004) and their survival (Ramachandra et al., 2016). However, the forests are being altered due to the uncontrolled anthropogenic activities such as industrialization, agriculture, deforestation, etc. affecting their structure and health. Forests cover about 31% today at globally as opposed to 50% of the earth's land area 8000 years ago depleted with the expanded extents of croplands, pastures, plantations, and urban areas (FAO, 2011). The Earth's land surface has lost 40 percent of natural forest by 1990 due to the expansion of cropland and permanent pasture (Ramachandra & Shruthi, 2007). The rapid conversion of forests for agriculture, timber production, infrastructure activities and other anthropogenic uses has generated vast, human-dominated landscapes with potentially calamitous consequences for biodiversity to sustain. Despite realizing the importance of these ecosystems, increasing awareness global deforestation rates have remained alarmingly high over the past decades (DeFries et al., 2010).

Land use Land cover (LULC) information of a forested landscape serves as a basis for understanding bio-geophysical processes and anthropogenic pressures on the ecosystem. The land cover is referred as biophysical attributes of the earth's surface and land use as human purpose or intent applied to effective usage of these biophysical attributes (Lambin et al., 2001). LULC changes include the land transformation from one land use to another, leading to land degradation with the decline of biological, ecological, hydrological and economic productivity. LULC change resulting in deforestation has been recognized as an important driver of global environmental change. This necessitates quantification of LULC changes to evolve sustainable natural resource management strategies. The uncontrolled LU changes in forest landscapes subdivide the continuous native forests to more and smaller sizes and isolated forest patches (Laurance et al., 2002; Bharath et al., 2012). Fragmentation is enumerated as a process of breaking contiguous natural forest patches into smaller tracts of forest surrounded by other land uses, causing a disruption in continuity of the natural landscape (Ramachanra et al., 2016). Habitat fragmentation with subsequent edge effects caused by linear projects, infrastructure developments influence ecosystem goods and services including carbon sequestration, hydrologic regime, and biodiversity (Vinay et al., 2013; Bharath et al., 2014). The edge effect will lead to often perishing of large trees and being replaced by short-lived pioneers, resulting in decreases in forest biomass and basal area (Harper et al., 2005). The edges will aggravate predation (Cagnolo et al., 2006), fire susceptibility, microclimate and enhance carbon emissions. The unrestrained deforestation rates will alter microclimate of the region, lead to increase in land surface temperate and proliferation of exotic species (Ramachandra et al., 2017).

The protected areas (PAs), national parks (NP), sanctuaries, nature/wildlife reserves, wildlife refuges, wilderness areas are created to reduce the magnitude of land conversion, protecting native habitat, biodiversity, and endemic species. Uncontrolled developmental activities, alarming deforestation rates in forested areas stress the requirement of PAs to increase awareness and reduce negative impacts on humankind. The protective measures based on global initiatives have resulted in exponential growth of the world's PAs over the past decades. The global forest cover of 7.7% has the status of protection under IUCN's four strictest protection categories (I-IV) as estimated using earth observation satellite data from MODIS 2005 and the extent of the protected forest using the World Database of Protected Areas (WDPA) for the year 2008 (Schmitt et al., 2009). PAs have become a cornerstone of the global conservation for the persistence of biodiversity and other natural processes in situ, through constraints on incompatible land uses (Possingham et al., 2006). The basic role of PAs is to separate elements of biodiversity from processes that threaten their existence in the wild (Hansen et al., 2007). Despite the high level of protection afforded national parks and other protected areas, many are not functioning as originally envisioned due to lack of proper management and socio-regulatory support. Exotic species are increasingly invading protected areas and anthropogenic activities expanding and intensifying in the surrounding of protected areas, resulting in changes in biodiversity ecological functions.

Conservation of forest ecosystem has become a critical task as increased high intensities of anthropogenic disturbances in the form of LULC changes as compared to natural disturbance processes (Kivinen and Kumpula, 2013). This has led to inspiring systematic conservation planning approach as an increasingly vital tool for protecting the nature around the world. Ecologically sensitive regions are defined under conservation planning approach as ''large units of land or water containing a geographically distinct assemblage of species, natural communities, and environmental conditions" (Olson et al., 2001). ESR has the capacity to support and maintain the balanced and integrated ecosystem in a particular region under protective measures. Systematic conservation by prioritization of sensitive regions has become an effective and economical method (Myers et al., 2000) and is widely used to improve ecosystem by conservation practices. With respect to Indian scenario, Union Ministry of Environment Forests and Climate change (MoEFCC) has taken an initiative to protect forests and maintenance under section 3of Environment (Protection) Act 1986 (EPA). Central Government can prohibit or restrict the location of industries and carry out certain operations on the basis of considerations like the ecological sensitivity under section 5 of EPA 1986. The MoEFCC had set up Pronab Sen Committee in the year 2000 to identify parameters for designating ESRs in the country to counter the rapid deterioration of the environment, both nationally and internationally (MoEF, 2000). The committee has defined ecological sensitivity or fragility as permanent and irreparable loss of extant life forms from the world; or significant damage to the natural processes of evolution and speciation.

The comprehensive knowledge about LULC has become increasingly important for planning and visualization of future growth to overcome the problems of haphazard, uncontrolled development in ecologically sensitive regions (Kennedy et al., 2009). Temporal remote sensing data, geographic information systems (GIS) techniques, free and open source software technologies are providing efficient methods for the analysis of LULC dynamics required for planning and protection (Ramachandra et al., 2014). The forests of Uttara Kannada are undergoing deforestation, while the forest under protected areas showing the very little risk of being converted to other land uses. The new unplanned developmental activities, un eco-friendly tourism activities are gaining more priority and resulting in an irreplaceable loss in PAs. There is a miserable move to de-notify 75% of Kali tiger reserve (KTR) eco-sensitive zone area (ESZ) (a major portion of Kali river basin) to assist senseless developmental activities in the eco-sensitive regions. Gazette notification dated November, 2016

The Central Government proposed 1201.94 km^2 as Eco-sensitive zone as per the sub-section (1), read with clause (v) and clause (xiv) of sub-section (2) and sub-section (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) under sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986. However, subsequent request by the State (due to political pressure and the protests from the economically influential sections of the society), ESZ was reduced from 1201.94 km^2 to 312.52 km^2. The de-notification of PAs eco-sensitive zone would affect the pristine forests influencing the water and food security apart from fragile ecology. In this regard, the current research (i) delineates ecological sensitive regions at village levels based on bio-geo climatic variables and (ii) understand land use dynamics in Kali river basin (Kali tiger reserve).

1.1 Study area: Kali River basin, Central Western Ghats - Kali river basin is the lifeline of district and source for major agriculture, horticulture, and energy production. Kali river has a catchment area of 5085.9 km^2 spread across districts of Uttara Kannada (Ankola, Karwar, Supa, Yellapur, Haliyal), Dharwad (Kalgatgi, Dharwad) and Belgaum (Khanapura, Bialhongal).

Uttara Kannada district forest region also referred as Kanara circle, comprises of 5 Territorial Forest Divisions and a wildlife division (Figure 1). The divisions are (i) Haliyal forest (includes taluks of Haliyal, part of Supa taluk); (ii) Honnavar forest division (comprises taluks of part of Ankola, Kumta, Honnavar, Bhatkal); (iii) Karwar division (covers part of Ankola, Karwar, part of Supa taluks); (iv) Sirsi division (covers Sirsi, Siddapura taluks); (v) Yellapur division (covers Yellapur, Mundgod taluks).

Dandeli wildlife division (ADTR-Anshi Dandeli tiger reserve; KTR – Kali Tiger Reserve) covers a major portion of Supa taluk. The total forest area of Uttara Kannada district is 8296 km^2, (as per the legal status) including areas released for various non-forestry activities and recent orders of regularization of encroachment. The forest area under the control of the Forest Department is 7759 km^2 (93.53% of the total forest area). The forest area under revenue and other departments are 536 km^2. These divisions harbors varieties of endemic flora and fauna.

Population in the Kali River catchment has increased from 4,97,892 (in 2001) to 5,42,036 (in 2011) as per the Census of India (http://censusindia.gov.in) and is projected to increase to 5,66,065 in the year 2016 at the decadal growth rate of 8.8%. Population density in the catchment is 111 persons per square kilometer as on 2016. Major Population is contained at towns such as Dandeli, Haliyar, Dharwad, Karwar, Yellapura, Ramnagar, Virje, Majali, Ammadalli.

The major vegetation types of Kali basin can be broadly grouped as 'natural vegetation' which includes evergreen, moist deciduous and dry deciduous forests, 'plantations or monocultures' which includes plantations of *Tectona grandis* (Teak), *Eucalyptus sp.* (Bluegum) *Casuarina equisetifolia*, *Acacia auriculiformis*, *Acacia nilotica*, and other exotics. The list of flora species available in the region has provided in Annexure 1. The most threatened and vulnerable species such as *Wisneria triandra*, *Holigarna beddomei*, *Holigarna grahamii*, *Garcinia gummi_gutta*, *Hopea ponga*, *Diospyros candolleana*, *Diospyros paniculata*, *Diospyros saldanhae*, *Cinnamomum malabatrum*, *Myristica malabarica* and *Psydrax umbellate* are found in the basin. The forests are suffering from many detrimental developmental activities and policy interventions, subsequently leading to the heavy removal of lofty trees across the district.

The dams/reservoirs (Supa dam, Bommanahalli reservoir, Tattihalla reservoir, Kodasalli dam, Kadra dam, Kaneri dam) in Kali river basin are getting sustained water due to pristine forest cover in Kali Tiger Reserve (KTR). The ADTR/KTR harbors diverse flora and faunal species with an area of 1427.35 km^2. The KTR was formed by merging Anshi national park, Dandeli Hornbill reserve and Dandeli tiger reserve in the year 2010. The KTR has seen several drastic changes in its boundaries due to various policy initiatives from past 60 decades. It was originally notified as a game sanctuary covering an area of 127 km^2 (on 10th May 1956). In 1975, it was declared as a wildlife sanctuary with an expanded area of 5,729 km^2 under project tiger. To facilitate development projects such as hydroelectric, nuclear, a naval base, roads, transmission lines, mining and other industries area of the sanctuary was reduced to 834 km^2 in 1987. The transmission lines of Kaiga nuclear power project has bisected thick forests, created numerous edges and resulted to fragmentation of forests. The major thick woods were removed for power lines to supply Hubli-Dharwad district, that in turn helped timber lobbies. The area further reduced as Anshi national park of 475 km^2 through a final notification issued on 09th March 1998. Then realizing sensitiveness of region, ADTR has formed (1427.35 km^2) by merging undisturbed reserve forests in Anshi, Dandeli of Supa, Haliyal tauks as a final notification in 2010. In December 2015, ADTR was renamed as Kali Tiger Reserve. The Kali Tiger Reserve (KTR) is a part of 8,800 km^2 of tiger conservation landscape comprising Protected Areas and reserved forests of Dandeli Wildlife Sanctuary towards the north of KTR abutting Bhimghad Wildlife Sanctuary and further connects Radhanagari and Koyna Wildlife Sanctuaries in Maharashtra. The reserved forests in the south connects KTR with Bedthi and Aghanashini Conservation Reserves and further down to Mookambika and Sharavathi Valley Wildlife Sanctuaries.

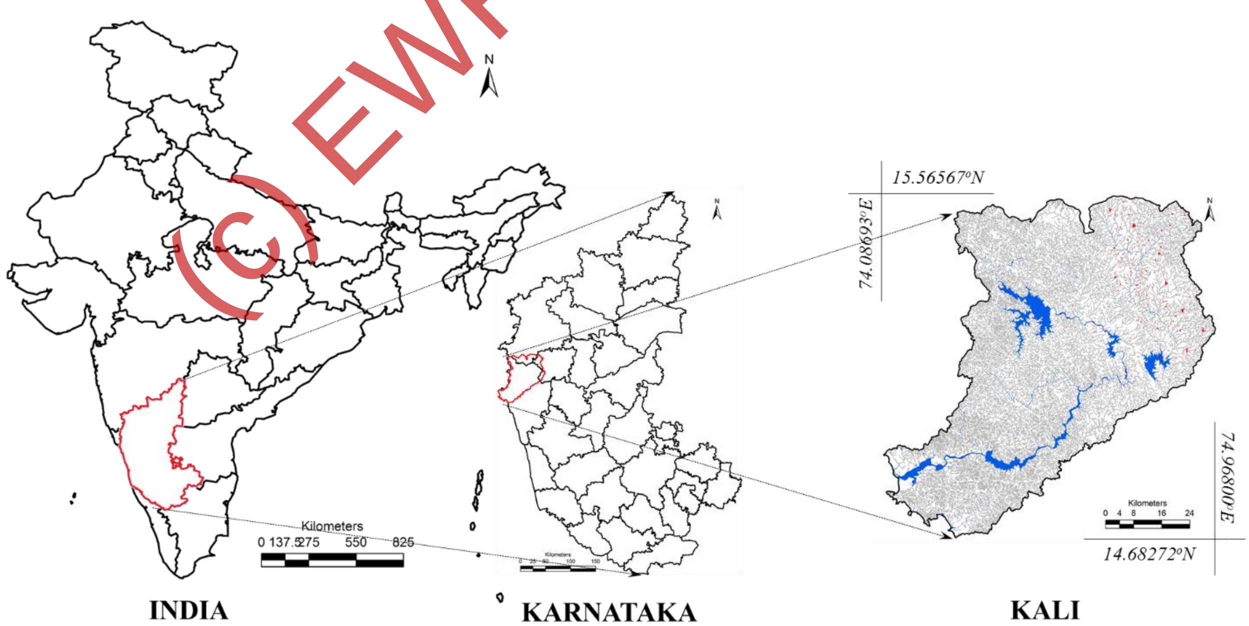


Figure 1 (a): Study area-Kali river basin.

Figure 1 (b, c): Flora and Faunal diversity of Kali River Basin.

2.0 Method:

Figure 2 outlines the protocol adopted for the analysis. Multiresolution RS data has been acquired through the sensors of U.S. Geological Survey Earth Observation Satellites (EOS). The RS data used in the study are Landsat multispectral sensor (MSS-1973), Operational Land Imager (OLI-2016) and online Google Earth data (http://earth.google.com). The ancillary data is used to assist the interpretation of different land use types from remote sensing data. Topographic maps provided ground control points to rectify remotely sensed data and scanned paper maps (topographic maps). Survey of India (SOI) toposheets (1:50000 and 1:250000 scales) and vegetation map of South India developed by French Institute (1986) of scale 1:250000 was digitized to identify various forest cover types and temporal analyses to find out the changes in vegetation. Pre-calibrated GPS (Global Positioning System - Garmin GPS unit) for field measurements. Ground control points are used to geometrically correct remote sensing data and also to validate the classified land use information. The supervised classification scheme of Gaussian maximum likelihood classifier (GMLC) scheme is adopted for land use analysis under 10 different land use categories using GRASS GIS (Geographical Analysis Support System). GRASS is a free and open source geospatial software with the robust functionalities for processing vector and raster data available at (http://wgbis.ces.iisc.ernet.in/grass/). The training data (60%) collected has been used for classification, while the balance is used for accuracy assessment to validate the classification. The test samples are then used to create error matrix (also referred as confusion matrix) kappa (κ) statistics and overall (producer's and user's) accuracies to assess the classification accuracies (Lillesand et al., 2014).

The study area is divided into 5’×5’ equal area grids (97) covering approximately 9 km^2 to account the changes at micro scale. The data of various themes were collected based on literature, unpublished datasets, and field surveys. A detailed database has been created for various themes covering all aspects from land to estuarine ecosystem. The initial workflow has derived a series of maps pertaining to various themes. The weightage metric score has been computed to captures the priorities associated with various themes (Figure 3). Developing a weightage metric score analysis requires combining knowledge from a wide array of disciplines (Termorshuizen & Opdam, 2009), planning should acknowledge and actively integrate present and future needs for landscape. The approach has chosen a framework proposed by Beinat, 1997 for weightaging eco-sensitive regions because it provides an objective and transparent system for combining multiple data sets together to infer the significance. The weightage is defined in Equation 1.

$$Weighatge = \sum_{i=1}^{n} W_i V_i \; \ldots(1)$$

Where n is the number of data sets, V_i is the value associated with criterion i, and W_i is the weight associated with that criterion. Each criterion is described by an indicator mapped to a value normalized between 10 to 1. The value 10 corresponds to very higher priority for conservation whereas 1 is converse to above. The value 7, 5 and 3 corresponds to high, moderate, low levels of conservation. In particular, the weightages, which is based on an individual proxy and draws extensively on GIS techniques, stands out as the most effective method. The final ESR map will result as a guide for the conservation of most sensitive regions and rest. The map can be used by decisionmakers as a basis for effective planning.

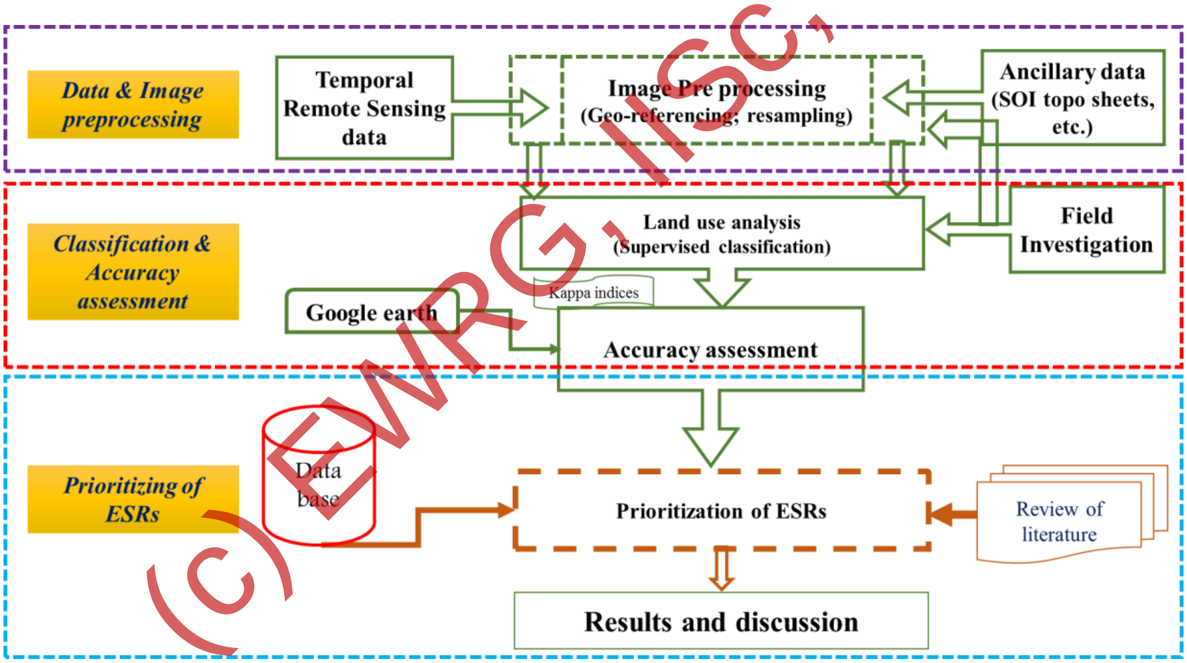


Figure 2: Method followed for land use analysis

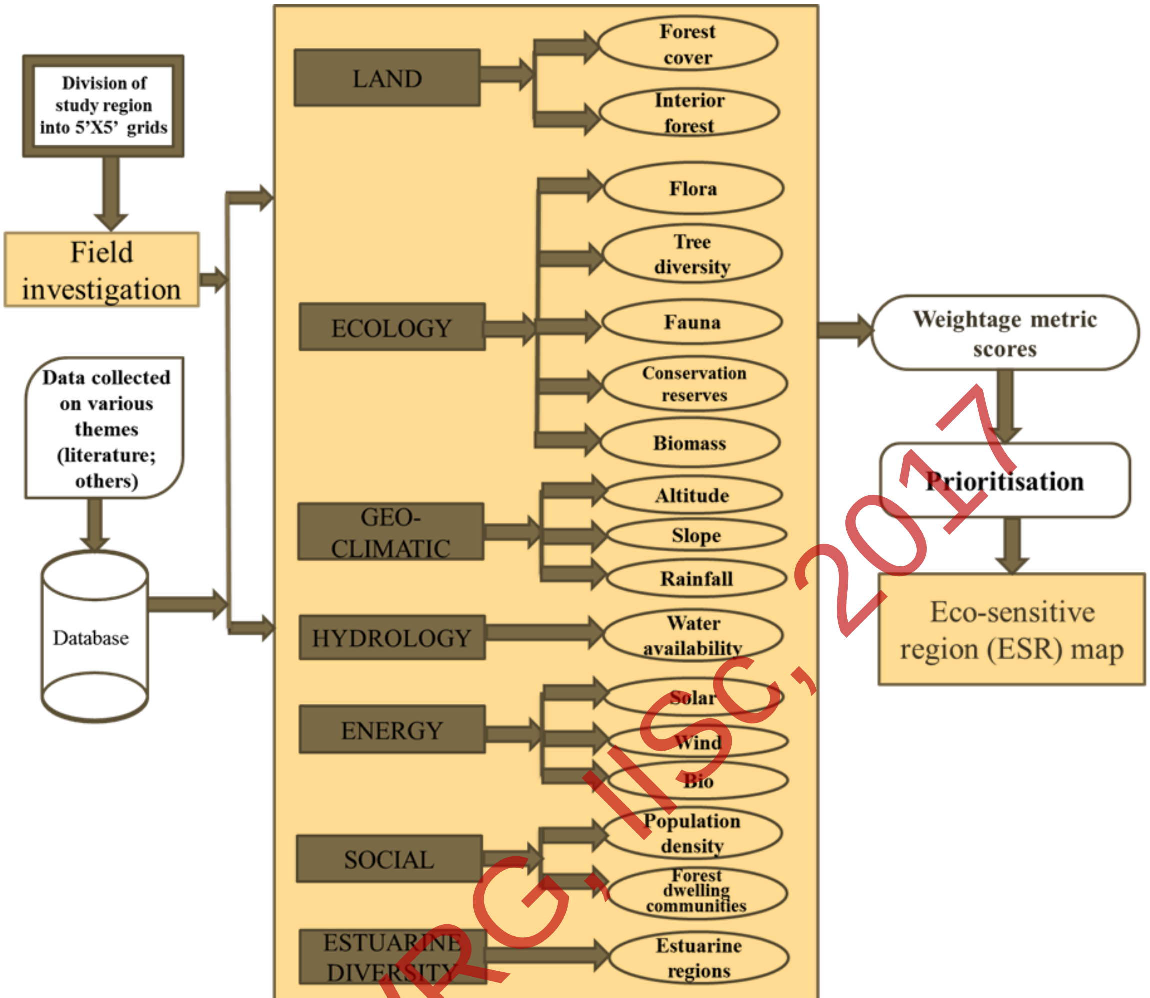


Figure 3: Computation of ecologically sensitive regions.

3.0 Results:

Spatiotemporal land use analysis: The forests of Kali river basin are acting as a rich resource base in the Western Ghats of Uttara Kannada district and providing a livelihood for various people. The land use analysis of Kali river basin depicts the spatiotemporal changes in this biodiversity-rich region from year 1973 to 2016 (Figure 4 and Table 1). The evergreen forest cover was lost due to hydroelectric, infrastructure projects and monoculture plantations from **61.79 to 38.5 %** (1973-2016). The natural forest cover has been replaced by the colonial forest department with exotic species such as Acacia, Eucalyptus, and Teak etc. This has led to change in major forest cover of Dandeli, Haliyal, and parts of Supa regions. The construction of series of dams and reservoirs have submerged large-scale forest land by affecting ecology. The transmission lines of

Kaiga nuclear powerhouse have bisected greater forest patches across the basin. The land conversion is major problem noticed i.e. conversion of forest to agriculture; agriculture to coco/areca nut plantations. The rehabilitation due to river valley projects, reservoirs have altered interior forests by the creation of more edges. The major portion of deciduous forest cover (7.82-2.24 %) in the eastern portion of the basin has been transformed to agriculture area from 9 to 17.7 % by 2016.

SNO	Year	1973		2016	
	Category	Ha	%	Ha	%
1	Evergreen to semi evergreen forest	314265.07	**61.79**	195829.13	**38.50**
2	Moist deciduous forest	76713.55	15.08	72231.41	14.20
3	Dry deciduous forest	39765.85	**7.82**	11369.70	**2.24**
4	Scrub forest/grass land	12857.72	2.53	17138.54	3.37
5	Teak/Bamboo/Acacia/Eucalyptus/Other plantations	8383.26	1.65	76666.09	**15.07**
6	Crop land	46783.90	**9.20**	90086.56	**17.71**
7	Coconut/Areca nut /Cashew nut plantations	54.26	0.01	8805.30	1.73
8	Open fields	5703.57	1.12	9449.90	1.86
9	Built-up	1985.22	0.39	8433.95	**1.66**
10	Water	2068.93	0.41	18570.75	3.65
Total		508581.33			

Table 1: Temporal changes in land use of Kali river basin.

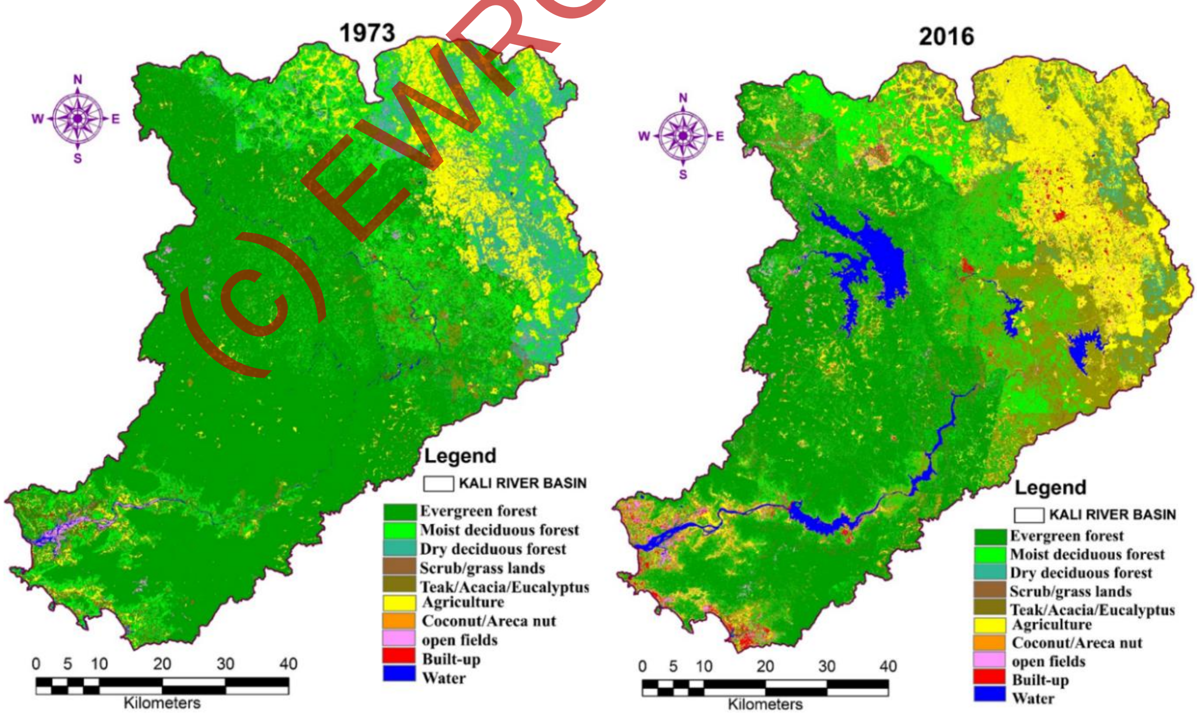


Figure 4: Land use dynamics in the Kali river basin.

Land uses in the KTR region (Figure 5) shows a forest loss from 91.5 to 71.85% due to protection and inaccessibility as compared to Kali river basin. The dense core forests were lost due to the construction of series of dams on river Kali and some area was replaced by plantations. The core forest remained, which is mostly concentrated Supa taluk and Kali river valley regions. Roads are another driver aid in the loss of core forest cover. The eastern portions of KTR region have major teal plantations constitute 7.6% of land mass. There is continuous pressure in the periphery area of KTR due to increase in the population of surrounding villages. The moist deciduous cover has gained by replacing semi-evergreen cover from 4.8 to 11.12 % due to degradation in northern portions. The core portion is still intact and supporting diverse flora and faunal species from extinction. If the de-notification of KTR has considered, then it will be a great loss to ecology. Pre-independence era tigers and elephants were distributed across the forests of Uttara Kannada, now they are confined to only Kali river basin due to various other reasons. The entire basin is acting as the lifeline for wildlife to thrive as it is the only habitat for key species such as tigers and elephants in the district. The accuracy of classification has been verified with sample data collected from the field and google earth. The overall accuracy of classification is 89, 91 % respectively for 1973 and 2016.

SNO	**Year**	**1973**		**2016**	
	Category	Ha	%	Ha	%
1	Evergreen to semi evergreen forest	130660.7	**91.5**	102,558.63	**71.85**
2	Moist deciduous forest	6836.6	4.8	15,872.42	11.12
3	Dry deciduous forest	258.3	0.2	775.2	0.54
4	Scrub forest/grass land	2021.8	1.4	4297.06	3.01
5	Teak/Bamboo/Acacia/Eucalyptus/Other plantations	1202.8	**0.8**	10851.49	**7.60**
6	Crop land	895.2	**0.6**	4136.89	**2.90**
7	Coconut/Areca nut /Cashew nut plantations	0.0	0.0	0	0.00
8	Open fields	463.0	0.3	3019.57	2.12
9	Built-up	42.6	0.0	304.75	0.21
10	Water	354.5	0.2	919.45	0.64
Total		142735.5			

Table 2: Temporal changes in land use of KTR.

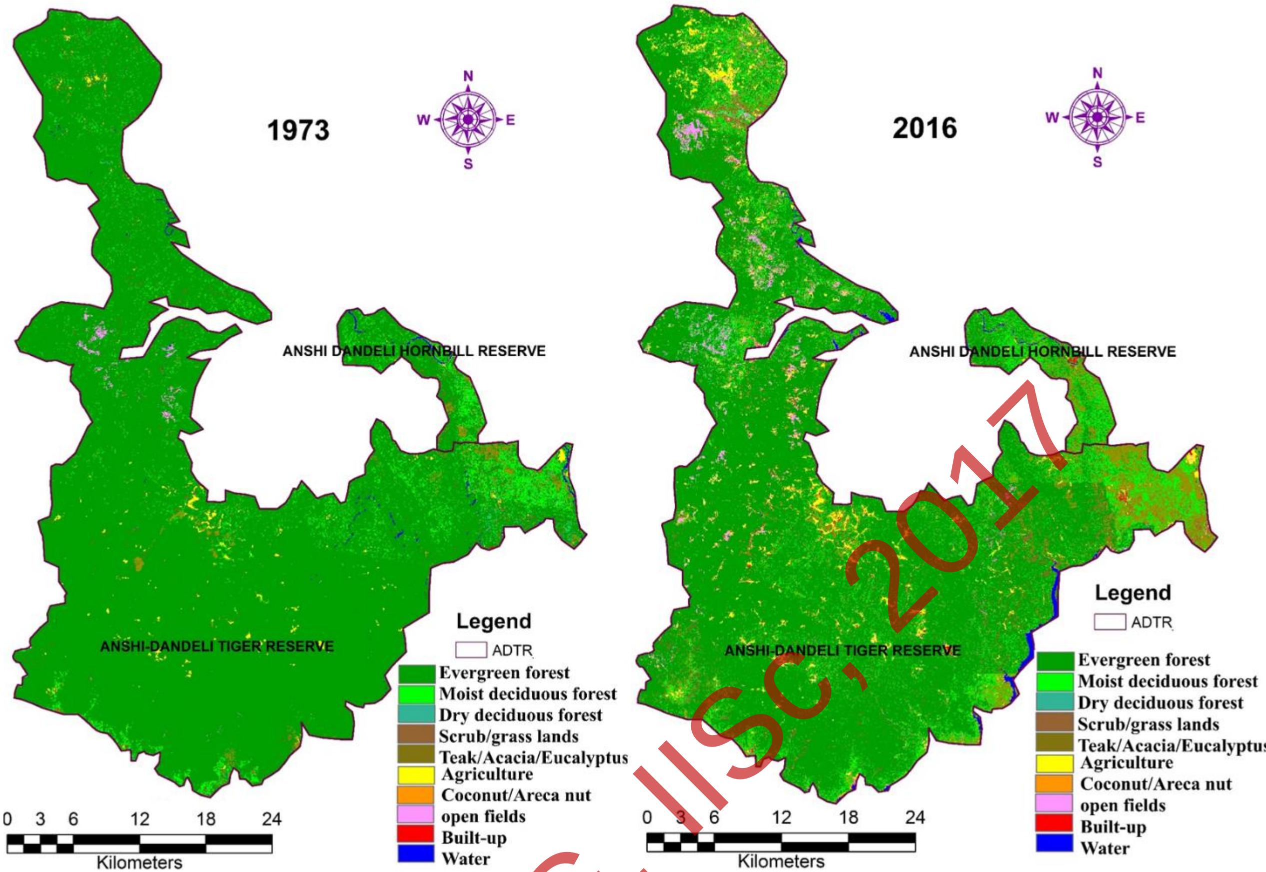


Figure 5: Land use analysis of ADTR (KTR).

4.0 Ecological Sensitive Regions (ESR) of Kali Basin:

ESR demarcation was done to get a detailed picture of Kali basin considering various themes for conservation planning. The various themes are selected and evaluated based on literature and field-based measurements. The land use analysis highlights (Figure 6a) the major forest cover (> 80%) has confined to KTR region, eastern parts are totally degraded due to higher pressure. The natural forest cover left today is 54.94 % only. The wide-scale land clearing and subsequent agricultural expansion, exotic plantations resulted in damage of large patches. The major developmental projects further disturbed the landscape and reduced the distribution of forest cover. The forest cover weightages (Figure 6b) shows higher, moderate ranking is observed in KTR and its surrounding regions. The interior forest cover is considered as another important variable, which emphasizes conservation connectivity and ecological functionalities (Figure 7a). The cultivation in the nearby plots and roads are badly affecting natural cover. The more edge and perforated patches are forming in the landscape, reveals loss of connectivity and largest forest patches. The higher interior forest can be seen in grids of Supa taluk (Figure 7b) and gained higher weightages. The plains (Haliyal, Hubli, Belgaum portions) are expressing least weightage (1, 3) due to more disturbed forest cover with least or no interior forest coverage.

The ecology of Kali basin was analyzed through prevailing patterns of biodiversity such as endemic flora, fauna, the biomass of forests, the status of conservation reserves etc. These information was compiled from literature review as well as field-based measurements. Field data was collected using pre-calibrated GPS (Global positioning System), which provided co-ordinates of the location - latitude, longitude and altitude. These information were plotted to understand the spatial patterns of distribution and the respective habitats. The Figure 8a, b gives the spatial distribution of endemic flora and its weightages.

The region is home to very rare and endangered wildlife (Figure 9a). Main predators are tiger (*Panthera tigris*), leopard, wild dog (dhole) and sloth bear. Leopards are in good number and wild dogs are in very less number, usually sighted in Kulgi and Phansoli ranges of Dandeli. Sloth bears are in very good number and these are frequently sighted in Ambikanagar, Virnoli, Bhagavati. Prey animals are barking deer, spotted deer (*Axis axis*), wild boar, sambar (*Cervus unicolor*), gaur (*Bos gaurus*). The region has an important elephant corridor between Karnataka and Maharashtra with at least 47 elephants which are frequently sighted near Sambrani, Bommanahalli dam backwaters. One can also find Malabar Giant Squirrel, Slender Loris etc. Some of the important birds are Malabar Trogon, Malabar Pied Hornbill, Malabar Grey Hornbill, Indian Grey Hornbill, Great Indian Hornbill, Emerald Dove, Ceylon Frog mouth, Pompador Pigeon etc. Kali river accommodates at least 200+ marsh crocodiles and a good number of these can be sighted near Dandelappa temple in Dandeli town. Another rare reptile found is Draco (Flying Lizard) which can be easily sighted near Mandurli IB, Anshi Nature Camp, Sathkhand falls. There are a wide variety of snakes can be found i.e., King Cobra, Cobra, Malabar Pit Viper, Hump nosed pit Viper, Bamboo Pit Viper, Kraft, Ornate flying snake, wolf snake etc. There is also a wide variety of butterflies found in the reserve. Some of them are Crimson Rose, Common Rose, Leaf, Clipper, Tigers, Southern Bird wing, Cruiser etc. So, higher weightages (10) are assigned for grids (Figure 9b) covering all endemic species and least were given as 3 for non-endemic fauna.

Biomass is considered as another significant variable in the analysis. The biomass data of Ramachandra et al., 2013 is considered as a base to derive the important regions of biomass and their protection. The analysis was calculated based on total standing biomass forest's vegetation (as per Brown, 1997; Ramachandra et al., 2000) and using field data with the remote sensing data. The dataset has used multiple regression equations for various regions. Statistically, significant regression equations were obtained for computation. The field transacts wise basal area were estimated using allometric equations. The basal area is also computed using regression equations and compared with field transact wise estimations. The biomass at each grid wise is estimated based on forest coverage (Figure 10a). The forests of Supa region have higher biomass (>1200 Gg) and eastern part deciduous to dry deciduous forests of Haliyal region have least biomass (< 200 Gg). The higher biomass regions are assigned greater weightages and vice versa (Figure 10b). Net Carbon uptake by the forests of is estimated as half of the biomass as per standards and literature. Since these regions are warehouse of carbon and degrading or disturbing these regions will result in a higher carbon emission with the loss of carbon sequestration potential. This will lead to an imbalance in the ecosystem and global warming, so higher conservation values are assigned (Figure 11a, b). The uniform higher weightages (Figure 12a, b) are assigned to KTR as it is acting as key eco-sensitive regions with diverse biodiversity.

Geo-climatic information of region has been analyzed to identify sensitive zones by considering altitude, slope, and rainfall. The high altitude regions are prone to landslides due to heavy rain, has extreme weather conditions, low humidity. The Figure 13a shows the altitude map of the district, highest elevation is 1758 m in Supa taluk. The weightage map is generated by considering > 600 mt as a higher priority for conservation and > 400 m is moderate and rest is least concern (Figure 13b). Slope map (Figure 14a) is generated to identify the regions which are more sensitive; alteration of these regions will have a higher impact. Increase in the population makes people move towards sensitive areas like highlands without considering the slope because of soil fertility, market based economy and agricultural intensification. In such areas, land scape disturbances will lead to soil erosion, landslides, secondary plant succession, and ultimately to land abandonment. The slope > 12 degrees is considered as a more sensitive region and assigned higher weightage (Figure 14b). The rainfall pattern of the district is analyzed to mark the sensitive regions for conservation. Most of the KTR region (Figure 15a) is falling in the high rainfall zone, except eastern parts of Haliyal. The endemic species are well distributed in higher rainfall region. The diversity, endemism, and rainfall are interrelated each other. The disturbance in these regions will have a major impact on the landscape. The Figure 15b shows weightage map considering higher rainfall gradient with greater weightage followed by moderate and low. Hydrology of the region is analyzed by sub basin wise to account perennial, seasonal flows of the region. Perennial flows of a region depict health of the ecosystem. The Figure 16a shows the stream flow at each grid of the district. The KTR, Supa region shows water availability of 12 months in the streams due to higher rainfall and forest cover. The weightages are assigned (Figure 16b) by considering perennial regions as high and seasonal flows as lower.

Environmentally sound alternative sources of energy are considered for prioritization to highlight the potentiality of them. Solar, Wind, Bioenergy data sets are collected and analyzed and weightages assigned (Figure 17-19). The entire region receives an average solar insolation of 5.42 kWh/m^2/day annually and has more than 300 clear sunny days. This solar potential can be utilized to meet the domestic and irrigation electricity demand. Domestic demand of the household in a rural region is about 50 to 100 kWh per month. The solar potential assessment reveals that domestic demand can be supplied by installing rooftop SPV modules since less the 5% of the rooftop is required in the majority of the houses and irrigation demand can be met by installing PV modules in a wasteland where less than 3% of available wasteland area is sufficient. Bioresource availability is computed based on the compilation of data on the area and productivity of agriculture and horticulture crops, forests and plantations. Sector-wise energy demand is computed based on the National Sample Survey Organisation (NSSO study) data, primary survey data and from the literature. The supply/demand ratio in the district ranges from less than 0.5 to more the 2. If the ratio is less than 1 (demand >supply) then that place is fuelwood deficit place and where the ratio is more than 1 (supply >demand) then that place is referred as fuelwood surplus region. Wind resource assessment shows Wind speed varies from 1.9 m/s (6.84 km/hr.) to 3.93 m/s (14.15 km/hr.) throughout the year with a minimum in October and maximum in June and July. Hybridizing wind energy systems with other locally available resources (solar, bioenergy) would assure the reliable energy supply to meet the energy demand at decentralized levels.

The forest dwelling communities of the region are considered as one of the key variables in prioritization (as per Forest Dwellers Act 2005 or Forests Rights Act 2005). These people are directly and indirectly being contingent on forest resources. The forest dwelling communities are *Kunbis, Siddis, Goulis, Gondas*. They are socially and politically backward and most of them depend on casual labor, trading forest products for their livelihood. The presence of tribes considered as higher weightages and absence is assigned least value (Figure 0a, b). Population density is considered as another proxy of ESR mapping. The population density of each grid is analyzed (Figure 21a) based on census data of 2011. It is evident that higher the population present, higher the resource extraction (Figure 21b). The higher population density has considered as least priority weightages (1) and lower density regions are projected as higher conservation priority weightages (10).

Estuarine ecosystems are a tiny ribbon of land, but the emissions from their destruction are nearly one-fifth of those attributed to deforestation worldwide (Pendelton et al., 2012). The major mangrove species present are *Rhizophora mucronata*, *Sonneratia alba, Avicennia marina*, *Avicennia officinalis, Kandelia candel*, *Rhizophora apiculata, Sonneratia caseolaris.* The farmers also plant rows of mangrove trees just outside these bunds to fortify them from collapse. This traditional system of estuarine cultivation with mangrove planting was a sustainable system. **Kali Estuary** has major dams with hydro power stations have affected mangroves, fish yield, and other substances. The weightages are assigned as per the data analyzed emphasizing productivity (Figure 22).

The weightage metric score associated with each theme has been computed and it resulted in ecologically sensitive regions (ESR) of 1, 2, 3 and 4. Figure 23 shows 47 grids represent ESR 1, 9 grids represent ESR 2, 8 grids represent ESR 3 and the rest 23 grids represent ESR 4. The 54% of the area of grids represents ESR 1, 10.34% of the area shows ESR 2, 9.19 % of the area shows ESR 3 and only 26.44 % area covers ESR 4. The Figure 24 and table 5 shows village level ecological sensitive region map with 4 categories. The ESR 1 represents zone of highest conservation, no further degradation allowed. ESR 1 can be treated as a high sensitive region of the district and more conservation is to be imposed by regulatory authorities as well as VFCs (Village forest committees). ESR 2 represents a zone of higher conservation and forms a transition for highest conservation and moderate conservation regions. ESR 3 represents moderate conservation region and only regulated development is allowed in these areas. ESR 4 represents least diversity areas and the developments are allowed as per the requirement by strict vigilance from regulatory authorities. It is recommended that these regions are also has a lot of scope for further enrichment of environment by stakeholders and forest department intervention. In ESR 2 & ESR 3 further developments are allowed by an only critical review from regulatory and extensive consultations with stakeholders. Small scale tourism should be encouraged adopting benefit sharing with local communities such as homestay, spice farms, eco-friendly boating etc. The uncontrolled development should be discouraged in and around of pristine lakes, primeval forest patches, perennial water bodies. The site specific (clustered base) sustainable developments can be taken up at each panchayat, which least affect the ecosystem.

The village wise ESR delineation has shown in Figure 24 and Annexure 2 provides taluk wise categorized ESR villages. The village wise ESR analysis shows Kali river basin covers total 524 villages of across three districts (Table 3). The ESR-1 shows 203 villages, ESR-2 shows 73 villages, ESR-3, 4 shows 77 and 181 villages respectively. The Uttara Kannada district has 331 villages out of which 190 villages depict ESR-1. Forests of these villages need to be protected and further degradation should be allowed. The controlled and regulated activities in each ESR region has shown in Table 4. The ADTR region its periphery of Kali basin is shown as a high conservation priority zone (Figure 25) signifies the need for conservation by arresting further degradation.

Table 3: ESR Villages under various districts of Kali river basin.

SNO	DISTRICT NAME	ESR-1	ESR-2	ESR-3	ESR-4	TOTAL
1	UTTARA KANNADA	190	45	48	48	331
2	BELGAUM	13	25	27	20	85
3	DHARWAD	0	3	2	103	108
KALI RIVER BASIN		203	73	77	171	**524**

Table 4: Activities that can be allowed in ESR -1, 2 3 & 4.

SNO	ACTIVITIES	ECOLOGICALLY SENSITIVE REGIONS			
		ESR-1	ESR-2	ESR-3	ESR-4
1	**ENERGY**				
	(A) Solar (Roof top)	✓	✓	✓	✓
	(B) Wind power	✗	✓	✓	✓
	(C) Bio energy	✗	✓	✓	✓
	(D) Coal based (Thermal power)	✗	✗	✗	✗
	(E) Gas or liquid fuel based	✗	✗	✗	✓

	(F) Hydro power (Major)	✘	✘	✘	✘
	(G) Hydro power (Micro)	✘	✘	✘	✓
	(H) Nuclear power	✘	✘	✘	✘
2	**FORESTS**				
	(A) Land use change (Forest to non-forest usages)	✘	✘	✘	✘
	(B) Monoculture plantations	✘	✘	✘	✘
	(C) Extraction of medicinal plants (with strict regulations)	✘	✘	✓	✓
	(D) Forest improvement through VFCs	✓	✓	✓	✓
	(E) NTFP collection	✓ (Strict regulation by department)	✓	✓	✓
3	**AGRICULTURE**				
	(A) Agro forestry	✓	✓	✓	✓
	(B) Organic farming	✓	✓	✓	✓
	(C) Land use change / Encroachments	✘	✘	✘	✘
	(D) Genetically modified crops	✘	✘	✘	✘
	(E) Animal Husbandry	✓	✓	✓	✓
4	**HORTICULTURE**				
	(A) Organic farming	✓	✓	✓	✓
	(B) Nitrogen and Phosphorus (N&P) fertilizers	✘	✘	✘	✓ Dosage as prescribed by Agriculture department
	(C) Endosulfan	✘	✘	✘	✘
	(D) Pesticide	✘	✘	✘	✓
	(E) Watermelon & Muskmelon farming	✘	✓	✓	✓
5	**INDUSTRIES (Larger scale)**				
	(A) Agro processing industries	✓	✓	✓	✓
	(B) Information Technology industries (IT)	✘	✘	✓	✓
	(C) Red category (Polluting) industries	✘	✘	✘	✘
	(D) Garment industries	✘	✘	✓	✓
	(E) New establishment of Industries	✘	✘	✘	✓ (Allowed only after critical review by local stake holders and experts)
	(F) Nonpolluting (Green) Industries	✘	✘	✓	✓

6	**INDUSTRIES (Small scale)**				
	(A) Garment industries	✗	✓	✓	✓
	(B) Domestic (Home based) industries a. Papad	✓	✓	✓	✓
	b. Mango processing	✓	✓	✓	✓
	c. Areca nut processing & Coir industries	✗	✓	✓	✓
	d. Milk products and processing	✓	✓	✓	✓
	e. Dry fruits & Spices	✓	✓	✓	✓
	f. Fruit processing (Ex: Kokum Juice *(Garcinia indica)*)	✓	✓	✓	✓
	g. Fish products processing	✓	✓	✓	✓
	h. Bee keeping and bee nurseries	✓	✓	✓	✓
	i. Pongamia plantations for biofuel (in private lands)	✗	✓	✓	✓
	j. Bio pesticides manufacturing	✗	✓	✓	✓
	k. Poultry farms and powdered eggs	✗	✓	✓	✓
	l. Vegetable dyes; fruits and vegetables preservation	✓	✓	✓	✓
	m. Medicinal plants cultivation and processing	✓	✓	✓	✓
	n. Aromatic plants and essential oil distillation; orchids and cut flowers harvesting industries	✗	✓	✓	✓
7	**TOURISM INDUSTRY**				
	(A) Ecotourism	✗	✓	✓	✓
	(B) Organic village and home stay	✓	✓	✓	✓
	(C) VFC managed tourism	✓	✓	✓	✓
	(D) VFC managed home stay tourism in higher forest cover regions and protected areas	✗	✓	✓	✓
	(E) Arts and handicrafts museum and trade center	✓	✓	✓	✓
8	**MINING AND MINERAL EXTRACTION**				
	(A) Iron ore	✗	✗	✗	✗
	(B) Manganese	✗	✗	✗	✗

	(C) Bauxite	✗	✗	✗	✗
	(D) Limestone	✗	✗	✗	✓
	(E) Quartz	✗	✗	✗	✓
	(F) Sand extraction (on sustainable basis by Ban on exporting)	✗	✗	✓	✓
9	**WASTE DISPOSAL**				
	(A) Hazardous waste processing units	✗	✗	✗	✗
	(B) Solid waste disposal	✗	✗	✗	✓ (For composting and manure preparation)
	(C) Liquid waste discharge	✗	✗	✗	✓ (Treatment plants (STP) for processing)
	(D) Recycling and waste processing and units	✗	✗	✗	✓ (compliant with PCB)
10	**TRANSPORTATION**				
	(A) Roads and express ways	✗	✗	✗	✓ (Allowed only after strict EIA)
	(B) Rail and freight corridors	**Subject to EIA; Strict regulation and social audit**			
	(C) Up gradation of existing infrastructure	✗	✗	✓ (Subject to EIAs, strict regulation and social audit)	✓

Remarks

- The ESR-1 represents zone of highest conservation, no further degradation allowed. ESR-2 has the potentiality to become as ESR-1 provided with strict regulations and improvement of forests and its environs by more protection. A small change in ESR-2 will have more adverse effects in ESR-1.
- Forest Rights Act to be implemented in its true spirit by reaching out to people.
- Monoculture plantations are not allowed, existing exotics should be replaced by planting endemic species.
- Promote decentralized electricity, use of renewable energy sources such as (solar, wind power).
- The local bio resource based industry should be promoted. All should be strictly regulated and be subject to social audit.
- Adapt development projects which will have a least environmental impact by involving local community members in decision making and environmental monitoring.
- No new major roads, railway lines are allowed, except when highly essential and subject to EIA, by imposing strict regulation and social audit.
- Tourism Master Plan should be based on MOEF regulations (after taking into account social and environmental costs).
- Controlled activities are permitted based on socio economic importance and activities such as depriving wetlands, natural forests, the introduction of alien invasive species are not permitted.

KTR region is a sensitive habitat for wild flora and fauna. Asper Wildlife Conservation Strategy 2002, Union government had proposed a 10 km buffer region as eco fragile zones (Eco-Sensitive Zones) around protected areas / national parks under Environmental (Protection) Act, 1986. Eco-Sensitive Zones are being specified by the union government as transition zones around protected forest areas, that would minimize forest depletion and human-animal conflict. These are intended to provide habitat improvement, enhance the environmental services, reduce edge effects, connectivity, reducing fragmentation of forests and also provides a physical barrier from human encroachment. Eco-Sensitive Zones are areas adjacent to protected areas/ national parks, on which land use is partially restricted to give an added layer of protection while providing valued benefits to neighboring rural communities. But, in the last two years due to various political pressures, the Environment Ministry approved a reduction of Eco-Sensitive Zones (from 10 km to 100m) by a series of notifications for a number of national parks and wildlife sanctuaries. Honorable Supreme Court while taking serious objections to these senseless reductions, has directed that a 10-km limit was to be treated as the Eco-Sensitive Zones. The guidelines for Eco-Sensitive Zones proposed that the boundary had to be site specific, decided in consultation with a field based team comprising representatives from the forest department, revenue department and Panchayat Raj institution. The objective of Eco-Sensitive Zones are not anti-people and do not intend to hamper their everyday activities. But, it makes sure under a legal framework to support ecologically sensitive habitats from further degradation of forests.

In the case of KTR, there is a serious move of reducing its Eco-Sensitive Zone (reduction of area by 75%) to 100 m and also reducing the total area of the reserve by 30 %. In this regard, Figure 26 represent ESR of KTR region with 85 villages covered under three taluks. Annexure 3 provides taluk wise village list for KTR region. Figure 27 represents villages covered in 10 km Eco-Sensitive Zones of KTR region. The eco-sensitive region covers total 155 villages in which 97 falls in ESR-1, 26 falls under ESR-2 and 28, 4 falls under ESR-3,4 respectively (Annexure 4). The Eco-Sensitive Zone needs to be enriched with native species to reduce further degradation. The state government should focus on sustainable development than de-notifying region.

LAND

Figure 6a: Forest cover of Kali river basin

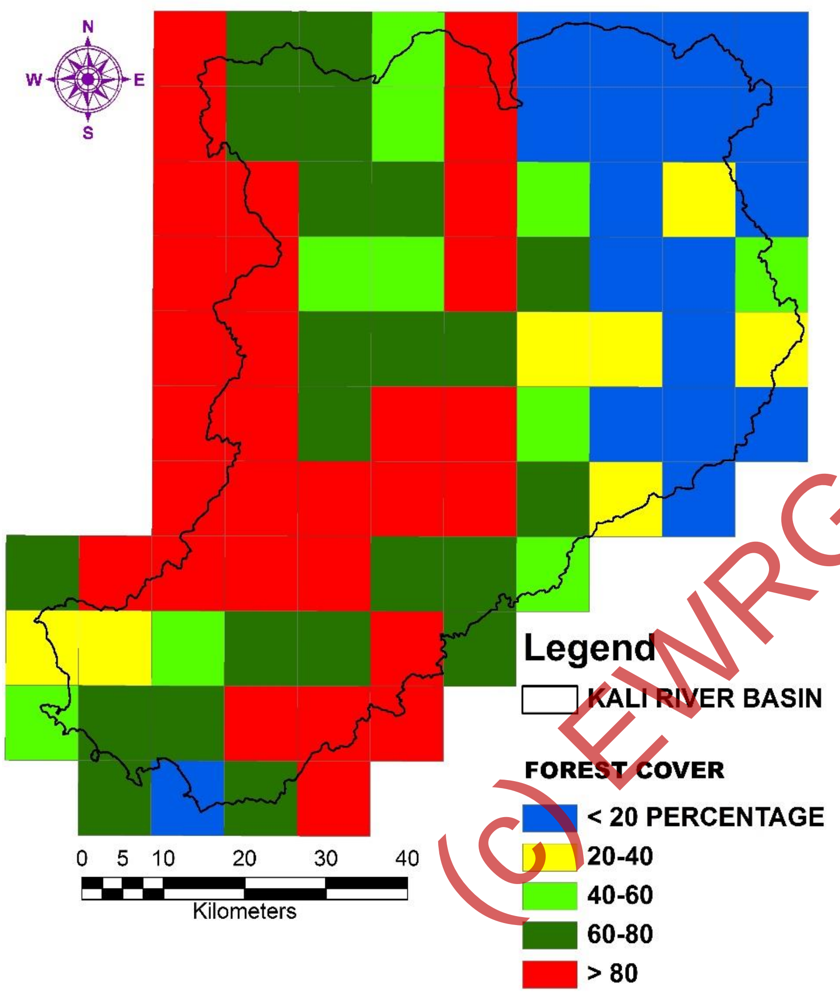


Figure 6b: Forest cover weightage map

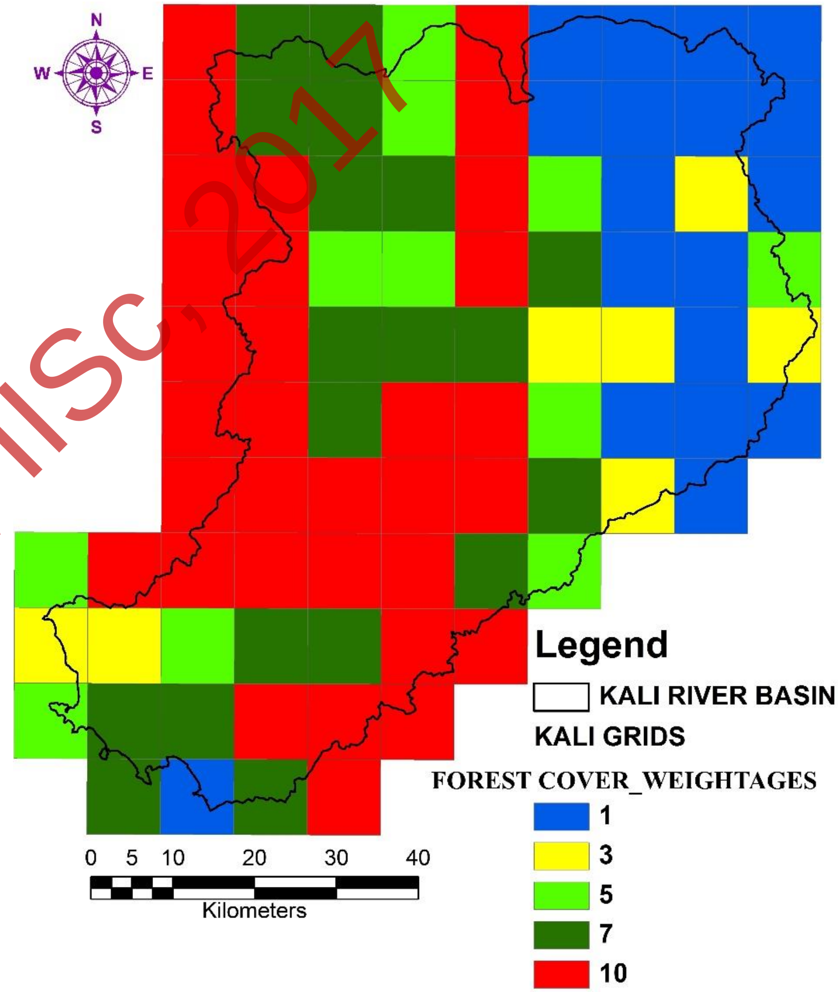


Figure 7a: Interior forest coverage of Kali basin

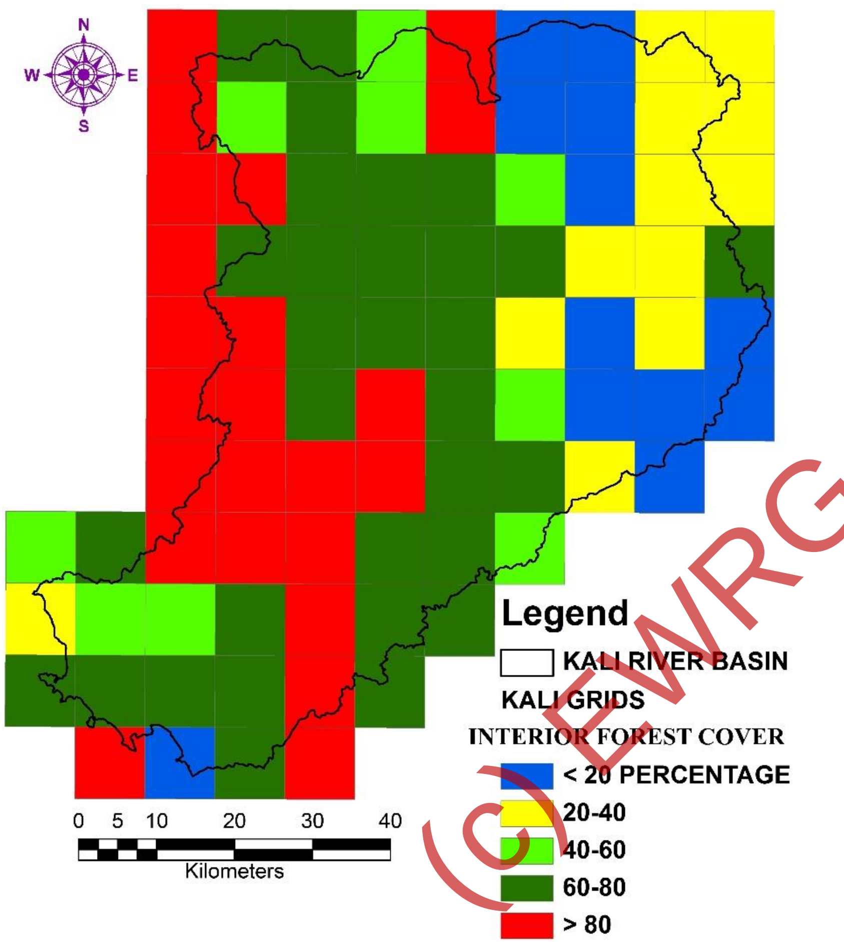
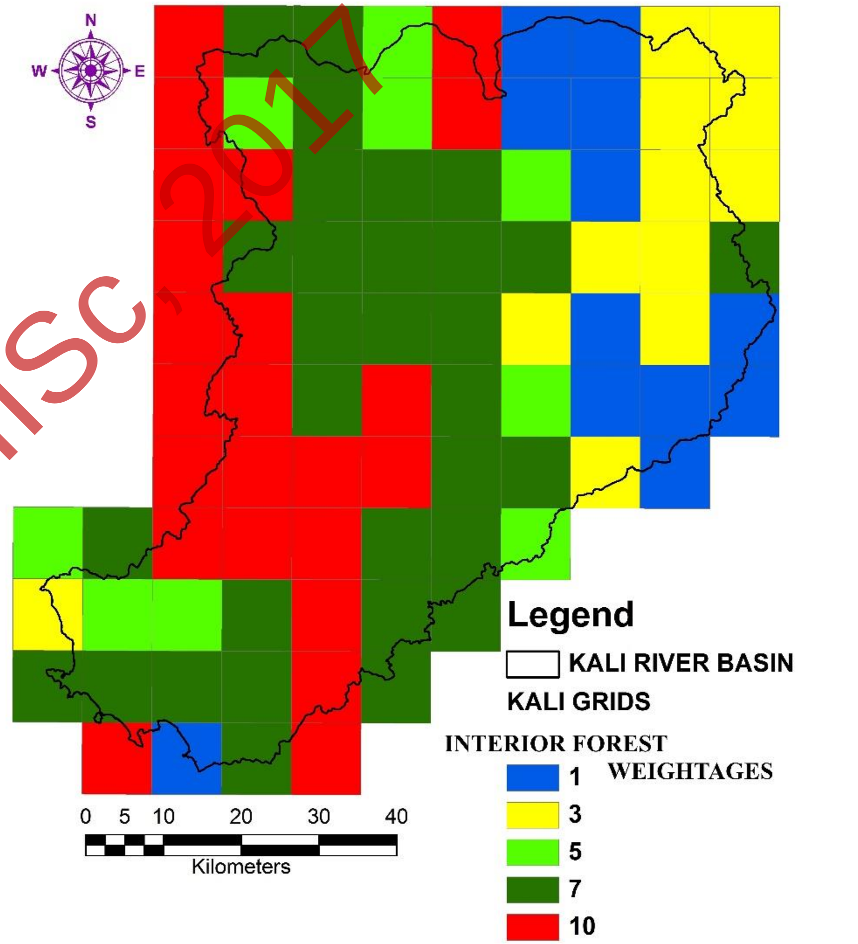


Figure 7b: Interior forest weightage map



Ecology

Figure 8a: Floral diversity of Uttara Kannada

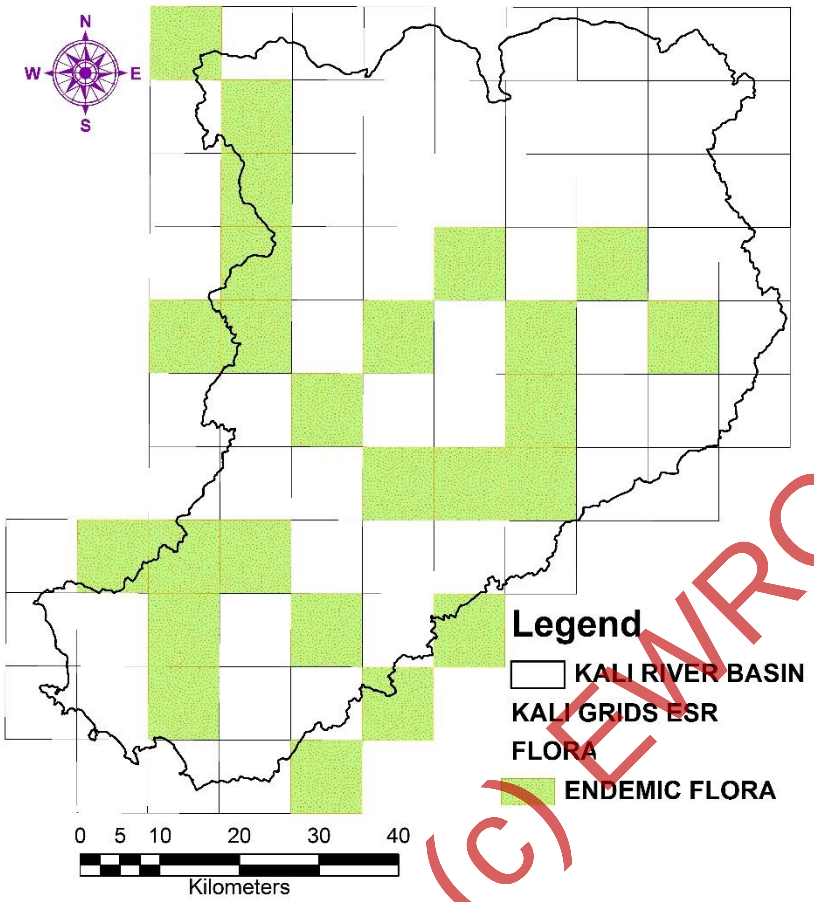


Figure 8b: Weightages of flora

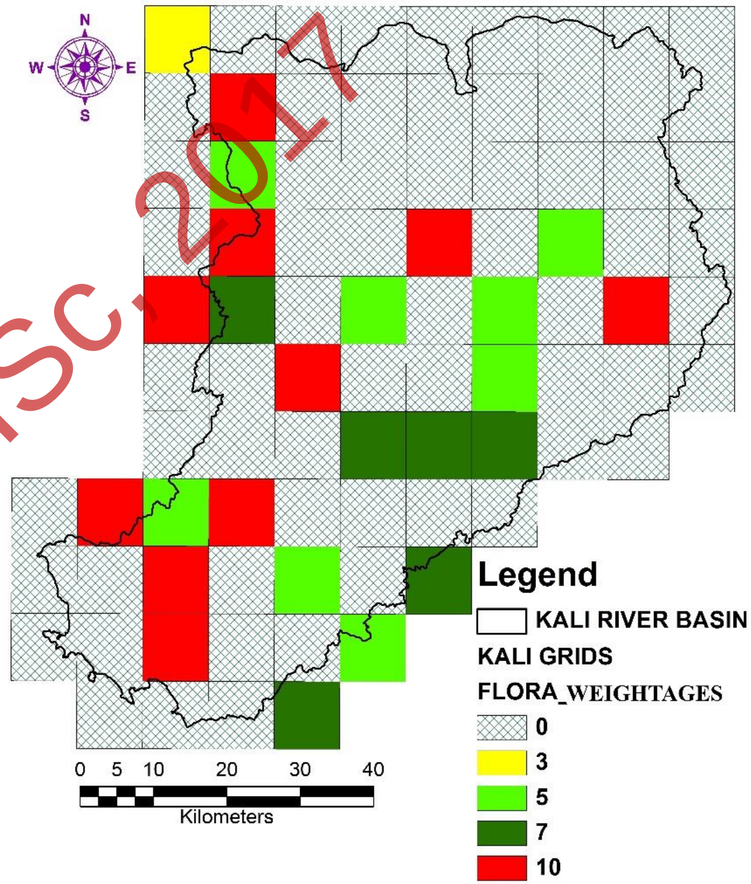


Figure 9a: Faunal diversity

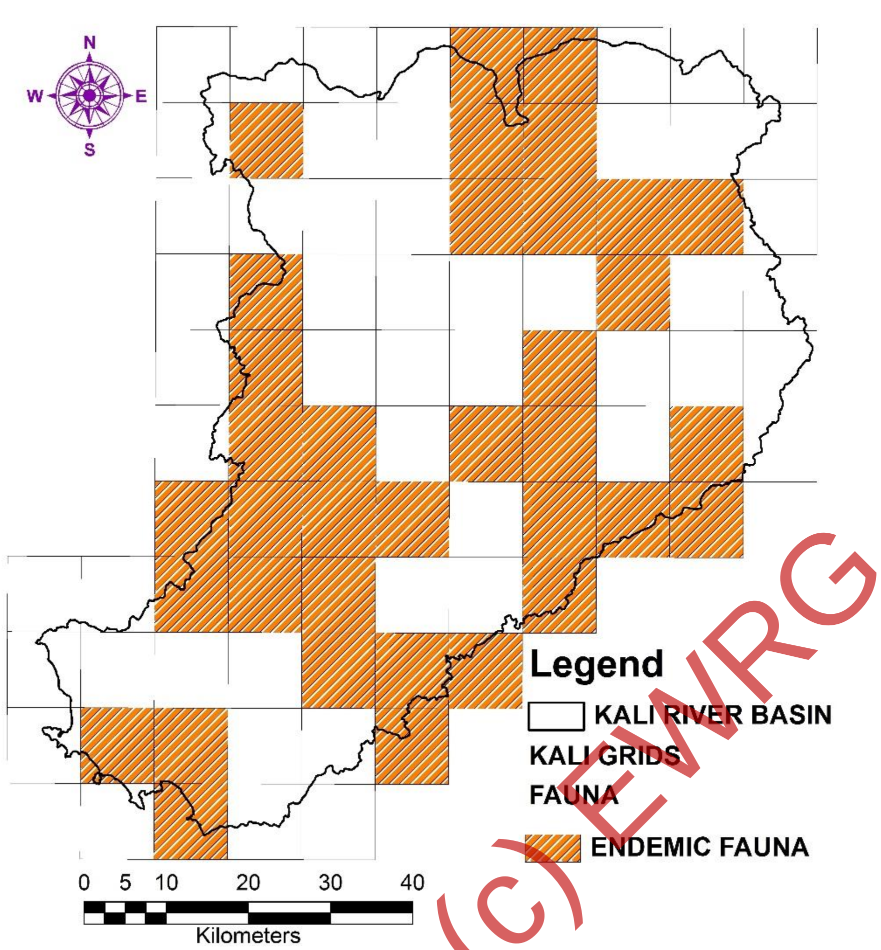


Figure 9b: Weightages of fauna

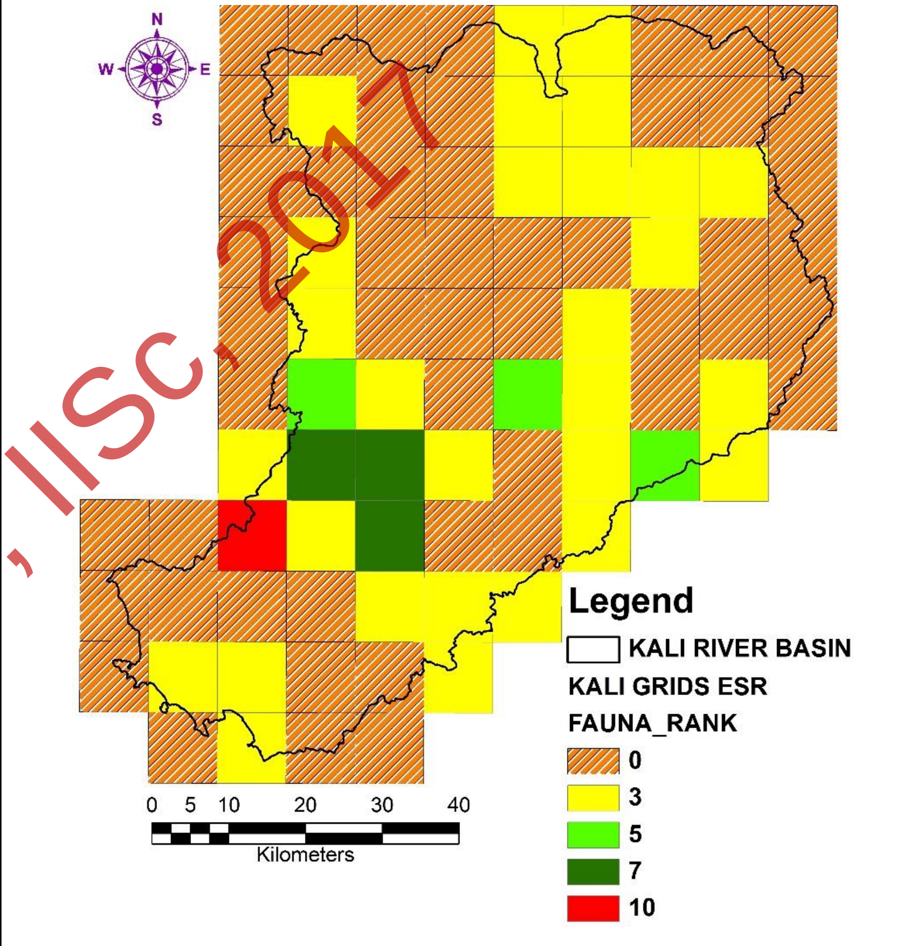


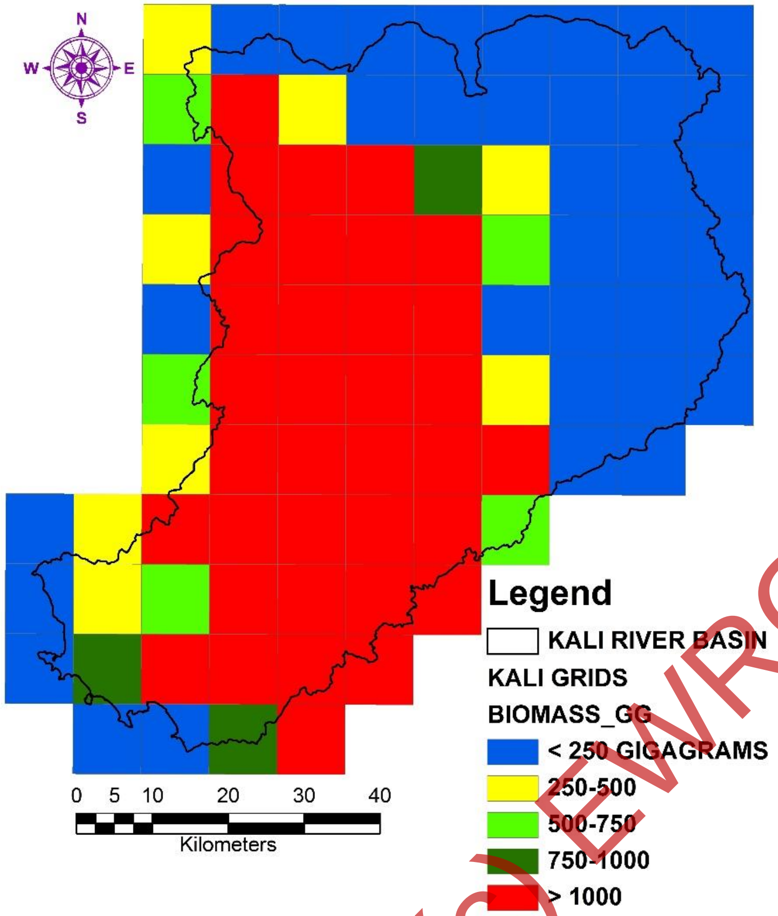
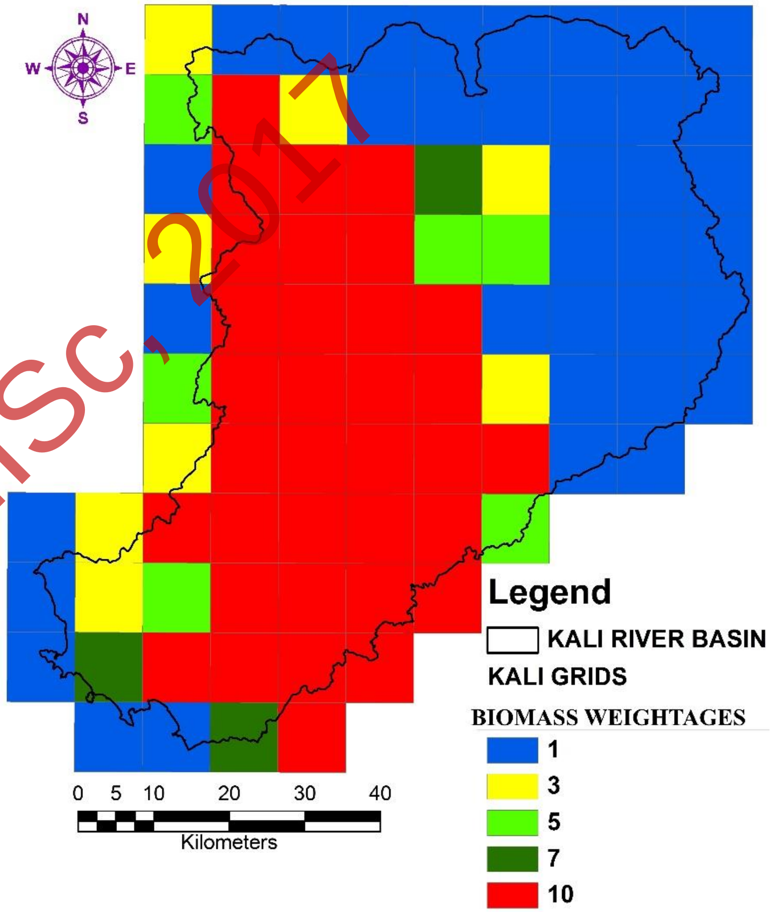
Figure 10a: Biomass of forests in Kali basin	Figure 10b: Biomass weightages of forests
	

Figure 11a: Carbon sequestration in Kali basin

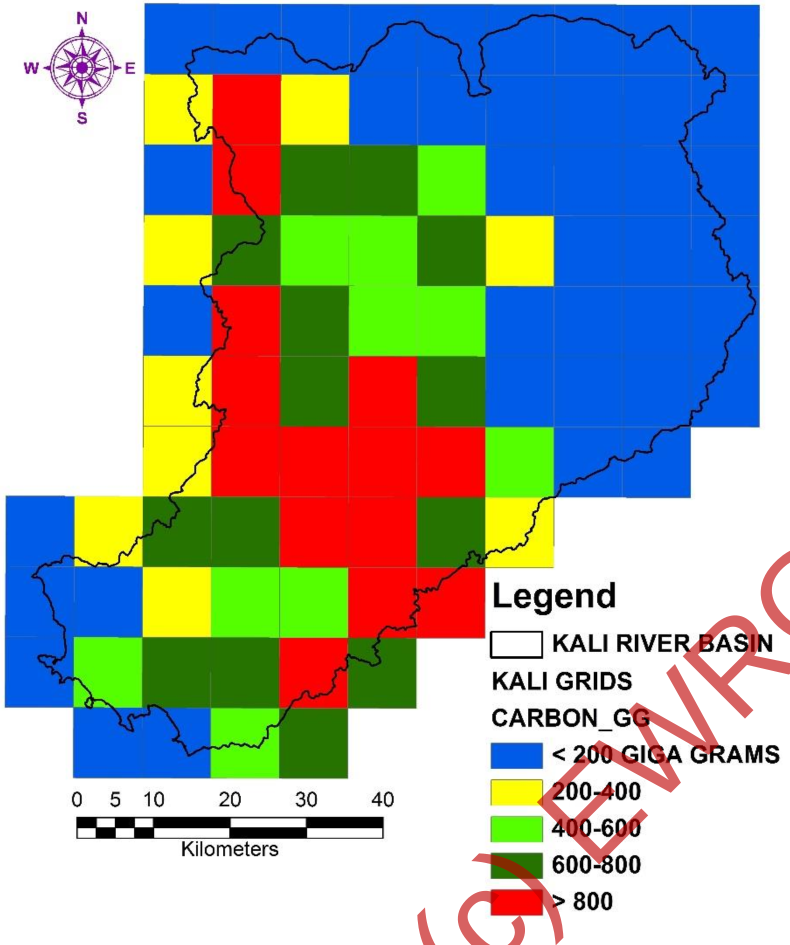


Figure 11b: Weightages

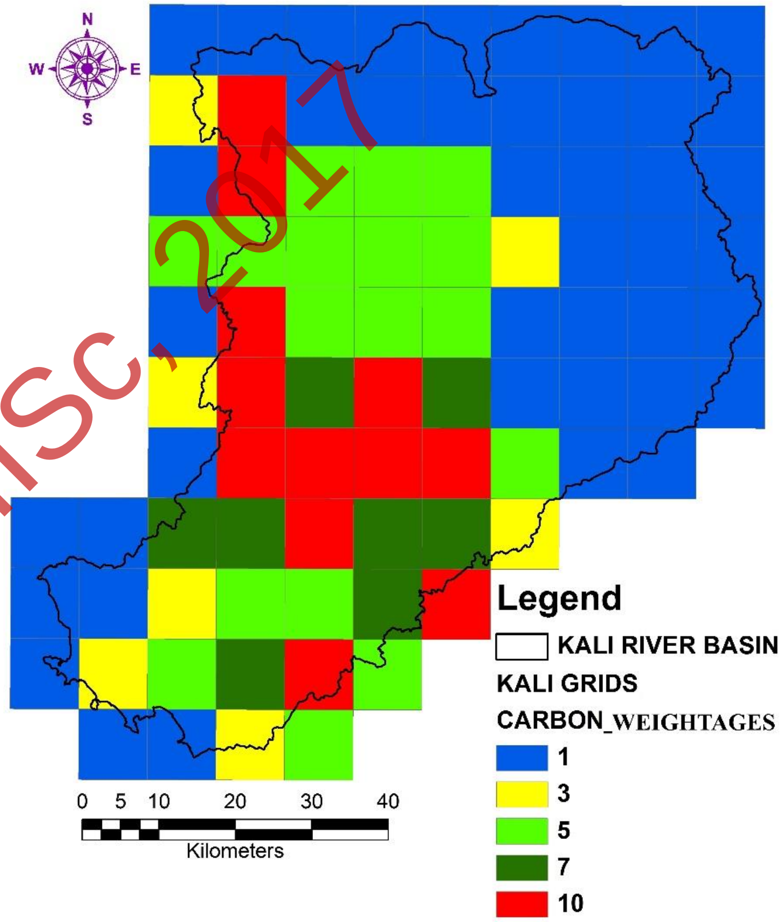


Figure 12a: Conservation reserves of Kali basin

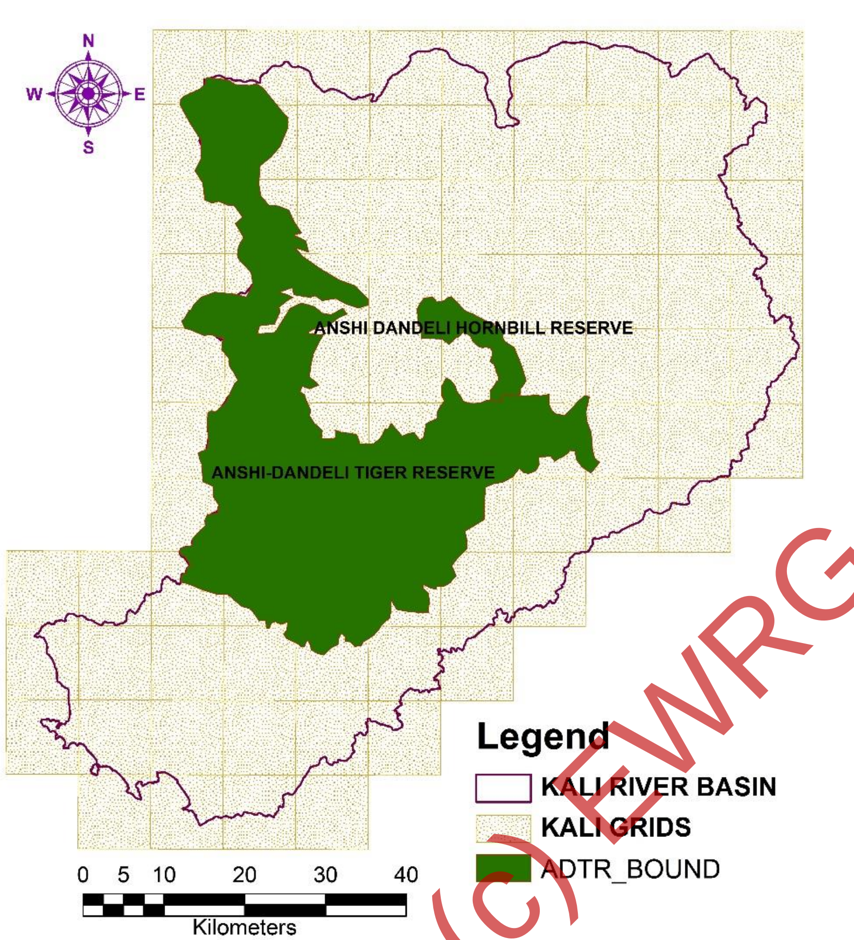
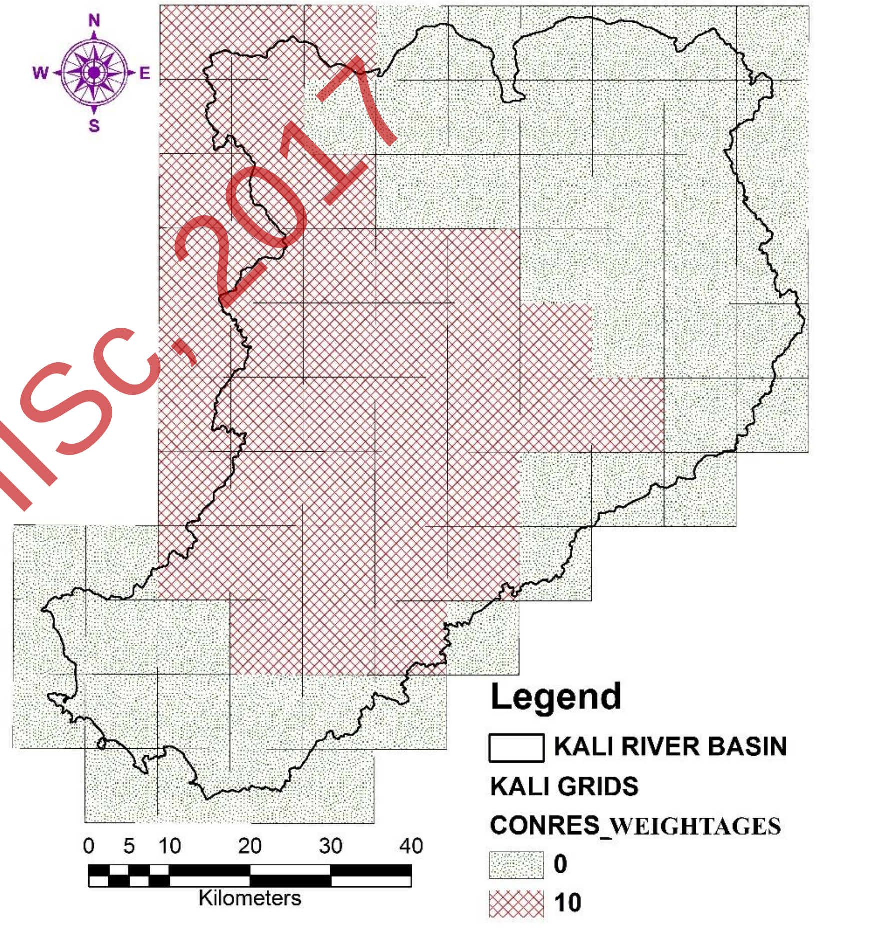
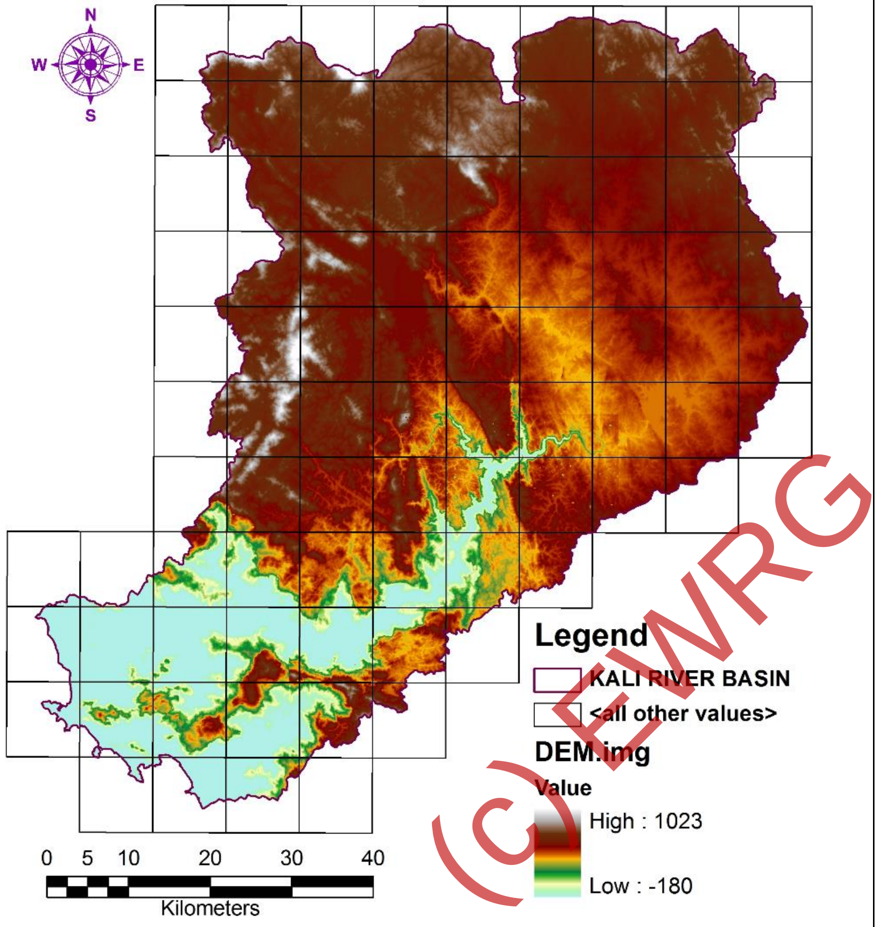


Figure 12b: Weightages of reserves



Geo-Climatic

Figure 13a: Altitude (m) of Uttara Kannada	Figure 13b: Weightages of altitude (m)



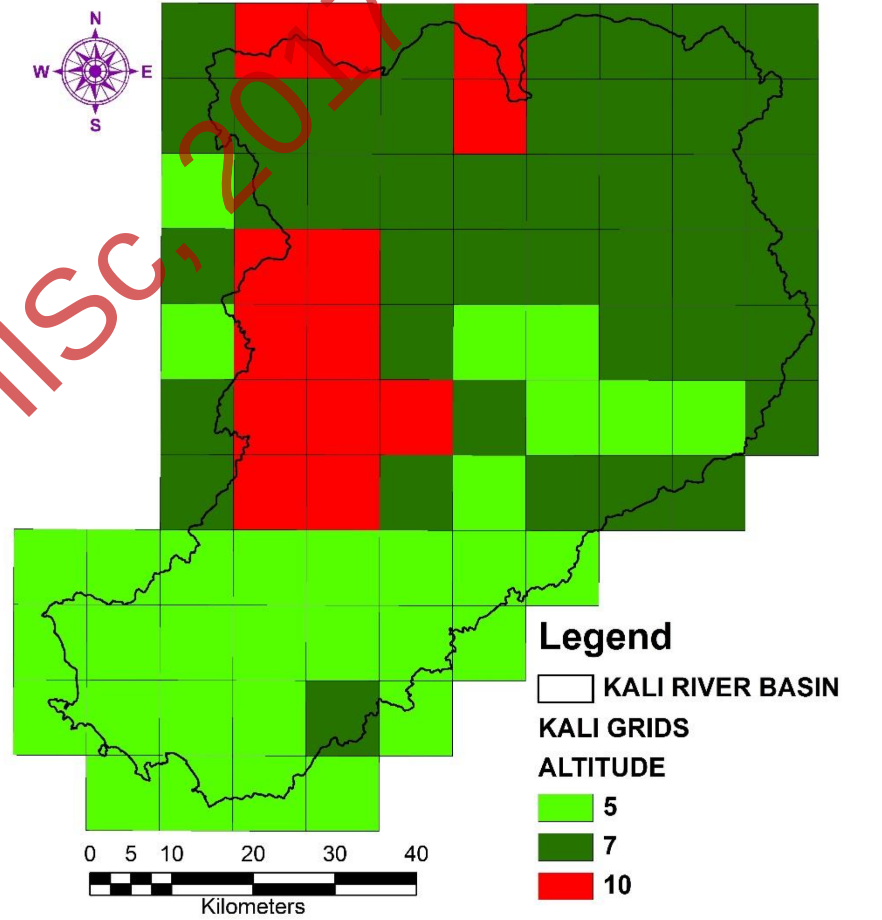


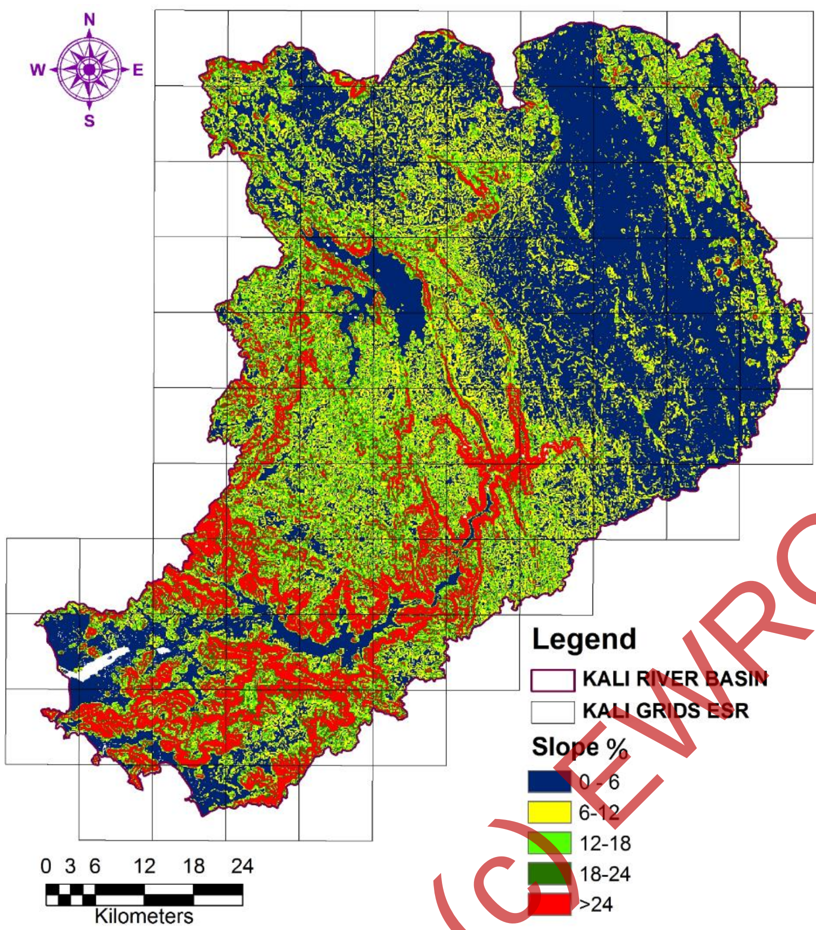
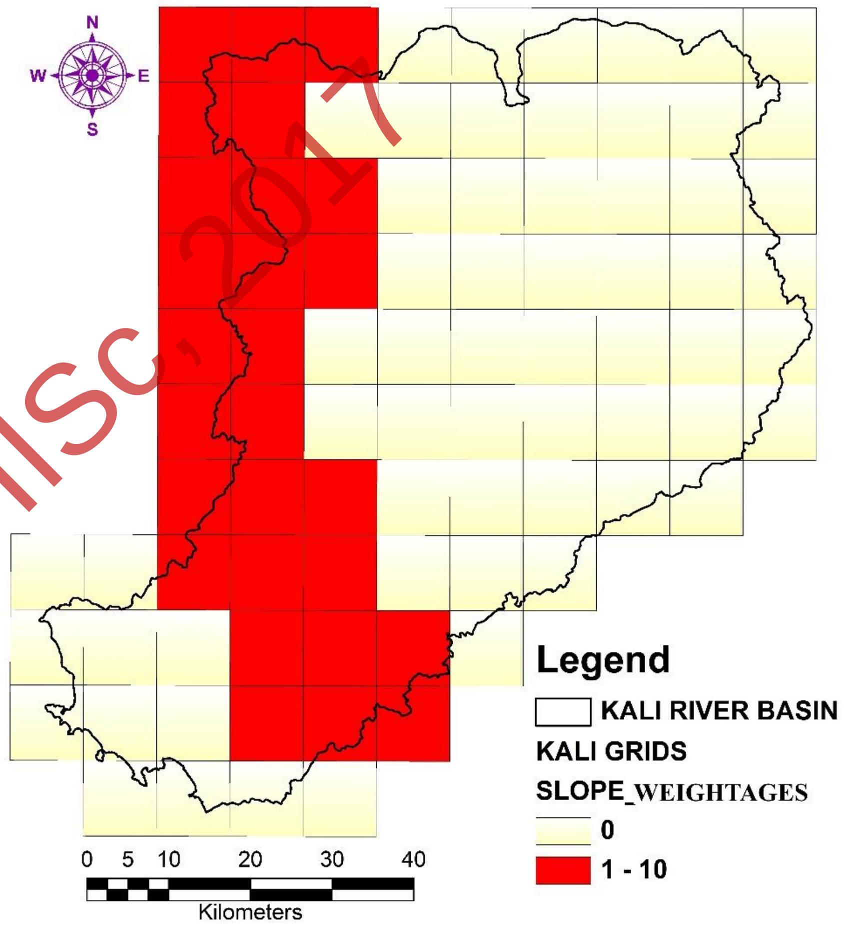
Figure 14a: Slope (%) map of Uttara Kannada	Figure 14b: Weightage map of slope values
	

Figure 15a: Rainfall map of Uttara Kannada

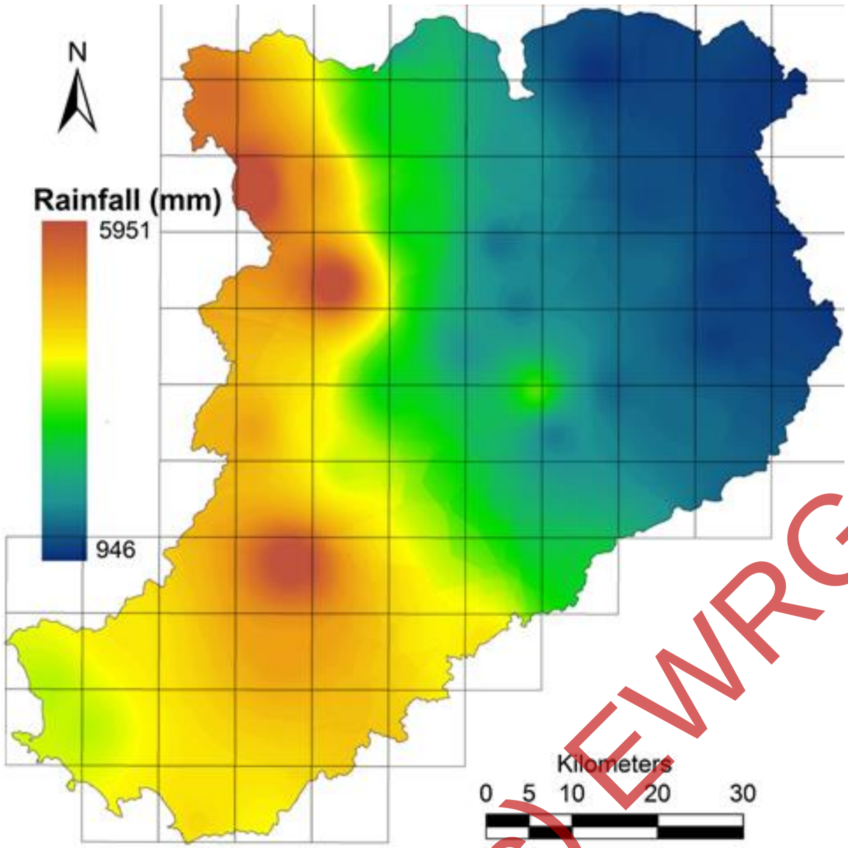
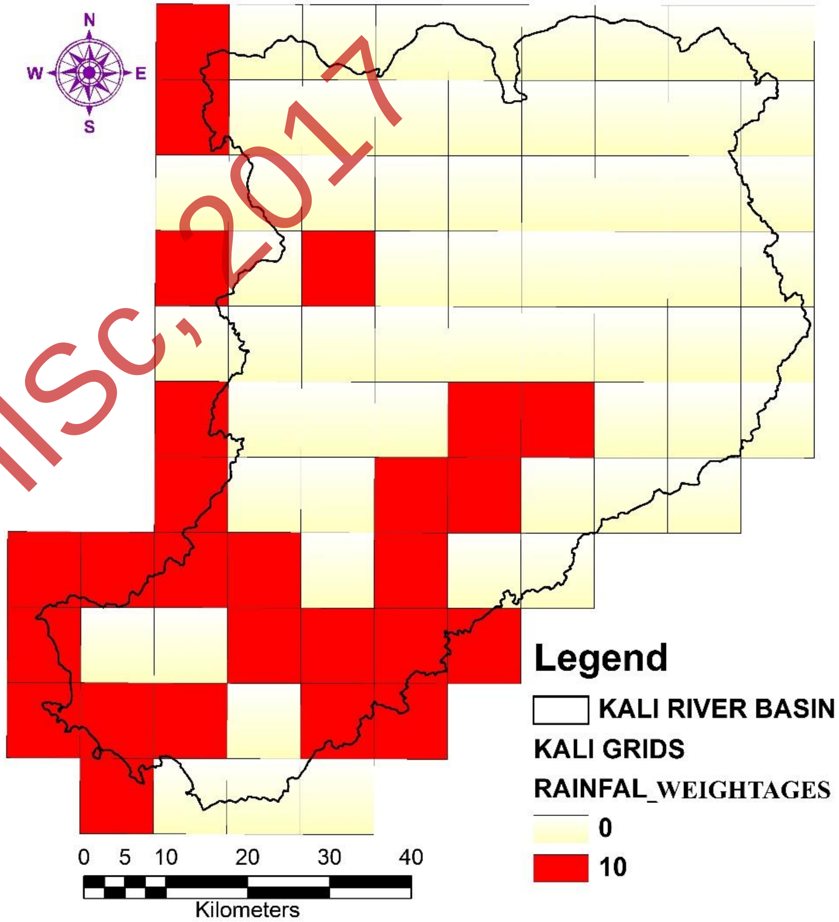
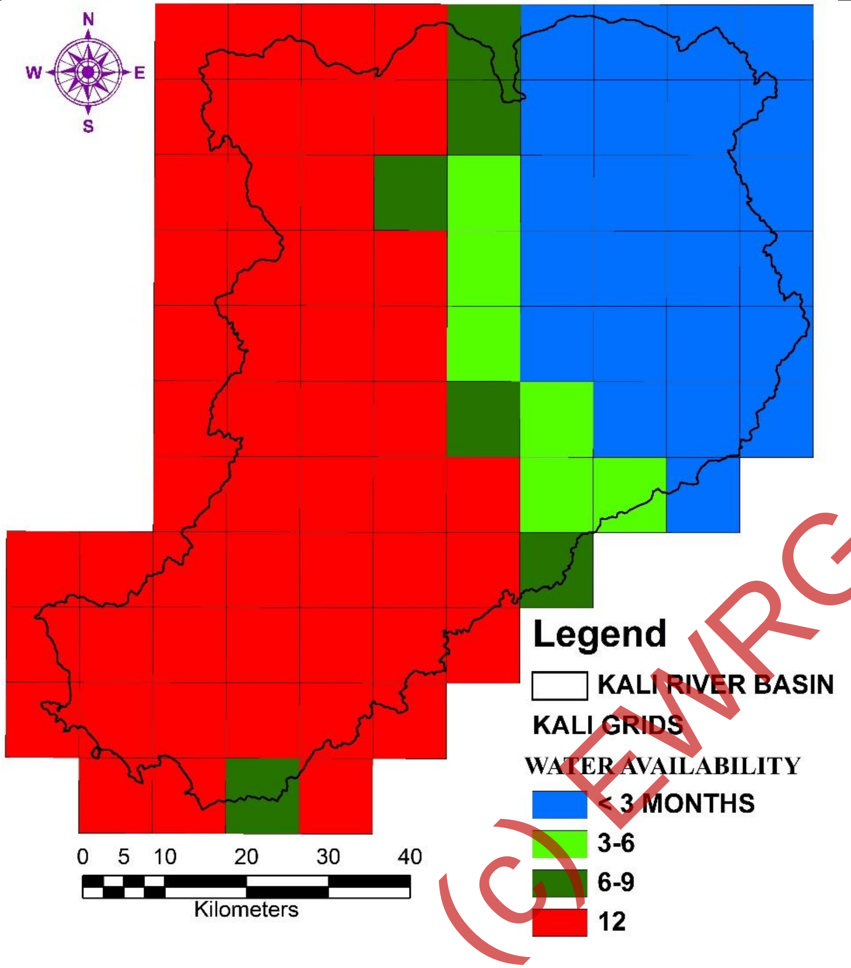
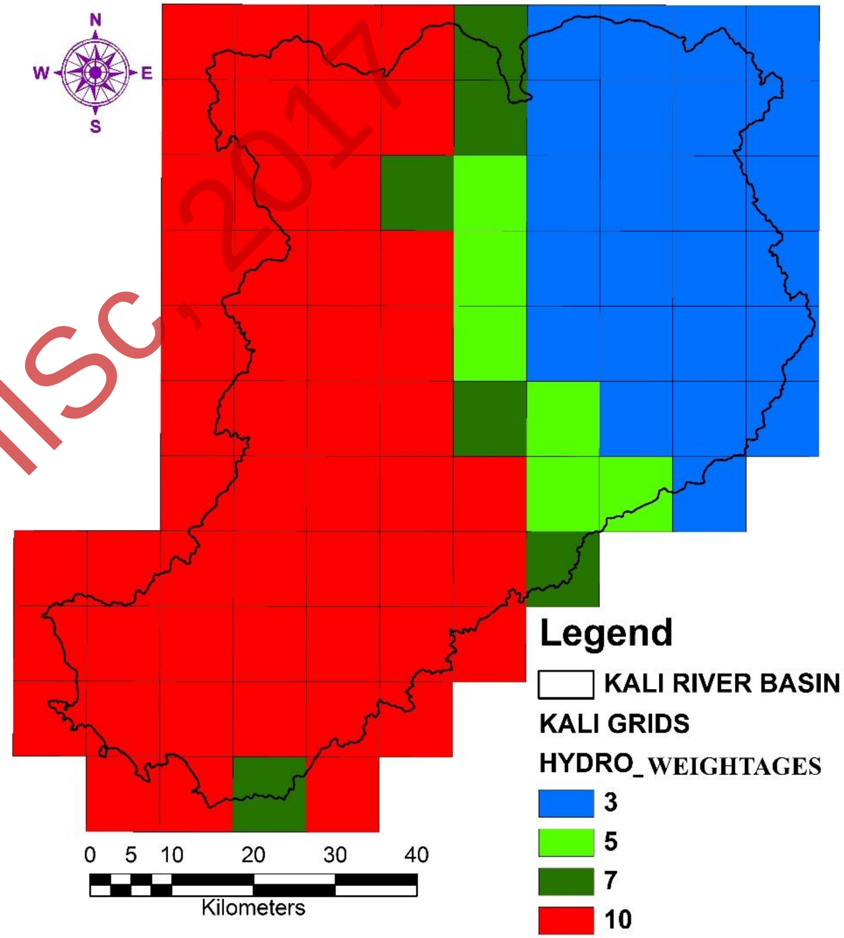


Figure 15b: Weightage map based on rainfall



Hydrology	
Figure 16a: Stream flow status of Uttara Kannada	Figure 16b: Weightages for stream flow





Energy

Figure 17: Solar energy

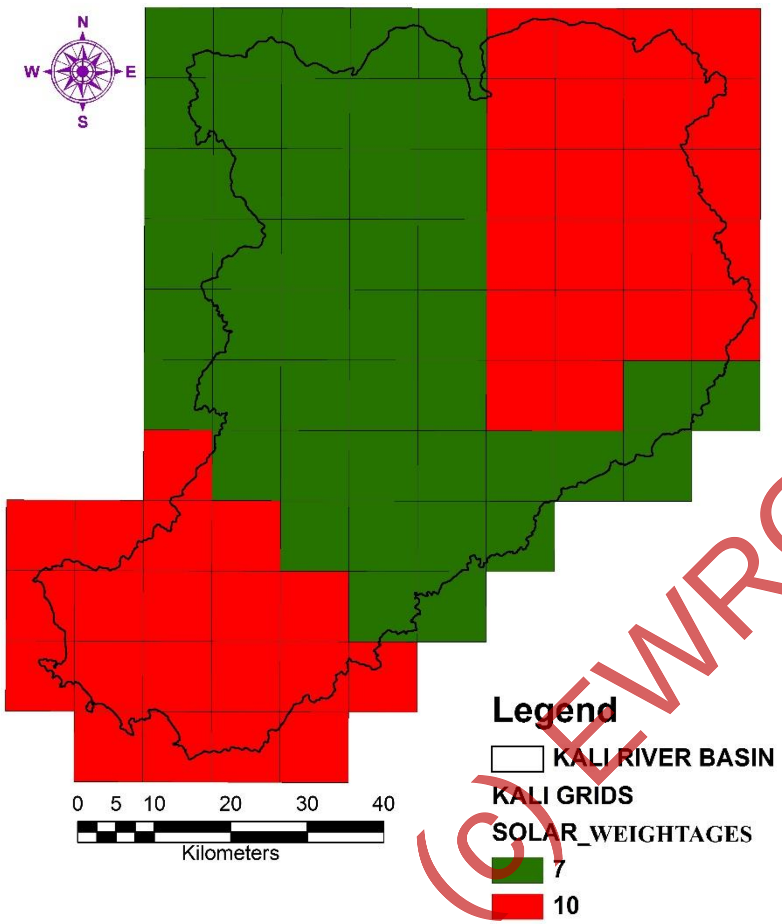


Figure 18: Wind energy

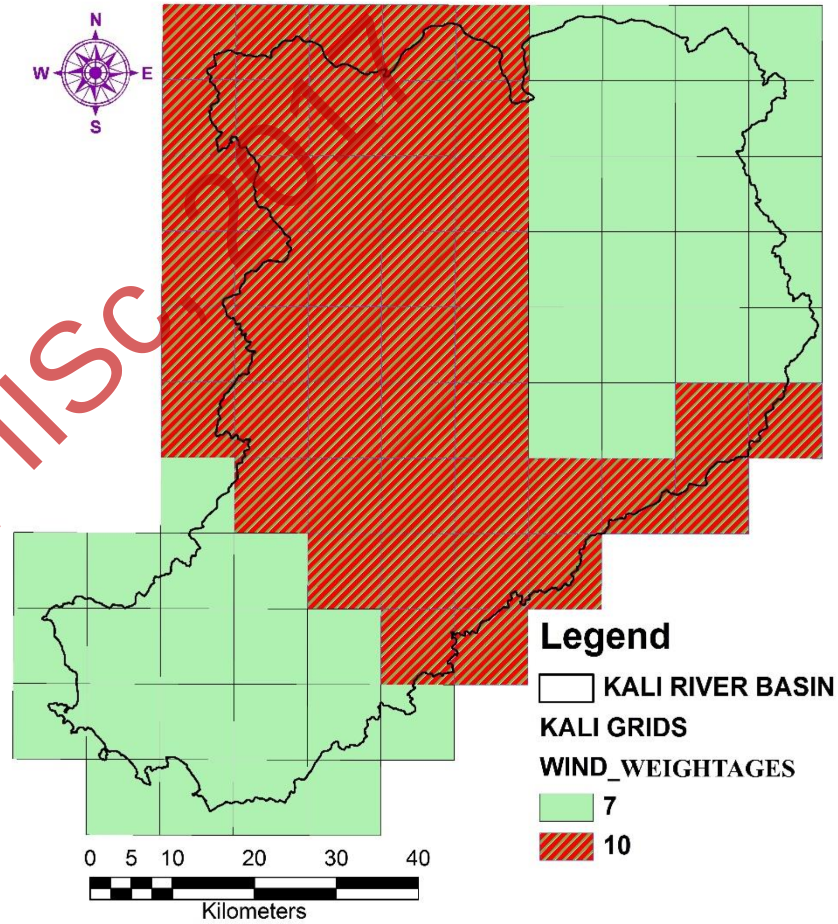


Figure 19(a): Bio energy

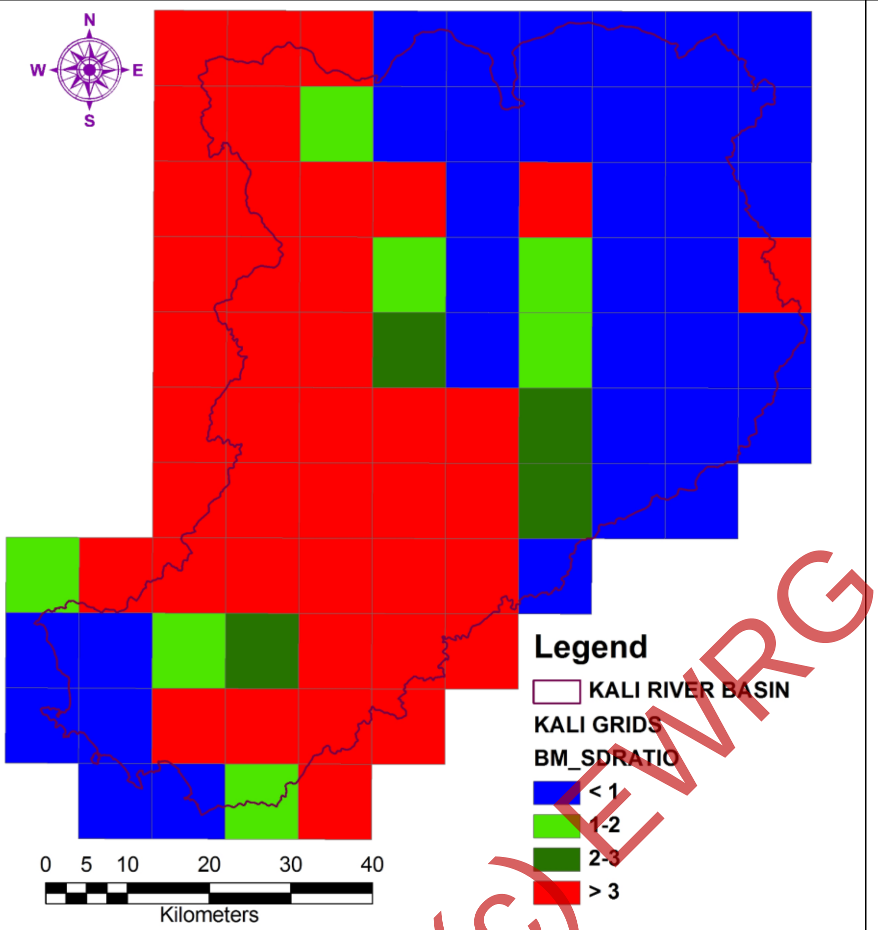
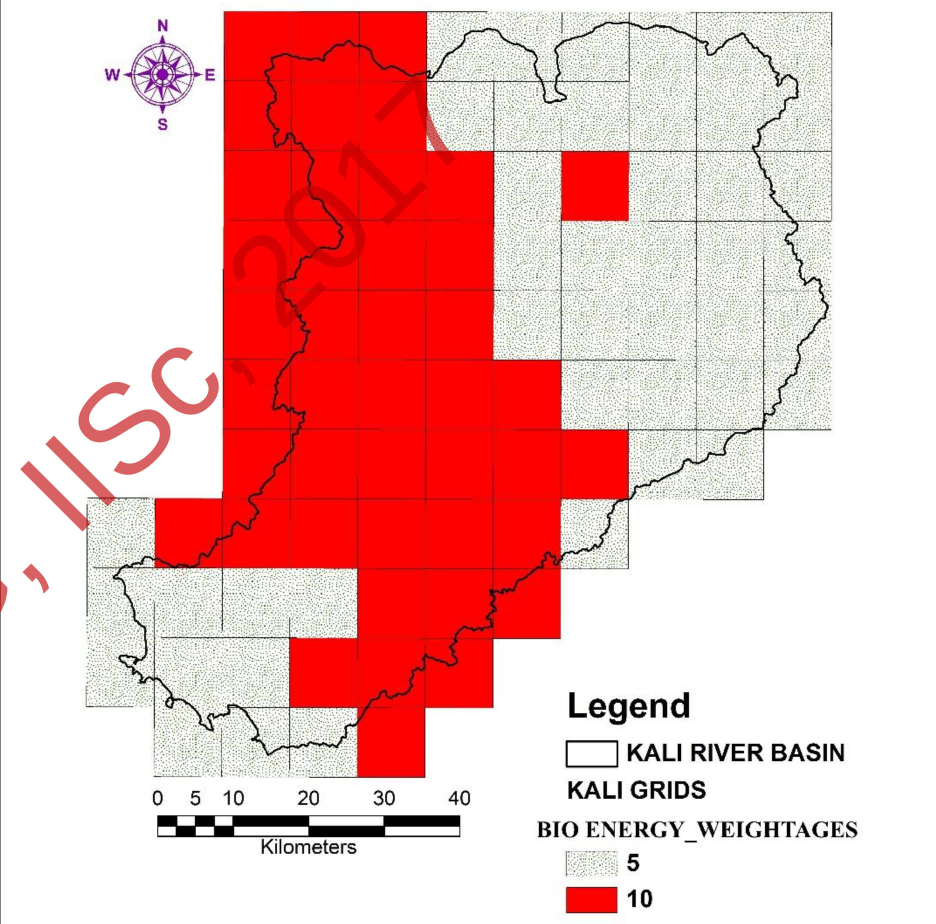


Figure 19(b): Weightages based on productivity



Social aspects

Figure 20a: Forest dwelling communities of Uttara Kannada

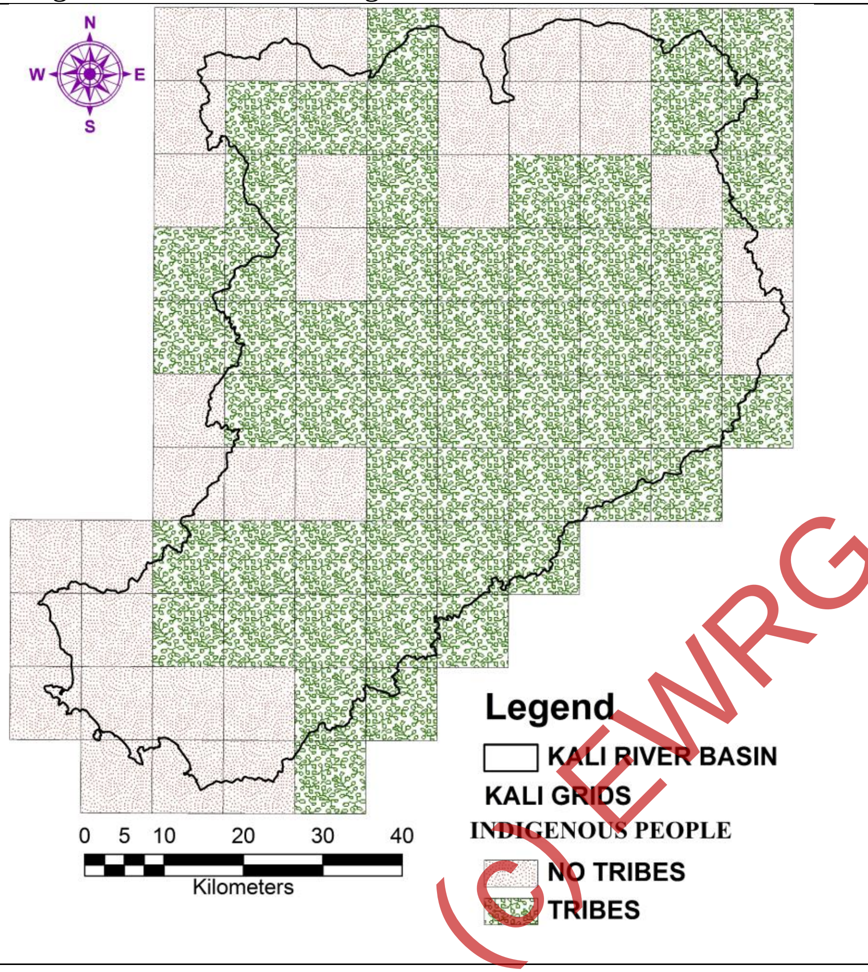


Figure 20b: Weightage map of forest dwelling communities

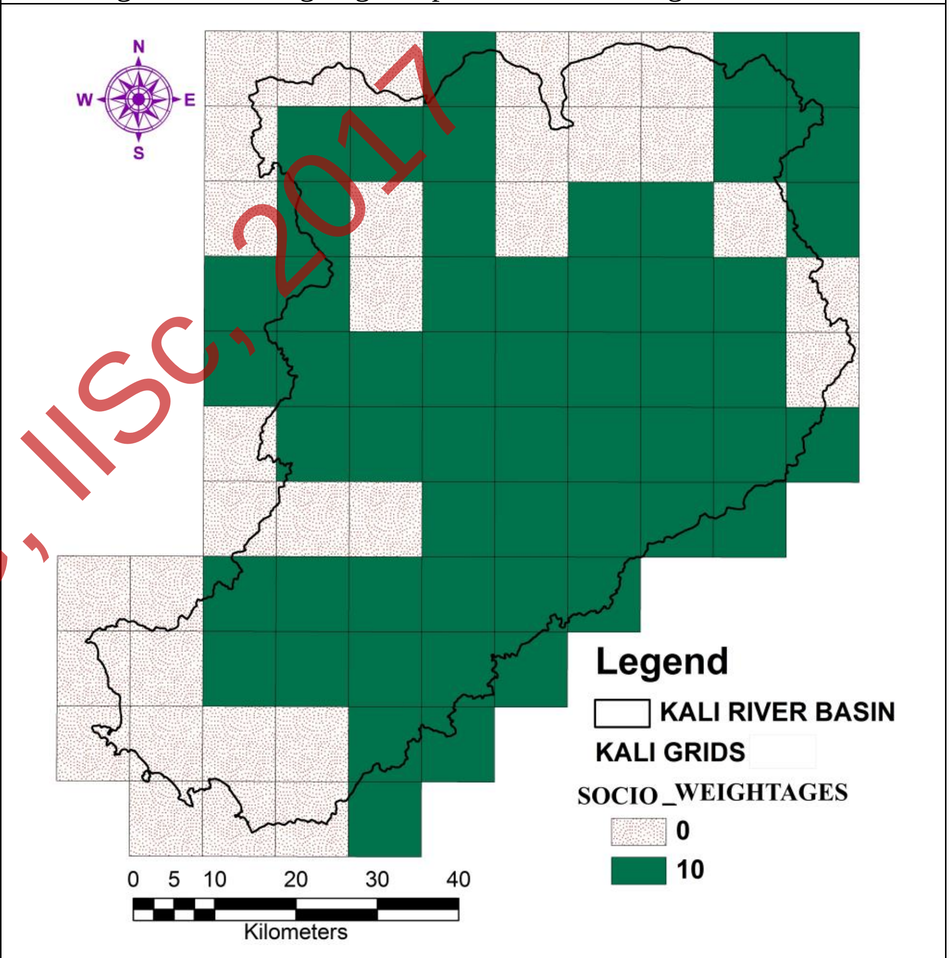
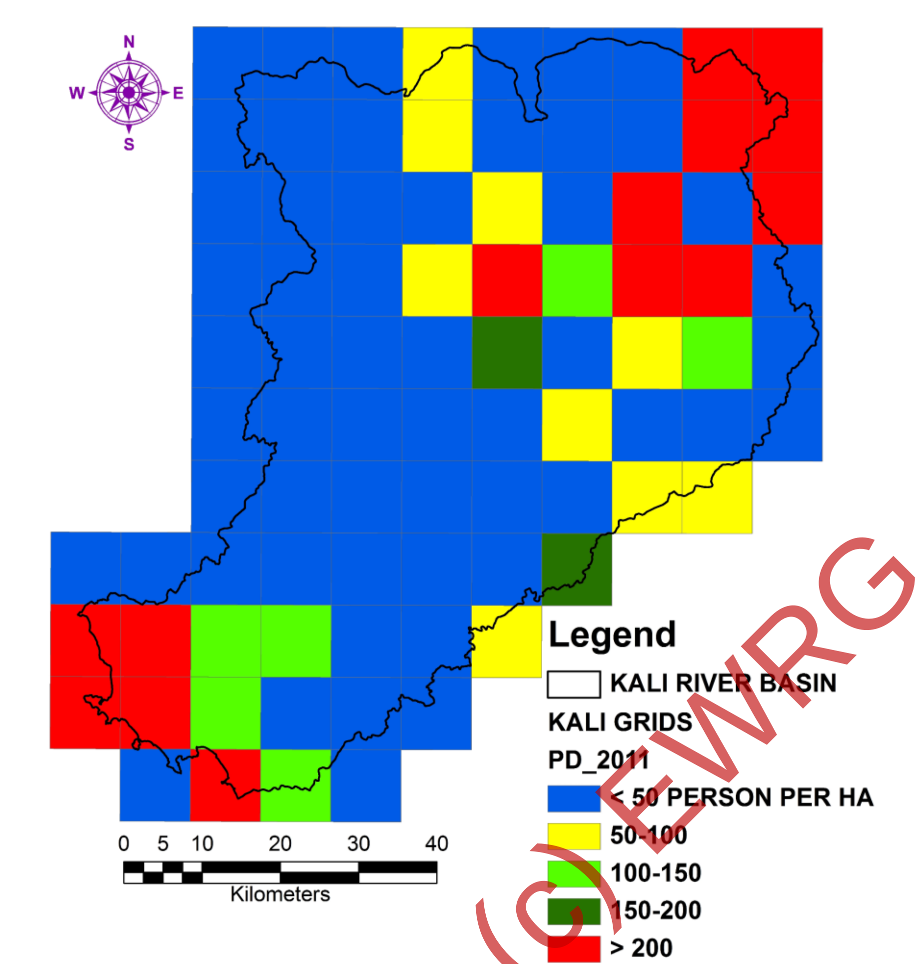
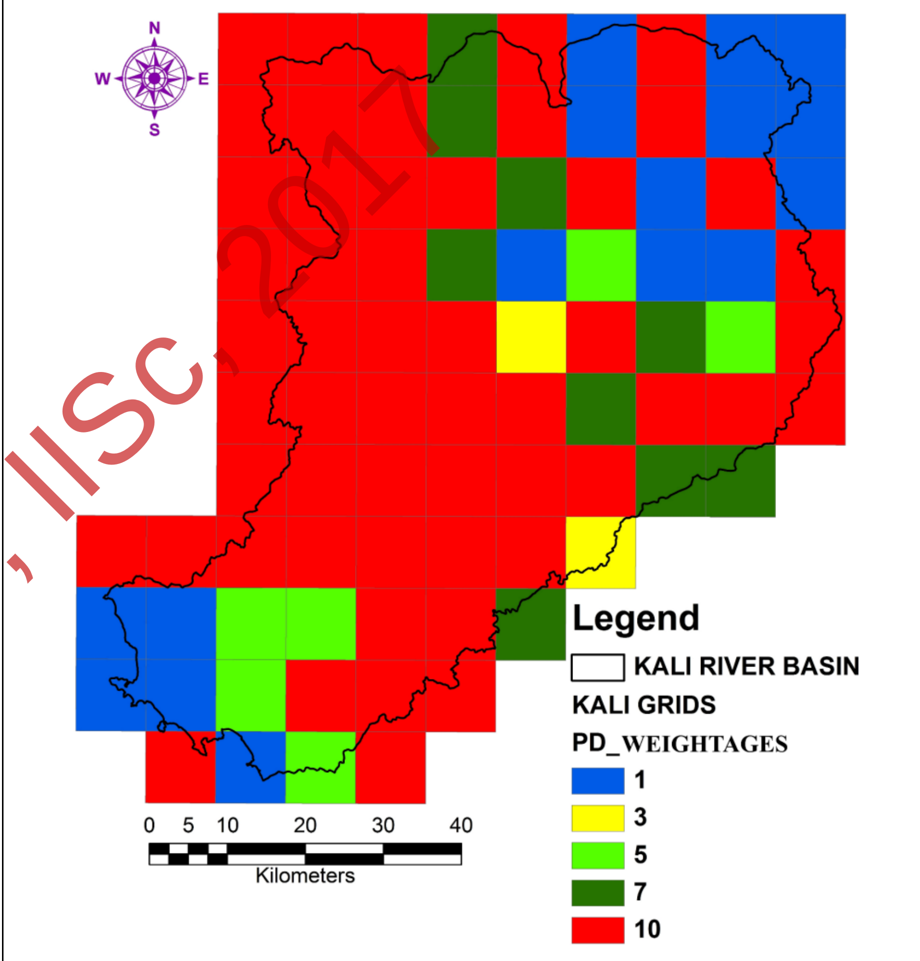


Figure 21a: Population density map	Figure 21b: Weightage associated with population density
	

Estuarine diversity

Figure 22: Estuarine diversity weightage map

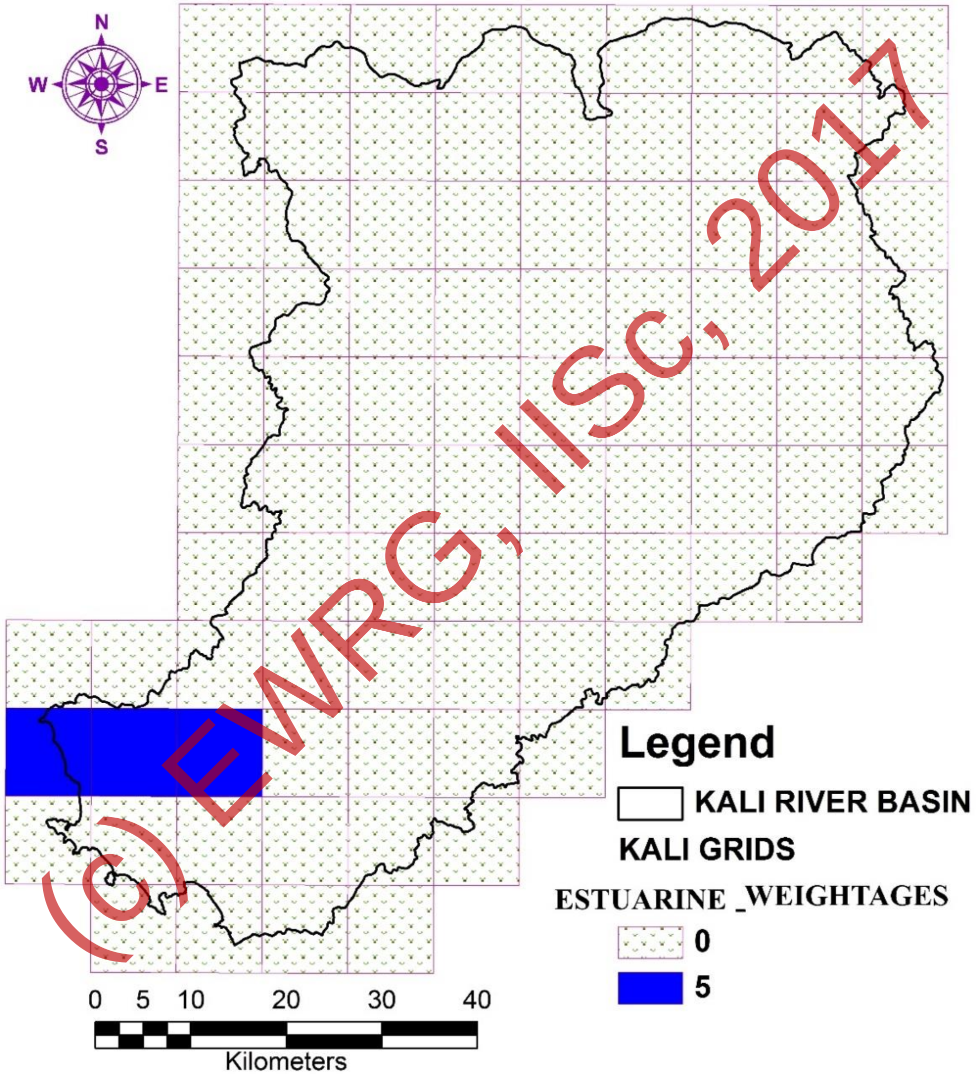


Figure 23: Ecologically Sensitive Regions of Kali river basin

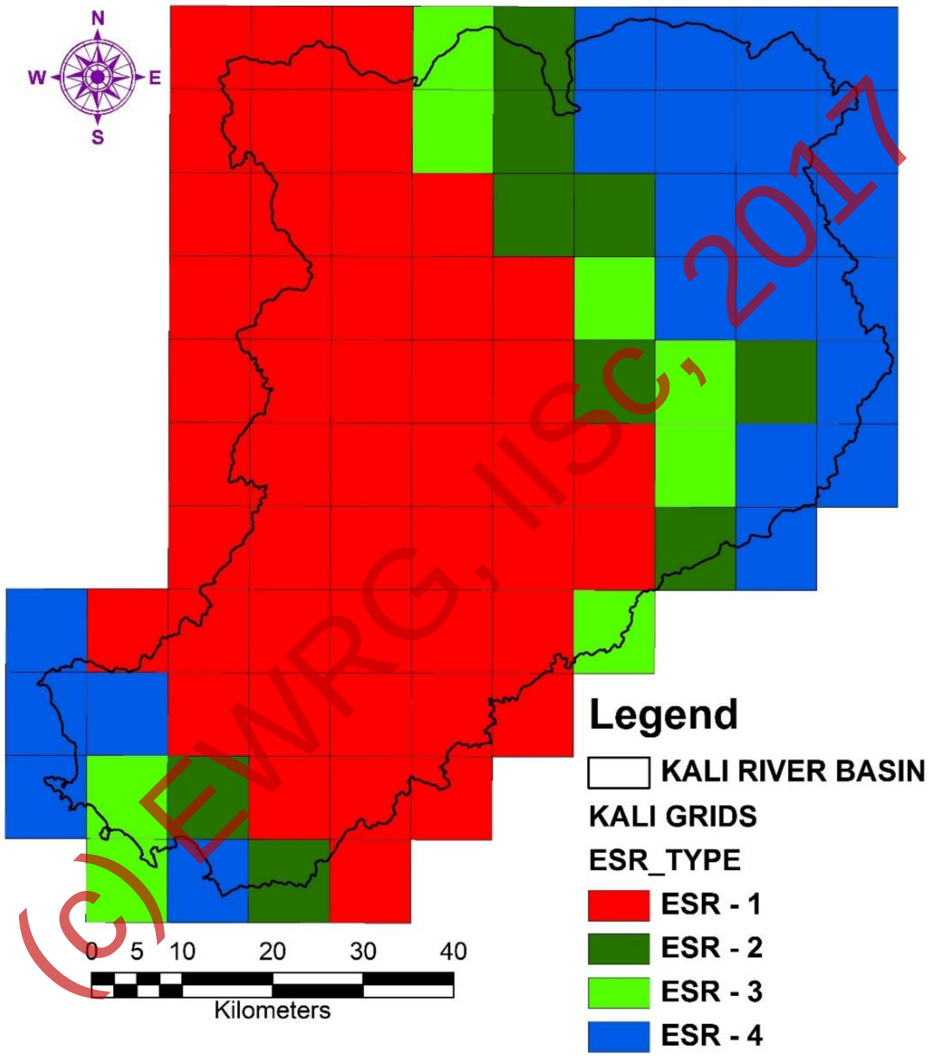


Figure 24: Ecologically Sensitive Regions of across various villages of basin

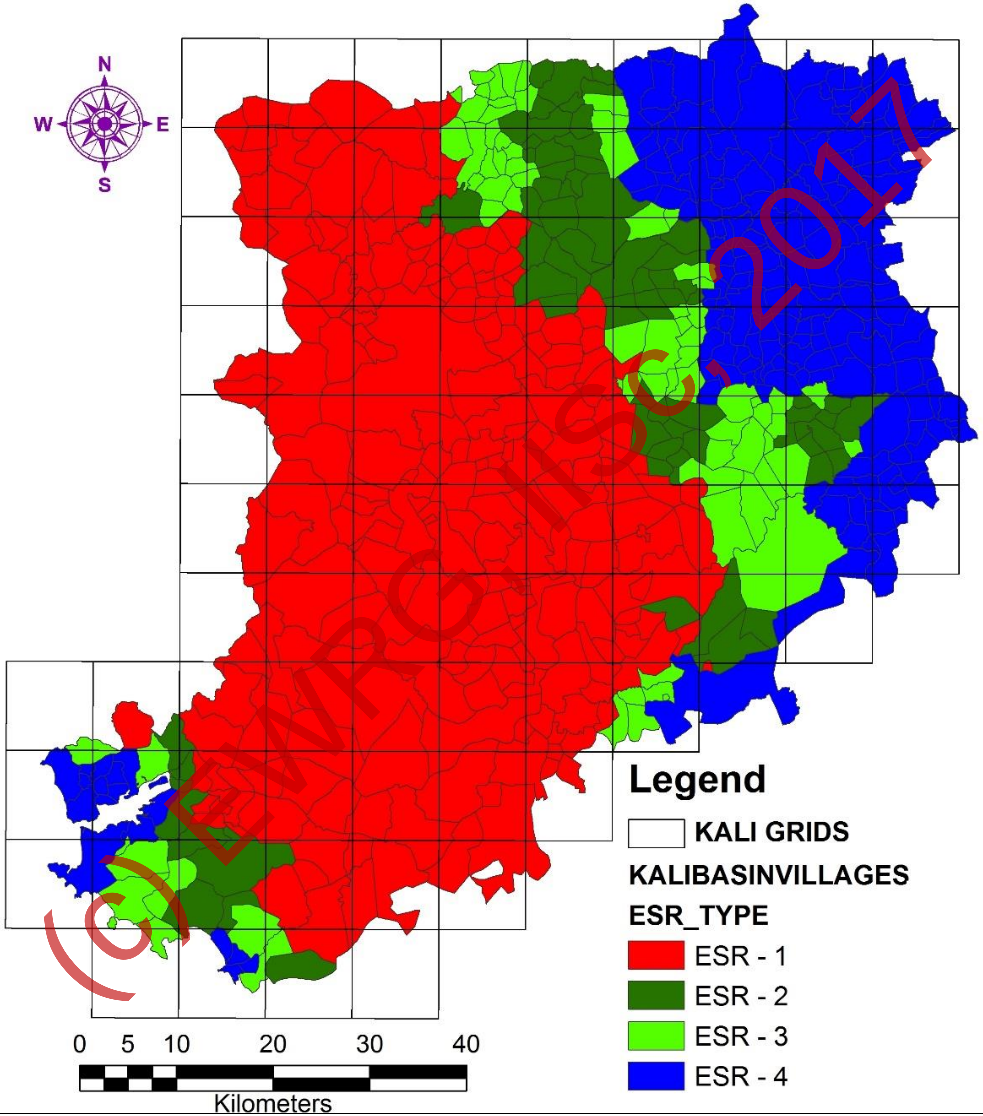


Figure 25: Ecologically Sensitive Regions of and KTR (ADTR)

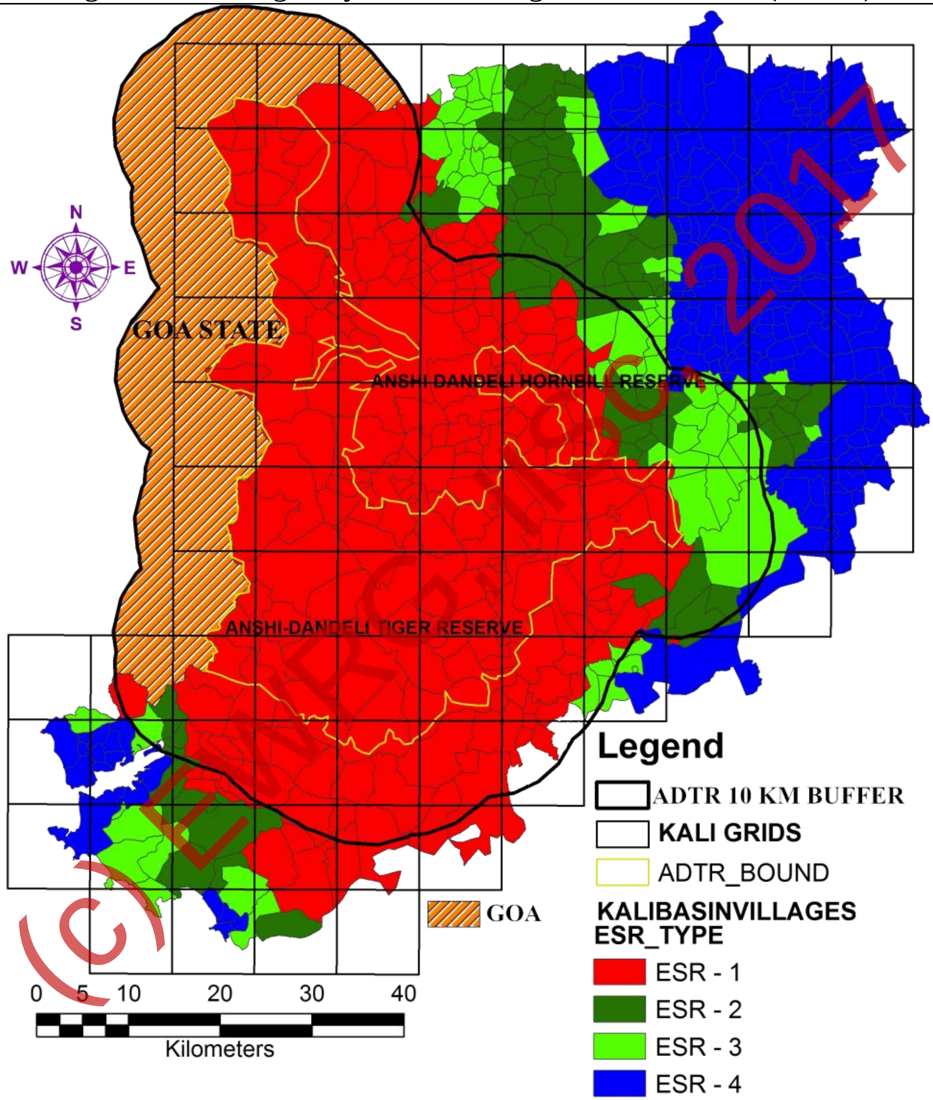


Figure 26: ESR map for villages of KTR (ADTR)

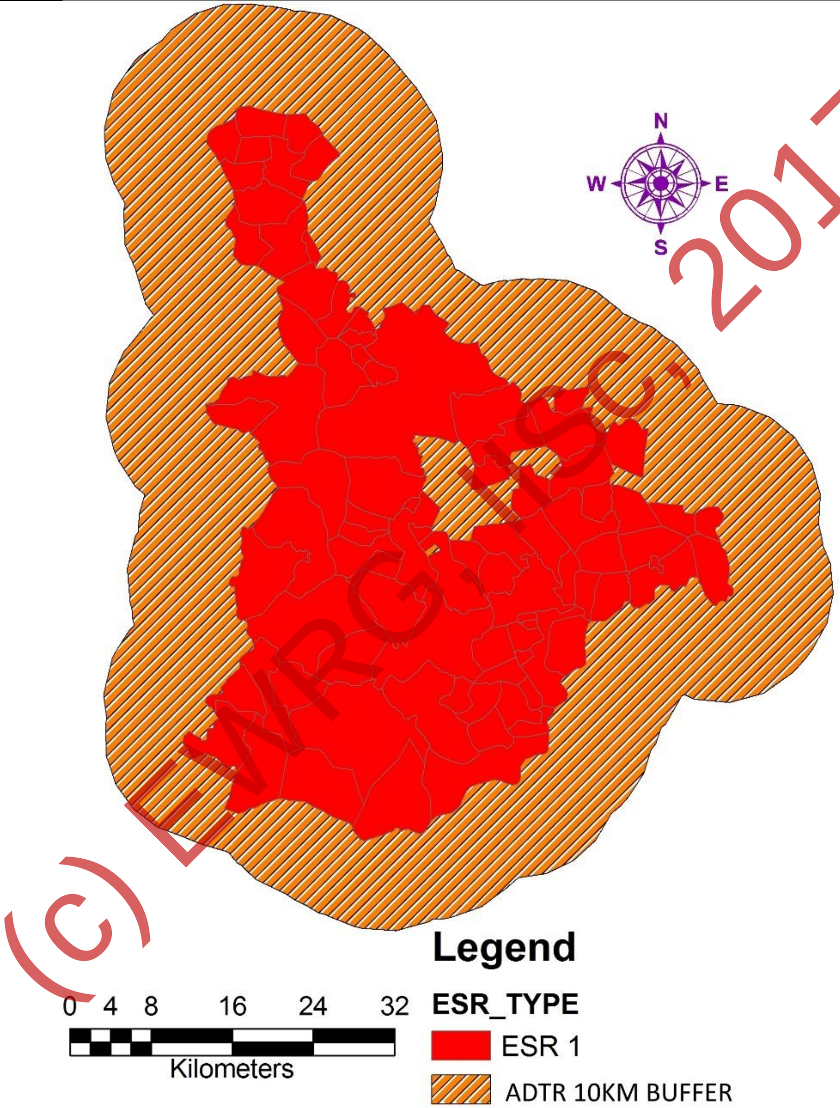
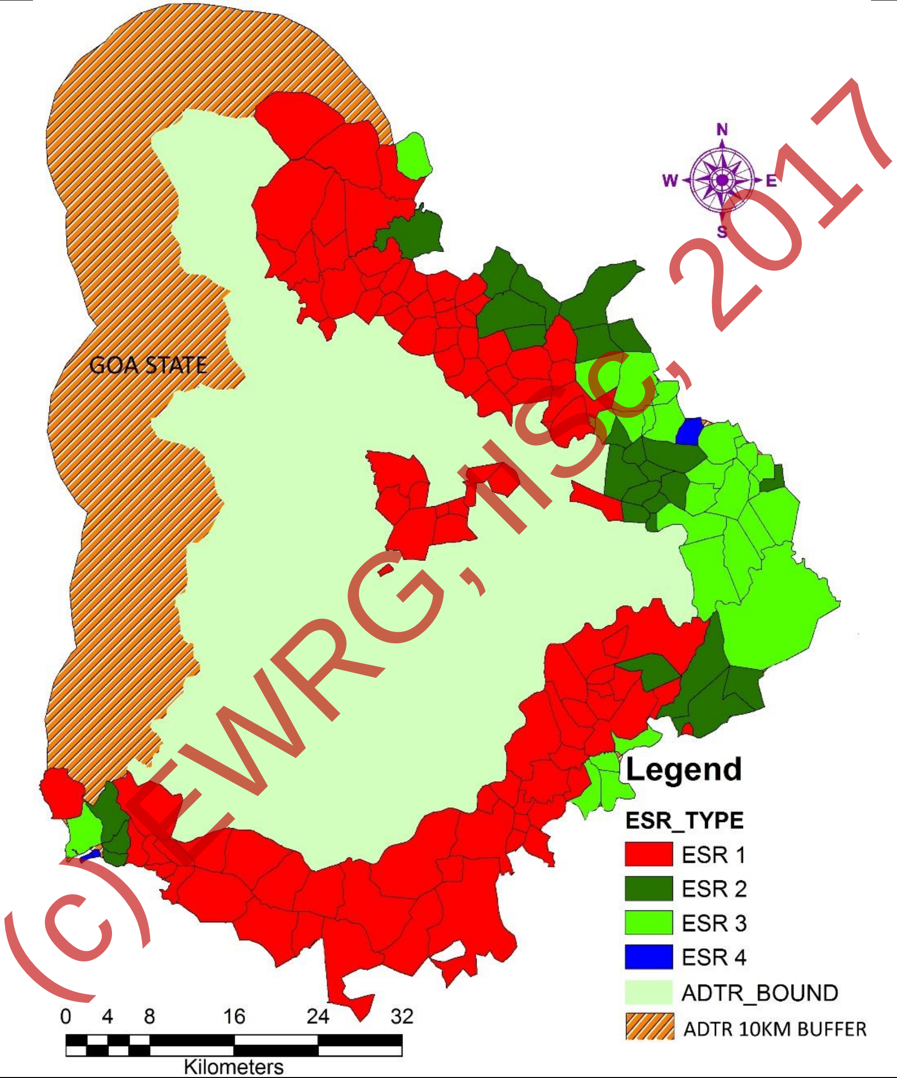


Figure 27: Village wise Ecologically Sensitive Regions of KTR with 10 km buffer



References:

1. Bharath Setturu, Bharath Aithal, H., Sanna Durgappa, D., Ramachandra T. V., 2012, Landscape Dynamics through Spatial Metrics, Proceedings of India Geospatial Conference, Epicenter, Gurgaon, India, 7-9 February, 2012.
2. Bharath Setturu, Rajan K S, Ramchandra T. V., 2014. Visualization of Forest Changes in Uttara Kannada, Vol. 8, Proceedings Lake 2014, 13-15 November.
3. Cabral, A.I.R., Vasconcelos, M.J., Oom, D. and Sardinha, R., 2011. Spatial dynamics and quantification of deforestation in the central-plateau woodlands of Angola (1990–2009). Applied Geography, 31(3), pp.1185-1193.
4. Cagnolo, L., Cabido, M. and Valladares, G., 2006. Plant species richness in the Chaco Serrano Woodland from central Argentina: ecological traits and habitat fragmentation effects. Biological Conservation, 132(4), pp.510-519.
5. DeFries, R.S., Foley, J.A. and Asner, G.P., 2004. Land‐use choices: Balancing human needs and ecosystem function. Frontiers in Ecology and the Environment, 2(5), pp.249-257.
6. DeFries, R.S., Rudel, T., Uriarte, M. and Hansen, M., 2010. Deforestation driven by urban population growth and agricultural trade in the twenty-first century. *Nature Geoscience*, *3*(3), p.178.
7. FAO, 2011. State of the World's Forests. Research and Extension, FAO, Viale delle Terme di Caracalla, 00153. Rome, Italy.
8. Gibson, L., Lee, T.M., Koh, L.P., Brook, B.W., Gardner, T.A., Barlow, J., Peres, C.A., Bradshaw, C.J., Laurance, W.F., Lovejoy, T.E. and Sodhi, N.S., 2011. Primary forests are irreplaceable for sustaining tropical biodiversity. *Nature*, *478*(7369), p.378.
9. Hansen, A.J., DeFries R., 2007. Ecological mechanisms linking protected areas to surrounding lands Ecol. Appl., 974-988.
10. Hansen, M.C., Potapov, P.V., Moore, R., Hancher, M., Turubanova, S., Tyukavina, A., Thau, D., Stehman, S.V., Goetz, S.J., Loveland, T.R. and Kommareddy, A., 2013. High-resolution global maps of 21st-century forest cover change. *science*, *342*(6160), pp.850-853.
11. Harper, K.A., Macdonald, S.E., Burton, P.J., Chen, J., Brosofske, K.D., Saunders, S.C., Euskirchen, E.S., Roberts, D.A.R., Jaiteh, M.S. and Esseen, P.A., 2005. Edge influence on

forest structure and composition in fragmented landscapes. Conservation Biology, 19(3), pp.768-782.

12. Kennedy, R.E., Townsend, P.A., Gross, J.E., Cohen, W.B., Bolstad, P., Wang, Y.Q. and Adams, P., 2009. Remote sensing change detection tools for natural resource managers: Understanding concepts and tradeoffs in the design of landscape monitoring projects. Remote sensing of environment, 113(7), pp.1382-1396.
13. Kindstrand, C., Norman, J., Boman, M. and Mattsson, L., 2008. Attitudes towards various forest functions: A comparison between private forest owners and forest officers. *Scandinavian Journal of Forest Research*, *23*(2), pp.133-136.
14. Kivinen, S. and Kumpula, T., 2014. Detecting land cover disturbances in the Lappi reindeer herding district using multi-source remote sensing and GIS data. *International Journal of Applied Earth Observation and Geoinformation*, *27*, pp.13-19.
15. Lambin, E. F., Geist, H., Lepers, E., 2003. Dynamics of land use and land cover change in tropical regions. Environment and Resources, 28, 205–241.
16. Laurance, W.F., Lovejoy, T.E., Vasconcelos, H.L., Bruna, E.M., Didham, R.K., Stouffer, P.C., Gascon, C., Bierregaard, R.O., Laurance, S.G., Sampaio, E., 2002. Ecosystem decay of Amazonian forest fragments: a 22-year investigation. Conservation Biology 16, pp. 605–618.
17. Li, M., Huang, C., Zhu, Z., Wen, W., Xu, D. and Liu, A., 2009. Use of remote sensing coupled with a vegetation change tracker model to assess rates of forest change and fragmentation in Mississippi, USA. *International Journal of Remote Sensing*, *30*(24), pp.6559-6574.
18. Lillesand, T., Kiefer, R.W. and Chipman, J., 2014. Remote sensing and image interpretation. John Wiley & Sons, Newyork.
19. Olson, D.M., Dinerstein, E., Wikramanayake, E.D., Burgess, N.D., Powell, G.V.N., Underwood, E.C., D'Amico, J.A., Itoua, I., Strand, H.E., Morrison, J.C., Loucks, C.J., Allnutt, T.F., Ricketts, T.H., Kura, Y., Lamoreux, J.F., Wettengel, W.W., Hedao, P., Kassem, K.R., 2001. Terrestrial ecoregions of the world: a new map of life on earth. BioScience 51, 933–938.
20. MoEF, 2000. Report of the Committee on identifying parameters for designating Ecologically Sensitive Areas in India (Pronab Sen Committee Report).
21. Myers, N., Mittermeier, R., Mittermeier, C., da Fonseca, G., Kent, J., 2000. Biodiversity hotspots for conservation priorities, Nature, 403 (6772), 853-858.

22. Pan, Y., Birdsey, R.A., Fang, J., Houghton, R., Kauppi, P.E., Kurz, W.A., Phillips, O.L., Shvidenko, A., Lewis, S.L., Canadell, J.G. and Ciais, P., 2011. A large and persistent carbon sink in the world's forests. *Science*, *333*(6045), pp.988-993.
23. Possingham, H.P., Wilson, K.A., Aldeman, S. J. and Vynne, C. H., 2006. Protected areas: goals, limitations, and design. Pages 509–551 in Groom, M.J., Meffe, G.K. and Carroll, C.R., editors. Principles of conservation biology. Third edition. Sinauer Associates, Sunderland, Massachusetts, USA.
24. Ramachandra T.V. and Shruthi, B.V., 2007. Spatial mapping of renewable energy potential, Renewable and Sustainable Energy Reviews, 11(7):1460-1480.
25. Ramachandra TV, Chandran MDS, Gururaja KV, Sreekantha (2007) Cumulative Environmental Impact Assessment, Nova Science Publishers, New York.
26. Ramachandra, T.V., Setturu Bharath and Aithal Bharath., 2014. Spatio-temporal dynamics along the terrain gradient of diverse landscape, Journal of Environmental Engineering and Landscape Management, 22:1, 50-63, doi:http://dx.doi.org/10.3846/16486897.2013.808639.
27. Ramachandra, T.V., Setturu, B. and Chandran, S., 2016. Geospatial analysis of forest fragmentation in Uttara Kannada District, India. *Forest Ecosystems*, *3*(1), p.10.
28. Ramachandra, T.V., Bharath, S. and Gupta, N., 2017. Modelling landscape dynamics with LST in protected areas of Western Ghats, Karnataka. Journal of Environmental Management, Aug 9, Article in press.
29. Reddy, C.S., Satish, K.V., Jha, C.S., Diwakar, P.G., Murthy, Y.K. and Dadhwal, V.K., 2016. Development of deforestation and land cover database for Bhutan (1930–2014). Environmental monitoring and assessment, 188(12), p.658.
30. Schmitt, C.B., Burgess, N.D., Coad, L., Belokurov, A., Besançon, C., Boisrobert, L., Campbell, A., Fish, L., Gliddon, D., Humphries, K. and Kapos, V., 2009. Global analysis of the protection status of the world's forests. Biological Conservation, 142(10), pp.2122-2130.
31. Vinay, S., Bharath, S., Bharath, H.A., Ramachandra, T.V., 2013. Hydrologic model with landscape dynamics for drought monitoring. In proceeding of: Joint International Workshop of ISPRS WG VIII/1 and WG IV/4 on Geospatial Data for Disaster and Risk Reduction, Hyderabad, November (pp. 21-22).

Annexure 1

FLORA OF KALI RIVER BASIN:

Figure I shows sampling locations for flora analyses. The field investigation was carried out at 39 locations of the basin accounting 217 species in which 91 are endemic.

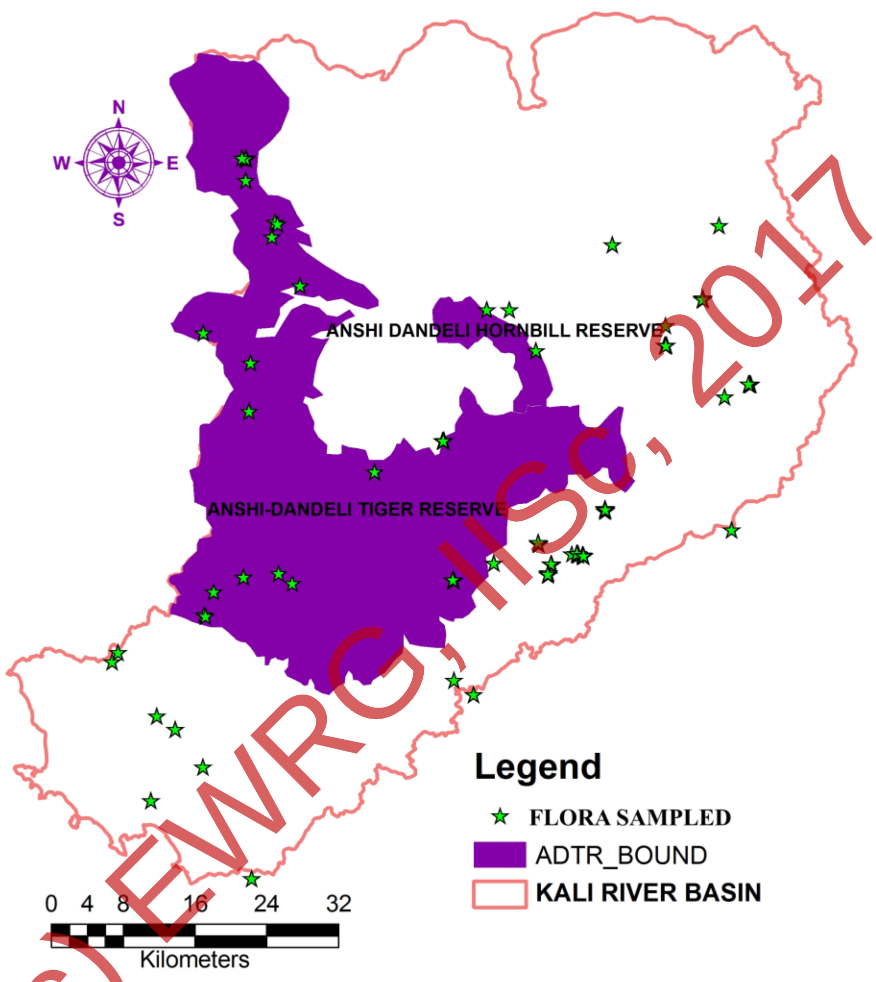


Figure I: Flora field investigation in kali basin.

Annexure I: Flora composition in Kali River Basin.

Sno	Latitude	Longitude	Family	Species Name	Locality	Taluk	Endemism	Status
1	14.771	74.235	Acanthaceae	*Hygrophila schulli*	Amdalli	Ankola	E	LC
2	14.805	74.289	Acanthaceae	*Hygrophila schulli*	Chittakula	Karwar	E	LC
3	14.911	74.194	Acanthaceae	*Hygrophila schulli*	Hankon	Karwar	E	LC
4	14.856	74.241	Acanthaceae	*Hygrophila schulli*	Sailwada	Karwar	E	LC
5	15.290	74.388	Acanthaceae	*Hygrophila schulli*	Bazarkunang	Supa	E	LC
6	15.242	74.288	Acanthaceae	*Hygrophila schulli*	Diggie	Supa	E	LC
7	15.103	74.466	Acanthaceae	*Hygrophila schulli*	Doodlimala	Supa	E	LC

8	15.225	74.633	Achariaceae	*Hydnocarpus laurifolia*	Dandeli	Haliyal	E	NE
9	15.179	74.829	Achariaceae	*Hydnocarpus laurifolia*	Tattigere	Haliyal	E	NE
10	14.981	74.299	Achariaceae	*Hydnocarpus laurifolia*	Kalni_Goyar	Karwar	E	
11	14.996	74.331	Achariaceae	*Hydnocarpus laurifolia*	Badpolli	Supa	E	NE
12	15.163	74.336	Achariaceae	*Hydnocarpus laurifolia*	Kushavali	Supa	E	
13	15.266	74.582	Achariaceae	*Hydnocarpus laurifolia*	Mavalinge	Supa	E	NE
14	14.981	74.299	Achariaceae	*Hydnocarpus pentandra*	Kalni_Goyar	Karwar	E	
15	15.011	74.590	Achariaceae	*Hydnocarpus pentandra*	Kattige	Yellapur	E	
16	15.351	74.823	Alangiaceae	*Alangium salvifolium*	Magvad	Haliyal		
17	14.771	74.235	Alismataceae	*Wisneria triandra*	Amdalli	Ankola	E	T
18	15.266	74.606	Alismataceae	*Wisneria triandra*	Dandeli	Haliyal	E	T
19	15.179	74.829	Alismataceae	*Wisneria triandra*	Tattigere	Haliyal	E	T
20	14.805	74.289	Alismataceae	*Wisneria triandra*	Chittakula	Karwar	E	T
21	14.911	74.194	Alismataceae	*Wisneria triandra*	Hankon	Karwar	E	T
22	14.856	74.241	Alismataceae	*Wisneria triandra*	Sailwada	Karwar	E	T
23	14.996	74.331	Alismataceae	*Wisneria triandra*	Badpolli	Supa	E	T
24	15.290	74.388	Alismataceae	*Wisneria triandra*	Bazarkunang	Supa	E	T
25	15.242	74.288	Alismataceae	*Wisneria triandra*	Diggie	Supa	E	T
26	15.103	74.466	Alismataceae	*Wisneria triandra*	Doodlimala	Supa	E	T
27	15.266	74.582	Alismataceae	*Wisneria triandra*	Mavalinge	Supa	E	T
28	14.771	74.235	Amaranthaceae	*Alternanthera sessilis*	Amdalli	Ankola	E	LC
29	14.805	74.289	Amaranthaceae	*Alternanthera sessilis*	Chittakula	Karwar	E	LC
30	14.911	74.194	Amaranthaceae	*Alternanthera sessilis*	Hankon	Karwar	E	LC
31	14.856	74.241	Amaranthaceae	*Alternanthera sessilis*	Sailwada	Karwar	E	LC
32	15.290	74.388	Amaranthaceae	*Alternanthera sessilis*	Bazarkunang	Supa	E	LC
33	15.242	74.288	Amaranthaceae	*Alternanthera sessilis*	Diggie	Supa	E	LC
34	15.103	74.466	Amaranthaceae	*Alternanthera sessilis*	Doodlimala	Supa	E	LC
35	14.693	74.340	Anacardiaceae	*Anacardium occidentale*	Kattangadde	Ankola		
36	14.693	74.340	Anacardiaceae	*Buchanania cochinchinensis*	Kattangadde	Ankola		
37	15.351	74.823	Anacardiaceae	*Buchanania cochinchinensis*	Magvad	Haliyal		
38	15.332	74.712	Anacardiaceae	*Buchanania cochinchinensis*	Yadoga	Haliyal		
39	15.352	74.364	Anacardiaceae	*Buchanania cochinchinensis*	Castlerock	Karwar		
40	14.843	74.260	Anacardiaceae	*Buchanania cochinchinensis*	Karwar	Karwar		
41	15.009	74.650	Anacardiaceae	*Buchanania cochinchinensis*	Balekodlu	Yellapur		
42	15.225	74.633	Anacardiaceae	*Holigarna arnottiana*	Dandeli	Haliyal	E	NE
43	15.179	74.829	Anacardiaceae	*Holigarna arnottiana*	Tattigere	Haliyal	E	NE
44	14.996	74.331	Anacardiaceae	*Holigarna arnottiana*	Badpolli	Supa	E	NE
45	15.266	74.582	Anacardiaceae	*Holigarna arnottiana*	Mavalinge	Supa	E	NE
46	15.020	74.677	Anacardiaceae	*Holigarna arnottiana*	Hasrapal	Yellapur		
47	15.019	74.683	Anacardiaceae	*Holigarna arnottiana*	Hulimundgi	Yellapur		
48	15.417	74.332	Anacardiaceae	*Holigarna beddomei*	Castlerock	Supa	E	EN

49	15.163	74.336	Anacardiaceae	*Holigarna beddomei*	Kushavali	Supa	E	EN
50	15.001	74.646	Anacardiaceae	*Holigarna ferruginea*	Hosmane	Yellapur	E/WG	NE
51	14.920	74.201	Anacardiaceae	*Holigarna grahamii*	Gopishetta	Karwar	E/WG	EN
52	15.396	74.319	Anacardiaceae	*Holigarna grahamii*	Castlerock_IB	Supa	E/WG	EN
53	15.212	74.337	Anacardiaceae	*Holigarna grahamii*	Gavni	Supa	E/WG	EN
54	15.419	74.332	Anacardiaceae	*Holigarna grahamii*	Joida	Supa	E/WG	EN
55	15.163	74.336	Anacardiaceae	*Holigarna grahamii*	Kushavali	Supa	E/WG	EN
56	15.010	74.650	Anacardiaceae	*Holigarna grahamii*	Balekodlu	Yellapur	E/WG	EN
57	15.020	74.677	Anacardiaceae	*Holigarna grahamii*	Hasrapal	Yellapur	E/WG	EN
58	15.019	74.682	Anacardiaceae	*Holigarna grahamii*	Hulimundgi	Yellapur	E/WG	EN
59	14.771	74.235	Anacardiaceae	*Lannea coromandelica*	Amdalli	Ankola		
60	15.277	74.806	Anacardiaceae	*Lannea coromandelica*	Golehalli	Haliyal		
61	15.192	74.855	Anacardiaceae	*Lannea coromandelica*	Kudalgi	Haliyal		
62	15.351	74.823	Anacardiaceae	*Lannea coromandelica*	Magvad	Haliyal		
63	15.231	74.769	Anacardiaceae	*Lannea coromandelica*	Sambrani	Haliyal		
64	15.332	74.712	Anacardiaceae	*Lannea coromandelica*	Yadoga	Haliyal		
65	14.805	74.289	Anacardiaceae	*Lannea coromandelica*	Chittakula	Karwar		
66	14.993	74.548	Anacardiaceae	*Lannea coromandelica*	Shivpura	Supa		
67	15.009	74.650	Anacardiaceae	*Lannea coromandelica*	Balekodlu	Yellapur		
68	14.879	74.569	Anacardiaceae	*Lannea coromandelica*	Gidgar	Yellapur		
69	15.000	74.646	Anacardiaceae	*Lannea coromandelica*	Hosmane	Yellapur		
70	15.045	74.836	Anacardiaceae	*Lannea coromandelica*	Kiruvatti	Yellapur		
71	15.066	74.705	Anacardiaceae	*Lannea coromandelica*	Lalguli	Yellapur		
72	14.981	74.299	Anacardiaceae	*Mangifera indica*	Kalni_Goyar	Karwar		
73	15.418	74.332	Anacardiaceae	*Mangifera indica*	Castlerock	Supa		
74	15.419	74.332	Anacardiaceae	*Mangifera indica*	Joida	Supa		
75	15.163	74.336	Anacardiaceae	*Mangifera indica*	Kushavali	Supa		
76	15.010	74.649	Anacardiaceae	*Mangifera indica*	Balekodlu	Yellapur		
77	15.020	74.677	Anacardiaceae	*Mangifera indica*	Hasrapal	Yellapur		
78	15.019	74.682	Anacardiaceae	*Mangifera indica*	Hulimundgi	Yellapur		
79	15.011	74.590	Anacardiaceae	*Mangifera indica*	Kattige	Yellapur		
80	15.419	74.332	Anacardiaceae	*Nothapodytes nimmoniana*	Joida	Supa		
81	15.000	74.367	Anacardiaceae	*Nothopegia racemosa*	Anshighat	Supa	E/WG	NE
82	15.419	74.332	Anacardiaceae	*Nothopegia racemosa*	Joida	Supa	E/WG	
83	15.163	74.336	Anacardiaceae	*Nothopegia racemosa*	Kushavali	Supa	E/WG	
84	14.981	74.299	Anacardiaceae	*Spondias pinnata*	Kalni_Goyar	Karwar		
85	15.011	74.590	Anacardiaceae	*Spondias pinnata*	Kattige	Yellapur		
86	15.163	74.336	Annonaceae	*Meiogyne pannosa*	Kushavali	Supa		
87	15.351	74.823	Annonaceae	*Miliusa tomentosa*	Magvad	Haliyal		
88	14.920	74.201	Annonaceae	*Miliusa tomentosa*	Gopishetta	Karwar		
89	14.843	74.260	Annonaceae	*Miliusa tomentosa*	Karwar	Karwar		

90	14.993	74.548	Annonaceae	*Miliusa tomentosa*	Shivpura	Supa		
91	14.879	74.569	Annonaceae	*Miliusa tomentosa*	Gidgar	Yellapur		
92	15.045	74.836	Annonaceae	*Miliusa tomentosa*	Kiruvatti	Yellapur		
93	15.225	74.633	Annonaceae	*Polyalthia fragrans*	Dandeli	Haliyal	E	NE
94	15.179	74.829	Annonaceae	*Polyalthia fragrans*	Tattigere	Haliyal	E	NE
95	14.981	74.299	Annonaceae	*Polyalthia fragrans*	Kalni_Goyar	Karwar	E	
96	14.996	74.331	Annonaceae	*Polyalthia fragrans*	Badpolli	Supa	E	NE
97	15.418	74.328	Annonaceae	*Polyalthia fragrans*	Ivolli	Supa	E	
98	15.266	74.582	Annonaceae	*Polyalthia fragrans*	Mavalinge	Supa	E	NE
99	15.020	74.677	Annonaceae	*Polyalthia fragrans*	Hasrapal	Yellapur	E	
100	14.981	74.299	Annonaceae	*Sagearea laurifolia*	Kalni_Goyar	Karwar	E	
101	15.396	74.319	Annonaceae	*Sagearea laurifolia*	Castlerock_IB	Supa	E	
102	14.771	74.235	Apiaceae	*Centella asiatica*	Amdalli	Ankola	E	NE
103	14.805	74.289	Apiaceae	*Centella asiatica*	Chittakula	Karwar	E	NE
104	14.911	74.194	Apiaceae	*Centella asiatica*	Hankon	Karwar	E	NE
105	14.856	74.241	Apiaceae	*Centella asiatica*	Sailwada	Karwar	E	NE
106	15.290	74.388	Apiaceae	*Centella asiatica*	Bazarkunang	Supa	E	NE
107	15.242	74.288	Apiaceae	*Centella asiatica*	Diggie	Supa	E	NE
108	15.103	74.466	Apiaceae	*Centella asiatica*	Doodlimala	Supa	E	NE
109	14.920	74.201	Apocynaceae	*Alstonia scholaris*	Gopishetta	Karwar		
110	14.957	74.291	Apocynaceae	*Alstonia scholaris*	Goyar	Karwar		
111	14.879	74.569	Apocynaceae	*Alstonia scholaris*	Gidgar	Yellapur		
112	15.011	74.590	Apocynaceae	*Plumeria rubra*	Kattige	Yellapur		
113	15.354	74.362	Apocynaceae	*Tabernaemontana alternifolia*	Castlerock	Karwar	E/WG	NE
114	14.920	74.201	Apocynaceae	*Tabernaemontana alternifolia*	Gopishetta	Karwar	E/WG	NE
115	14.957	74.291	Apocynaceae	*Tabernaemontana alternifolia*	Goyar	Karwar	E/WG	NE
116	15.418	74.328	Apocynaceae	*Tabernaemontana alternifolia*	Ivolli	Supa	E/WG	NE
117	15.000	74.646	Apocynaceae	*Tabernaemontana alternifolia*	Hosmane	Yellapur	E/WG	NE
118	15.011	74.590	Apocynaceae	*Tabernaemontana alternifolia*	Kattige	Yellapur	E/WG	NE
119	15.030	74.636	Apocynaceae	*Tabernaemontana alternifolia*	Nagarkan	Yellapur	E/WG	NE
120	14.843	74.260	Apocynaceae	*Wrightia tinctoria*	Karwar	Karwar		LC
121	14.771	74.235	Araceae	*Cryptocoryne spiralis*	Amdalli	Ankola	E	NE
122	14.805	74.289	Araceae	*Cryptocoryne spiralis*	Chittakula	Karwar	E	NE
123	14.911	74.194	Araceae	*Cryptocoryne spiralis*	Hankon	Karwar	E	NE
124	14.856	74.241	Araceae	*Cryptocoryne spiralis*	Sailwada	Karwar	E	NE
125	15.290	74.388	Araceae	*Cryptocoryne spiralis*	Bazarkunang	Supa	E	NE
126	15.242	74.288	Araceae	*Cryptocoryne spiralis*	Diggie	Supa	E	NE
127	15.103	74.466	Araceae	*Cryptocoryne spiralis*	Doodlimala	Supa	E	NE

128	14.771	74.235	Araceae	*Lagenandra meeboldii*	Amdalli	Ankola	E	NE
129	14.805	74.289	Araceae	*Lagenandra meeboldii*	Chittakula	Karwar	E	NE
130	14.911	74.194	Araceae	*Lagenandra meeboldii*	Hankon	Karwar	E	NE
131	14.856	74.241	Araceae	*Lagenandra meeboldii*	Sailwada	Karwar	E	NE
132	15.290	74.388	Araceae	*Lagenandra meeboldii*	Bazarkunang	Supa	E	NE
133	15.242	74.288	Araceae	*Lagenandra meeboldii*	Diggie	Supa	E	NE
134	15.103	74.466	Araceae	*Lagenandra meeboldii*	Doodlimala	Supa	E	NE
135	15.225	74.633	Arecaceae	*Caryota urens*	Dandeli	Haliyal	E	NE
136	15.179	74.829	Arecaceae	*Caryota urens*	Tattigere	Haliyal	E	NE
137	14.996	74.331	Arecaceae	*Caryota urens*	Badpolli	Supa	E	NE
138	15.419	74.332	Arecaceae	*Caryota urens*	Joida	Supa	E	NE
139	15.163	74.336	Arecaceae	*Caryota urens*	Kushavali	Supa	E	NE
140	15.266	74.582	Arecaceae	*Caryota urens*	Mavalinge	Supa	E	NE
141	15.009	74.650	Arecaceae	*Caryota urens*	Balekodlu	Yellapur	E	NE
142	15.001	74.646	Arecaceae	*Caryota urens*	Hosmane	Yellapur	E	NE
143	15.019	74.682	Arecaceae	*Caryota urens*	Hulimundgi	Yellapur	E	NE
144	15.225	74.633	Aristolochiaceae	*Aristolochia indica*	Dandeli	Haliyal	E	NE
145	15.179	74.829	Aristolochiaceae	*Aristolochia indica*	Tattigere	Haliyal	E	NE
146	14.996	74.331	Aristolochiaceae	*Aristolochia indica*	Badpolli	Supa	E	NE
147	15.266	74.582	Aristolochiaceae	*Aristolochia indica*	Mavalinge	Supa	E	NE
148	14.771	74.235	Asteraceae	*Eclipta alba*	Amdalli	Ankola	E	NE
149	14.805	74.289	Asteraceae	*Eclipta alba*	Chittakula	Karwar	E	NE
150	14.911	74.194	Asteraceae	*Eclipta alba*	Hankon	Karwar	E	NE
151	14.856	74.241	Asteraceae	*Eclipta alba*	Sailwada	Karwar	E	NE
152	15.290	74.388	Asteraceae	*Eclipta alba*	Bazarkunang	Supa	E	NE
153	15.242	74.288	Asteraceae	*Eclipta alba*	Diggie	Supa	E	NE
154	15.103	74.466	Asteraceae	*Eclipta alba*	Doodlimala	Supa	E	NE
155	14.771	74.235	Asteraceae	*Epaltes divaricata*	Amdalli	Ankola	E	NE
156	15.225	74.633	Asteraceae	*Epaltes divaricata*	Dandeli	Haliyal	E	NE
157	15.179	74.829	Asteraceae	*Epaltes divaricata*	Tattigere	Haliyal	E	NE
158	14.805	74.289	Asteraceae	*Epaltes divaricata*	Chittakula	Karwar	E	NE
159	14.911	74.194	Asteraceae	*Epaltes divaricata*	Hankon	Karwar	E	NE
160	14.856	74.241	Asteraceae	*Epaltes divaricata*	Sailwada	Karwar	E	NE
161	14.996	74.331	Asteraceae	*Epaltes divaricata*	Badpolli	Supa	E	NE
162	15.290	74.388	Asteraceae	*Epaltes divaricata*	Bazarkunang	Supa	E	NE
163	15.242	74.288	Asteraceae	*Epaltes divaricata*	Diggie	Supa	E	NE
164	15.103	74.466	Asteraceae	*Epaltes divaricata*	Doodlimala	Supa	E	NE
165	15.266	74.582	Asteraceae	*Epaltes divaricata*	Mavalinge	Supa	E	NE
166	14.771	74.235	Asteraceae	*Grangea maderaspatana*	Amdalli	Ankola	E	LC
167	14.805	74.289	Asteraceae	*Grangea maderaspatana*	Chittakula	Karwar	E	LC
168	14.911	74.194	Asteraceae	*Grangea maderaspatana*	Hankon	Karwar	E	LC

169	14.856	74.241	Asteraceae	*Grangea maderaspatana*	Sailwada	Karwar	E	LC
170	15.290	74.388	Asteraceae	*Grangea maderaspatana*	Bazarkunang	Supa	E	LC
171	15.242	74.288	Asteraceae	*Grangea maderaspatana*	Diggie	Supa	E	LC
172	15.103	74.466	Asteraceae	*Grangea maderaspatana*	Doodlimala	Supa	E	LC
173	14.771	74.235	Asteraceae	*Spilanthes paniculata*	Amdalli	Ankola	E	NE
174	14.805	74.289	Asteraceae	*Spilanthes paniculata*	Chittakula	Karwar	E	NE
175	14.911	74.194	Asteraceae	*Spilanthes paniculata*	Hankon	Karwar	E	NE
176	14.856	74.241	Asteraceae	*Spilanthes paniculata*	Sailwada	Karwar	E	NE
177	15.290	74.388	Asteraceae	*Spilanthes paniculata*	Bazarkunang	Supa	E	NE
178	15.242	74.288	Asteraceae	*Spilanthes paniculata*	Diggie	Supa	E	NE
179	15.103	74.466	Asteraceae	*Spilanthes paniculata*	Doodlimala	Supa	E	NE
180	14.920	74.201	Bignoniaceae	*Heterophragma quadriloculare*	Gopishetta	Karwar		
181	14.957	74.291	Bignoniaceae	*Heterophragma quadriloculare*	Goyar	Karwar		
182	14.957	74.291	Bignoniaceae	*Stereospermum tetragonum*	Goyar	Karwar		
183	14.981	74.299	Bignoniaceae	*Stereospermum tetragonum*	Kalni_Goyar	Karwar		
184	14.843	74.260	Bignoniaceae	*Stereospermum tetragonum*	Karwar	Karwar		
185	15.212	74.337	Bignoniaceae	*Stereospermum tetragonum*	Gavni	Supa		
186	15.010	74.650	Bignoniaceae	*Stereospermum tetragonum*	Balekodlu	Yellapur		
187	14.879	74.569	Bignoniaceae	*Stereospermum tetragonum*	Gidgar	Yellapur		
188	15.001	74.646	Bignoniaceae	*Stereospermum tetragonum*	Hosmane	Yellapur		
189	15.019	74.682	Bignoniaceae	*Stereospermum tetragonum*	Hulimundgi	Yellapur		
190	14.693	74.340	Bombacaceae	*Bombax ceiba*	Kattangadde	Ankola		
191	15.192	74.854	Bombacaceae	*Bombax ceiba*	Kudalgi	Haliyal		
192	14.920	74.201	Bombacaceae	*Bombax ceiba*	Gopishetta	Karwar		
193	14.843	74.260	Bombacaceae	*Bombax ceiba*	Karwar	Karwar		
194	14.771	74.235	Boraginaceae	*Coldenia procumbens*	Amdalli	Ankola	E	NE
195	14.805	74.289	Boraginaceae	*Coldenia procumbens*	Chittakula	Karwar	E	NE
196	14.911	74.194	Boraginaceae	*Coldenia procumbens*	Hankon	Karwar	E	NE
197	14.856	74.241	Boraginaceae	*Coldenia procumbens*	Sailwada	Karwar	E	NE
198	15.290	74.388	Boraginaceae	*Coldenia procumbens*	Bazarkunang	Supa	E	NE
199	15.242	74.288	Boraginaceae	*Coldenia procumbens*	Diggie	Supa	E	NE
200	15.103	74.466	Boraginaceae	*Coldenia procumbens*	Doodlimala	Supa	E	NE
201	15.278	74.806	Boraginaceae	*Cordia myxa*	Golehalli	Haliyal		
202	15.351	74.823	Boraginaceae	*Cordia myxa*	Magvad	Haliyal		
203	14.771	74.235	Boraginaceae	*Rotula aquatica*	Amdalli	Ankola	E	LC
204	14.805	74.289	Boraginaceae	*Rotula aquatica*	Chittakula	Karwar	E	LC
205	14.911	74.194	Boraginaceae	*Rotula aquatica*	Hankon	Karwar	E	LC
206	14.856	74.241	Boraginaceae	*Rotula aquatica*	Sailwada	Karwar	E	LC
207	15.290	74.388	Boraginaceae	*Rotula aquatica*	Bazarkunang	Supa	E	LC
208	15.242	74.288	Boraginaceae	*Rotula aquatica*	Diggie	Supa	E	LC

209	15.103	74.466	Boraginaceae	*Rotula aquatica*	Doodlimala	Supa	E	LC
210	14.981	74.299	Burseraceae	*Canarium strictum*	Kalni_Goyar	Karwar	E/WG	NE
211	15.020	74.677	Cannabaceae	*Aphananthe cuspidata*	Hasrapal	Yellapur		
212	15.419	74.332	Celastraceae	*Cassine glauca*	Joida	Supa		
213	15.001	74.646	Celastraceae	*Cassine glauca*	Hosmane	Yellapur		
214	15.396	74.319	Celastraceae	*Euonymus indicus*	Castlerock_IB	Supa	E/WG	NE
215	15.396	74.319	Celastraceae	*Lophopetalum wightianum*	Castlerock_IB	Supa		
216	15.018	74.682	Celastraceae	*Lophopetalum wightianum*	Hulimundgi	Yellapur		
217	14.981	74.299	Clusiaceae	*Calophyllum polyanthum*	Kalni_Goyar	Karwar	E/WG	NE
218	15.396	74.319	Clusiaceae	*Calophyllum polyanthum*	Castlerock_IB	Supa	E/WG	NE
219	15.163	74.336	Clusiaceae	*Calophyllum polyanthum*	Kushavali	Supa	E/WG	NE
220	15.212	74.337	Clusiaceae	*Garcinia gummi_gutta*	Gavni	Supa	E/WG	VU
221	15.163	74.336	Clusiaceae	*Garcinia gummi_gutta*	Kushavali	Supa	E/WG	VU
222	15.225	74.633	Clusiaceae	*Garcinia indica*	Dandeli	Haliyal	E	NE
223	15.179	74.829	Clusiaceae	*Garcinia indica*	Tattigere	Haliyal	E	NE
224	14.996	74.331	Clusiaceae	*Garcinia indica*	Badpolli	Supa	E	NE
225	15.266	74.582	Clusiaceae	*Garcinia indica*	Mavalinge	Supa	E	NE
226	15.396	74.319	Clusiaceae	*Garcinia morella*	Castlerock_IB	Supa		
227	15.212	74.337	Clusiaceae	*Garcinia morella*	Gavni	Supa		
228	15.396	74.319	Clusiaceae	*Garcinia talbotii*	Castlerock_IB	Supa	E/WG	NE
229	15.225	74.633	Clusiaceae	*Mammea suriga*	Dandeli	Haliyal	E	NE
230	15.179	74.829	Clusiaceae	*Mammea suriga*	Tattigere	Haliyal	E	NE
231	14.996	74.331	Clusiaceae	*Mammea suriga*	Badpolli	Supa	E	NE
232	15.418	74.328	Clusiaceae	*Mammea suriga*	Ivolli	Supa	E	NE
233	15.266	74.582	Clusiaceae	*Mammea suriga*	Mavalinge	Supa	E	NE
234	15.011	74.649	Clusiaceae	*Mammea suriga*	Balekodlu	Yellapur	E	NE
235	15.001	74.646	Clusiaceae	*Mammea suriga*	Hosmane	Yellapur	E	NE
236	15.011	74.590	Clusiaceae	*Mammea suriga*	Kattige	Yellapur	E	NE
237	15.278	74.806	Combretaceae	*Anogeissus latifolia*	Golehalli	Haliyal		
238	15.192	74.855	Combretaceae	*Anogeissus latifolia*	Kudalgi	Haliyal		
239	15.351	74.823	Combretaceae	*Anogeissus latifolia*	Magvad	Haliyal		
240	15.230	74.768	Combretaceae	*Anogeissus latifolia*	Sambrani	Haliyal		
241	15.332	74.712	Combretaceae	*Anogeissus latifolia*	Yadoga	Haliyal		
242	15.045	74.836	Combretaceae	*Anogeissus latifolia*	Kiruvatti	Yellapur		
243	14.920	74.201	Combretaceae	*Calicopteris floribunda*	Gopishetta	Karwar		
244	14.957	74.291	Combretaceae	*Calicopteris floribunda*	Goyar	Karwar		
245	14.993	74.548	Combretaceae	*Calicopteris floribunda*	Shivpura	Supa		
246	15.009	74.650	Combretaceae	*Calicopteris floribunda*	Balekodlu	Yellapur		
247	15.019	74.683	Combretaceae	*Calicopteris floribunda*	Hulimundgi	Yellapur		
248	14.693	74.340	Combretaceae	*Terminalia alata*	Kattangadde	Ankola		
249	15.277	74.806	Combretaceae	*Terminalia alata*	Golehalli	Haliyal		

250	15.192	74.855	Combretaceae	*Terminalia alata*	Kudalgi	Haliyal		
251	15.351	74.823	Combretaceae	*Terminalia alata*	Magvad	Haliyal		
252	15.230	74.768	Combretaceae	*Terminalia alata*	Sambrani	Haliyal		
253	15.352	74.364	Combretaceae	*Terminalia alata*	Castlerock	Karwar		
254	14.920	74.201	Combretaceae	*Terminalia alata*	Gopishetta	Karwar		
255	14.957	74.291	Combretaceae	*Terminalia alata*	Goyar	Karwar		
256	14.843	74.260	Combretaceae	*Terminalia alata*	Karwar	Karwar		
257	15.212	74.337	Combretaceae	*Terminalia alata*	Gavni	Supa		
258	15.010	74.650	Combretaceae	*Terminalia alata*	Balekodlu	Yellapur		
259	14.879	74.569	Combretaceae	*Terminalia alata*	Gidgar	Yellapur		
260	15.018	74.683	Combretaceae	*Terminalia alata*	Hulimundgi	Yellapur		
261	15.045	74.836	Combretaceae	*Terminalia alata*	Kiruvatti	Yellapur		
262	15.065	74.706	Combretaceae	*Terminalia alata*	Lalguli	Yellapur		
263	15.011	74.590	Combretaceae	*Terminalia arjuna*	Kattige	Yellapur		
264	14.957	74.291	Combretaceae	*Terminalia bellirica*	Goyar	Karwar		
265	15.212	74.337	Combretaceae	*Terminalia bellirica*	Gavni	Supa		
266	15.419	74.332	Combretaceae	*Terminalia bellirica*	Joida	Supa		
267	14.993	74.548	Combretaceae	*Terminalia bellirica*	Shivpura	Supa		
268	15.009	74.650	Combretaceae	*Terminalia bellirica*	Balekodlu	Yellapur		
269	15.030	74.636	Combretaceae	*Terminalia bellirica*	Nagarkan	Yellapur		
270	15.352	74.364	Combretaceae	*Terminalia chebula*	Castlerock	Karwar		
271	14.843	74.260	Combretaceae	*Terminalia chebula*	Karwar	Karwar		
272	15.011	74.590	Combretaceae	*Terminalia chebula*	Kattige	Yellapur		
273	14.693	74.340	Combretaceae	*Terminalia paniculata*	Kattangadde	Ankola	E	NE
274	15.278	74.806	Combretaceae	*Terminalia paniculata*	Golehalli	Haliyal	E	NE
275	15.192	74.855	Combretaceae	*Terminalia paniculata*	Kudalgi	Haliyal	E	NE
276	15.351	74.823	Combretaceae	*Terminalia paniculata*	Magvad	Haliyal	E	NE
277	15.230	74.768	Combretaceae	*Terminalia paniculata*	Sambrani	Haliyal	E	NE
278	15.332	74.712	Combretaceae	*Terminalia paniculata*	Yadoga	Haliyal	E	NE
279	15.352	74.364	Combretaceae	*Terminalia paniculata*	Castlerock	Karwar	E	NE
280	14.920	74.201	Combretaceae	*Terminalia paniculata*	Gopishetta	Karwar	E	NE
281	14.957	74.291	Combretaceae	*Terminalia paniculata*	Goyar	Karwar	E	NE
282	14.981	74.299	Combretaceae	*Terminalia paniculata*	Kalni_Goyar	Karwar	E	NE
283	14.843	74.260	Combretaceae	*Terminalia paniculata*	Karwar	Karwar	E	NE
284	15.134	74.536	Combretaceae	*Terminalia paniculata*	Desaivada	Supa	E	NE
285	15.212	74.337	Combretaceae	*Terminalia paniculata*	Gavni	Supa	E	NE
286	15.418	74.328	Combretaceae	*Terminalia paniculata*	Ivolli	Supa	E	NE
287	15.419	74.332	Combretaceae	*Terminalia paniculata*	Joida	Supa	E	NE
288	14.893	74.549	Combretaceae	*Terminalia paniculata*	Shivpura	Supa	E	NE
289	15.009	74.650	Combretaceae	*Terminalia paniculata*	Balekodlu	Yellapur	E	NE
290	14.879	74.569	Combretaceae	*Terminalia paniculata*	Gidgar	Yellapur	E	NE

291	15.019	74.683	Combretaceae	*Terminalia paniculata*	Hulimundgi	Yellapur	E	NE
292	15.045	74.836	Combretaceae	*Terminalia paniculata*	Kiruvatti	Yellapur	E	NE
293	15.063	74.705	Combretaceae	*Terminalia paniculata*	Lalguli	Yellapur	E	NE
294	15.030	74.636	Combretaceae	*Terminalia paniculata*	Nagarkan	Yellapur	E	NE
295	14.771	74.235	Commelinaceae	*Amiscophacelus axillaris*	Amdalli	Ankola	E	NE
296	14.805	74.289	Commelinaceae	*Amiscophacelus axillaris*	Chittakula	Karwar	E	NE
297	14.911	74.194	Commelinaceae	*Amiscophacelus axillaris*	Hankon	Karwar	E	NE
298	14.856	74.241	Commelinaceae	*Amiscophacelus axillaris*	Sailwada	Karwar	E	NE
299	15.290	74.388	Commelinaceae	*Amiscophacelus axillaris*	Bazarkunang	Supa	E	NE
300	15.242	74.288	Commelinaceae	*Amiscophacelus axillaris*	Diggie	Supa	E	NE
301	15.103	74.466	Commelinaceae	*Amiscophacelus axillaris*	Doodlimala	Supa	E	NE
302	14.771	74.235	Commelinaceae	*Commelina diffusa*	Amdalli	Ankola	E	LC
303	14.805	74.289	Commelinaceae	*Commelina diffusa*	Chittakula	Karwar	E	LC
304	14.911	74.194	Commelinaceae	*Commelina diffusa*	Hankon	Karwar	E	LC
305	14.856	74.241	Commelinaceae	*Commelina diffusa*	Sailwada	Karwar	E	LC
306	15.290	74.388	Commelinaceae	*Commelina diffusa*	Bazarkunang	Supa	E	LC
307	15.242	74.288	Commelinaceae	*Commelina diffusa*	Diggie	Supa	E	LC
308	15.103	74.466	Commelinaceae	*Commelina diffusa*	Doodlimala	Supa	E	LC
309	14.771	74.235	Commelinaceae	*Murdannia nudiflora*	Amdalli	Ankola	E	NE
310	14.805	74.289	Commelinaceae	*Murdannia nudiflora*	Chittakula	Karwar	E	NE
311	14.911	74.194	Commelinaceae	*Murdannia nudiflora*	Hankon	Karwar	E	NE
312	14.856	74.241	Commelinaceae	*Murdannia nudiflora*	Sailwada	Karwar	E	NE
313	15.290	74.388	Commelinaceae	*Murdannia nudiflora*	Bazarkunang	Supa	E	NE
314	15.242	74.288	Commelinaceae	*Murdannia nudiflora*	Diggie	Supa	E	NE
315	15.103	74.466	Commelinaceae	*Murdannia nudiflora*	Doodlimala	Supa	E	NE
316	14.771	74.235	Cyperaceae	*Cyperus iria*	Amdalli	Ankola	E	NE
317	15.225	74.633	Cyperaceae	*Cyperus iria*	Dandeli	Haliyal	E	NE
318	15.179	74.829	Cyperaceae	*Cyperus iria*	Tattigere	Haliyal	E	NE
319	14.805	74.289	Cyperaceae	*Cyperus iria*	Chittakula	Karwar	E	NE
320	14.911	74.194	Cyperaceae	*Cyperus iria*	Hankon	Karwar	E	NE
321	14.856	74.241	Cyperaceae	*Cyperus iria*	Sailwada	Karwar	E	NE
322	14.996	74.331	Cyperaceae	*Cyperus iria*	Badpolli	Supa	E	NE
323	15.290	74.388	Cyperaceae	*Cyperus iria*	Bazarkunang	Supa	E	NE
324	15.242	74.288	Cyperaceae	*Cyperus iria*	Diggie	Supa	E	NE
325	15.103	74.466	Cyperaceae	*Cyperus iria*	Doodlimala	Supa	E	NE
326	15.266	74.582	Cyperaceae	*Cyperus iria*	Mavalinge	Supa	E	NE
327	14.771	74.235	Cyperaceae	*Cyperus rotundus*	Amdalli	Ankola	E	NE
328	14.805	74.289	Cyperaceae	*Cyperus rotundus*	Chittakula	Karwar	E	NE
329	14.911	74.194	Cyperaceae	*Cyperus rotundus*	Hankon	Karwar	E	NE
330	14.856	74.241	Cyperaceae	*Cyperus rotundus*	Sailwada	Karwar	E	NE
331	15.290	74.388	Cyperaceae	*Cyperus rotundus*	Bazarkunang	Supa	E	NE

332	15.242	74.288	Cyperaceae	*Cyperus rotundus*	Diggie	Supa	E	NE
333	15.103	74.466	Cyperaceae	*Cyperus rotundus*	Doodlimala	Supa	E	NE
334	14.771	74.235	Cyperaceae	*Elaeocharis dulcis*	Amdalli	Ankola	E	NE
335	14.805	74.289	Cyperaceae	*Elaeocharis dulcis*	Chittakula	Karwar	E	NE
336	14.911	74.194	Cyperaceae	*Elaeocharis dulcis*	Hankon	Karwar	E	NE
337	14.856	74.241	Cyperaceae	*Elaeocharis dulcis*	Sailwada	Karwar	E	NE
338	15.290	74.388	Cyperaceae	*Elaeocharis dulcis*	Bazarkunang	Supa	E	NE
339	15.242	74.288	Cyperaceae	*Elaeocharis dulcis*	Diggie	Supa	E	NE
340	15.103	74.466	Cyperaceae	*Elaeocharis dulcis*	Doodlimala	Supa	E	NE
341	14.771	74.235	Cyperaceae	*Elaeocharis retroflexa*	Amdalli	Ankola	E	NE
342	14.805	74.289	Cyperaceae	*Elaeocharis retroflexa*	Chittakula	Karwar	E	NE
343	14.911	74.194	Cyperaceae	*Elaeocharis retroflexa*	Hankon	Karwar	E	NE
344	14.856	74.241	Cyperaceae	*Elaeocharis retroflexa*	Sailwada	Karwar	E	NE
345	15.290	74.388	Cyperaceae	*Elaeocharis retroflexa*	Bazarkunang	Supa	E	NE
346	15.242	74.288	Cyperaceae	*Elaeocharis retroflexa*	Diggie	Supa	E	NE
347	15.103	74.466	Cyperaceae	*Elaeocharis retroflexa*	Doodlimala	Supa	E	NE
348	14.990	74.381	Cyperaceae	*Fimbristylis pubisquama*	Karwar	Karwar	E	NE
349	14.771	74.235	Cyperaceae	*Fimbristylis woodrowii*	Amdalli	Ankola	E	NE
350	14.805	74.289	Cyperaceae	*Fimbristylis woodrowii*	Chittakula	Karwar	E	NE
351	14.911	74.194	Cyperaceae	*Fimbristylis woodrowii*	Hankon	Karwar	E	NE
352	14.856	74.241	Cyperaceae	*Fimbristylis woodrowii*	Sailwada	Karwar	E	NE
353	15.290	74.388	Cyperaceae	*Fimbristylis woodrowii*	Bazarkunang	Supa	E	NE
354	15.242	74.288	Cyperaceae	*Fimbristylis woodrowii*	Diggie	Supa	E	NE
355	15.103	74.466	Cyperaceae	*Fimbristylis woodrowii*	Doodlimala	Supa	E	NE
356	14.771	74.235	Cyperaceae	*Fuirena uncinata*	Amdalli	Ankola	E	LC
357	14.805	74.289	Cyperaceae	*Fuirena uncinata*	Chittakula	Karwar	E	LC
358	14.911	74.194	Cyperaceae	*Fuirena uncinata*	Hankon	Karwar	E	LC
359	14.856	74.241	Cyperaceae	*Fuirena uncinata*	Sailwada	Karwar	E	LC
360	15.290	74.388	Cyperaceae	*Fuirena uncinata*	Bazarkunang	Supa	E	LC
361	15.242	74.288	Cyperaceae	*Fuirena uncinata*	Diggie	Supa	E	LC
362	15.103	74.466	Cyperaceae	*Fuirena uncinata*	Doodlimala	Supa	E	LC
363	14.771	74.235	Cyperaceae	*Kyllinga brevifolia*	Amdalli	Ankola	E	NE
364	14.805	74.289	Cyperaceae	*Kyllinga brevifolia*	Chittakula	Karwar	E	NE
365	14.911	74.194	Cyperaceae	*Kyllinga brevifolia*	Hankon	Karwar	E	NE
366	14.856	74.241	Cyperaceae	*Kyllinga brevifolia*	Sailwada	Karwar	E	NE
367	15.290	74.388	Cyperaceae	*Kyllinga brevifolia*	Bazarkunang	Supa	E	NE
368	15.242	74.288	Cyperaceae	*Kyllinga brevifolia*	Diggie	Supa	E	NE
369	15.103	74.466	Cyperaceae	*Kyllinga brevifolia*	Doodlimala	Supa	E	NE
370	14.771	74.235	Cyperaceae	*Schoenoplectus articulatus*	Amdalli	Ankola	E	LC
371	14.805	74.289	Cyperaceae	*Schoenoplectus articulatus*	Chittakula	Karwar	E	LC
372	14.911	74.194	Cyperaceae	*Schoenoplectus articulatus*	Hankon	Karwar	E	LC

373	14.856	74.241	Cyperaceae	*Schoenoplectus articulatus*	Sailwada	Karwar	E	LC
374	15.290	74.388	Cyperaceae	*Schoenoplectus articulatus*	Bazarkunang	Supa	E	LC
375	15.242	74.288	Cyperaceae	*Schoenoplectus articulatus*	Diggie	Supa	E	LC
376	15.103	74.466	Cyperaceae	*Schoenoplectus articulatus*	Doodlimala	Supa	E	LC
377	15.352	74.364	Dilleniaceae	*Dillenia pentagyana*	Castlerock	Karwar		
378	14.957	74.291	Dilleniaceae	*Dillenia pentagyana*	Goyar	Karwar		
379	14.981	74.299	Dilleniaceae	*Dillenia pentagyana*	Kalni_Goyar	Karwar		
380	15.134	74.537	Dilleniaceae	*Dillenia pentagyana*	Desaivada	Supa		
381	14.893	74.549	Dilleniaceae	*Dillenia pentagyana*	Shivpura	Supa		
382	14.879	74.569	Dilleniaceae	*Dillenia pentagyana*	Gidgar	Yellapur		
383	15.011	74.590	Dilleniaceae	*Dillenia pentagyana*	Kattige	Yellapur		
384	15.065	74.705	Dilleniaceae	*Dillenia pentagyana*	Lalguli	Yellapur		
385	15.266	74.606	Dipterocarpaceae	*Hopea ponga*	Dandeli	Haliyal	E/WG	EN
386	15.179	74.829	Dipterocarpaceae	*Hopea ponga*	Tattigere	Haliyal	E/WG	EN
387	14.996	74.331	Dipterocarpaceae	*Hopea ponga*	Badpolli	Supa	E/WG	EN
388	15.396	74.319	Dipterocarpaceae	*Hopea ponga*	Castlerock_IB	Supa	E/WG	EN
389	15.212	74.337	Dipterocarpaceae	*Hopea ponga*	Gavni	Supa	E/WG	EN
390	15.266	74.582	Dipterocarpaceae	*Hopea ponga*	Mavalinge	Supa	E/WG	EN
391	15.000	74.367	Dipterocarpaceae	*Hopea wightiana*	Anshighat	Supa	E/WG	EN
392	14.771	74.235	Droseraceae	*Drosera burmanni*	Amdalli	Ankola	E	LC
393	14.805	74.289	Droseraceae	*Drosera burmanni*	Chittakula	Karwar	E	LC
394	14.911	74.194	Droseraceae	*Drosera burmanni*	Hankon	Karwar	E	LC
395	14.856	74.241	Droseraceae	*Drosera burmanni*	Sailwada	Karwar	E	LC
396	15.290	74.388	Droseraceae	*Drosera burmanni*	Bazarkunang	Supa	E	LC
397	15.242	74.288	Droseraceae	*Drosera burmanni*	Diggie	Supa	E	LC
398	15.103	74.466	Droseraceae	*Drosera burmanni*	Doodlimala	Supa	E	LC
399	15.020	74.677	Ebenaceae	*Diospyros buxifolia*	Hasrapal	Yellapur		
400	15.019	74.683	Ebenaceae	*Diospyros buxifolia*	Hulimundgi	Yellapur		
401	15.352	74.364	Ebenaceae	*Diospyros candolleana*	Castlerock	Karwar	E/WG	VU
402	14.981	74.299	Ebenaceae	*Diospyros candolleana*	Kalni_Goyar	Karwar	E/WG	VU
403	15.396	74.319	Ebenaceae	*Diospyros candolleana*	Castlerock_IB	Supa	E/WG	VU
404	15.212	74.337	Ebenaceae	*Diospyros candolleana*	Gavni	Supa	E/WG	VU
405	15.339	74.359	Ebenaceae	*Diospyros candolleana*	Ivolli	Supa	E/WG	VU
406	15.163	74.336	Ebenaceae	*Diospyros candolleana*	Kushavali	Supa	E/WG	VU
407	15.278	74.806	Ebenaceae	*Diospyros melanoxylon*	Golehalli	Haliyal		
408	15.192	74.855	Ebenaceae	*Diospyros melanoxylon*	Kudalgi	Haliyal		
409	15.230	74.768	Ebenaceae	*Diospyros montana*	Sambrani	Haliyal		
410	15.352	74.364	Ebenaceae	*Diospyros montana*	Castlerock	Karwar		
411	14.920	74.201	Ebenaceae	*Diospyros montana*	Gopishetta	Karwar		
412	14.957	74.291	Ebenaceae	*Diospyros montana*	Goyar	Karwar		
413	15.419	74.332	Ebenaceae	*Diospyros montana*	Joida	Supa		

414	15.009	74.650	Ebenaceae	*Diospyros montana*	Balekodlu	Yellapur		
415	15.001	74.646	Ebenaceae	*Diospyros montana*	Hosmane	Yellapur		
416	15.011	74.590	Ebenaceae	*Diospyros montana*	Kattige	Yellapur		
417	14.981	74.299	Ebenaceae	*Diospyros oocarpa*	Kalni_Goyar	Karwar		
418	15.396	74.319	Ebenaceae	*Diospyros oocarpa*	Castlerock_IB	Supa		
419	15.020	74.676	Ebenaceae	*Diospyros oocarpa*	Hasrapal	Yellapur		
420	14.981	74.299	Ebenaceae	*Diospyros paniculata*	Kalni_Goyar	Karwar	E	EN
421	15.396	74.319	Ebenaceae	*Diospyros paniculata*	Castlerock_IB	Supa	E	EN
422	15.352	74.364	Ebenaceae	*Diospyros pruriens*	Castlerock	Karwar		
423	15.396	74.319	Ebenaceae	*Diospyros saldanhae*	Castlerock_IB	Supa	E	EN
424	15.212	74.337	Ebenaceae	*Diospyros saldanhae*	Gavni	Supa	E	EN
425	15.163	74.336	Ebenaceae	*Diospyros saldanhae*	Kushavali	Supa	E	EN
426	14.771	74.235	Eriocaulaceae	*Eriocaulon cuspidatum*	Amdalli	Ankola	E	LC
427	14.805	74.289	Eriocaulaceae	*Eriocaulon cuspidatum*	Chittakula	Karwar	E	LC
428	14.911	74.194	Eriocaulaceae	*Eriocaulon cuspidatum*	Hankon	Karwar	E	LC
429	14.856	74.241	Eriocaulaceae	*Eriocaulon cuspidatum*	Sailwada	Karwar	E	LC
430	15.290	74.388	Eriocaulaceae	*Eriocaulon cuspidatum*	Bazarkunang	Supa	E	LC
431	15.242	74.288	Eriocaulaceae	*Eriocaulon cuspidatum*	Diggie	Supa	E	LC
432	15.103	74.466	Eriocaulaceae	*Eriocaulon cuspidatum*	Doodlimala	Supa	E	LC
433	14.771	74.235	Eriocaulaceae	*Eriocaulon dalzelli*	Amdalli	Ankola	E	LC
434	14.805	74.289	Eriocaulaceae	*Eriocaulon dalzelli*	Chittakula	Karwar	E	LC
435	14.911	74.194	Eriocaulaceae	*Eriocaulon dalzelli*	Hankon	Karwar	E	LC
436	14.856	74.241	Eriocaulaceae	*Eriocaulon dalzelli*	Sailwada	Karwar	E	LC
437	15.290	74.388	Eriocaulaceae	*Eriocaulon dalzelli*	Bazarkunang	Supa	E	LC
438	15.242	74.288	Eriocaulaceae	*Eriocaulon dalzelli*	Diggie	Supa	E	LC
439	15.103	74.466	Eriocaulaceae	*Eriocaulon dalzelli*	Doodlimala	Supa	E	LC
440	14.771	74.235	Eriocaulaceae	*Eriocaulon eurypeplon*	Amdalli	Ankola	E	LC
441	14.805	74.289	Eriocaulaceae	*Eriocaulon eurypeplon*	Chittakula	Karwar	E	LC
442	14.911	74.194	Eriocaulaceae	*Eriocaulon eurypeplon*	Hankon	Karwar	E	LC
443	14.856	74.241	Eriocaulaceae	*Eriocaulon eurypeplon*	Sailwada	Karwar	E	LC
444	15.290	74.388	Eriocaulaceae	*Eriocaulon eurypeplon*	Bazarkunang	Supa	E	LC
445	15.242	74.288	Eriocaulaceae	*Eriocaulon eurypeplon*	Diggie	Supa	E	LC
446	15.103	74.466	Eriocaulaceae	*Eriocaulon eurypeplon*	Doodlimala	Supa	E	LC
447	14.771	74.235	Eriocaulaceae	*Eriocaulon fysonii*	Amdalli	Ankola	E	LC
448	14.805	74.289	Eriocaulaceae	*Eriocaulon fysonii*	Chittakula	Karwar	E	LC
449	14.911	74.194	Eriocaulaceae	*Eriocaulon fysonii*	Hankon	Karwar	E	LC
450	14.856	74.241	Eriocaulaceae	*Eriocaulon fysonii*	Sailwada	Karwar	E	LC
451	15.290	74.388	Eriocaulaceae	*Eriocaulon fysonii*	Bazarkunang	Supa	E	LC
452	15.242	74.288	Eriocaulaceae	*Eriocaulon fysonii*	Diggie	Supa	E	LC
453	15.103	74.466	Eriocaulaceae	*Eriocaulon fysonii*	Doodlimala	Supa	E	LC
454	14.771	74.235	Eriocaulaceae	*Eriocaulon heterolepis*	Amdalli	Ankola	E	LC

455	14.805	74.289	Eriocaulaceae	*Eriocaulon heterolepis*	Chittakula	Karwar	E	LC
456	14.911	74.194	Eriocaulaceae	*Eriocaulon heterolepis*	Hankon	Karwar	E	LC
457	14.856	74.241	Eriocaulaceae	*Eriocaulon heterolepis*	Sailwada	Karwar	E	LC
458	15.290	74.388	Eriocaulaceae	*Eriocaulon heterolepis*	Bazarkunang	Supa	E	LC
459	15.242	74.288	Eriocaulaceae	*Eriocaulon heterolepis*	Diggie	Supa	E	LC
460	15.103	74.466	Eriocaulaceae	*Eriocaulon heterolepis*	Doodlimala	Supa	E	LC
461	14.771	74.235	Eriocaulaceae	*Eriocaulon lanceolatum*	Amdalli	Ankola	E	LC
462	14.805	74.289	Eriocaulaceae	*Eriocaulon lanceolatum*	Chittakula	Karwar	E	LC
463	14.911	74.194	Eriocaulaceae	*Eriocaulon lanceolatum*	Hankon	Karwar	E	LC
464	14.856	74.241	Eriocaulaceae	*Eriocaulon lanceolatum*	Sailwada	Karwar	E	LC
465	15.290	74.388	Eriocaulaceae	*Eriocaulon lanceolatum*	Bazarkunang	Supa	E	LC
466	15.242	74.288	Eriocaulaceae	*Eriocaulon lanceolatum*	Diggie	Supa	E	LC
467	15.103	74.466	Eriocaulaceae	*Eriocaulon lanceolatum*	Doodlimala	Supa	E	LC
468	14.771	74.235	Eriocaulaceae	*Eriocaulon stellatum*	Amdalli	Ankola	E	LC
469	14.805	74.289	Eriocaulaceae	*Eriocaulon stellatum*	Chittakula	Karwar	E	LC
470	14.911	74.194	Eriocaulaceae	*Eriocaulon stellatum*	Hankon	Karwar	E	LC
471	14.856	74.241	Eriocaulaceae	*Eriocaulon stellatum*	Sailwada	Karwar	E	LC
472	15.290	74.388	Eriocaulaceae	*Eriocaulon stellatum*	Bazarkunang	Supa	E	LC
473	15.242	74.288	Eriocaulaceae	*Eriocaulon stellatum*	Diggie	Supa	E	LC
474	15.103	74.466	Eriocaulaceae	*Eriocaulon stellatum*	Doodlimala	Supa	E	LC
475	15.163	74.336	Euphorbiaceae	*Bischofia javanica*	Kushavali	Supa		
476	15.396	74.319	Euphorbiaceae	*Blachia umbellata*	Castlerock_IB	Supa	E	EN
477	15.352	74.364	Euphorbiaceae	*Bridelia crenulata*	Castlerock	Karwar		
478	15.212	74.337	Euphorbiaceae	*Bridelia scandens*	Gavni	Supa		
479	15.065	74.705	Euphorbiaceae	*Bridelia scandens*	Lalguli	Yellapur		
480	14.957	74.291	Euphorbiaceae	*Macaranga peltata*	Goyar	Karwar		
481	14.981	74.299	Euphorbiaceae	*Macaranga peltata*	Kalni_Goyar	Karwar		
482	15.417	74.332	Euphorbiaceae	*Macaranga peltata*	Castlerock	Supa		
483	15.396	74.319	Euphorbiaceae	*Macaranga peltata*	Castlerock_IB	Supa		
484	15.163	74.336	Euphorbiaceae	*Macaranga peltata*	Kushavali	Supa		
485	15.020	74.677	Euphorbiaceae	*Macaranga peltata*	Hasrapal	Yellapur		
486	15.011	74.590	Euphorbiaceae	*Macaranga peltata*	Kattige	Yellapur		
487	15.030	74.636	Euphorbiaceae	*Macaranga peltata*	Nagarkan	Yellapur		
488	14.981	74.299	Euphorbiaceae	*Mallotus philippensis*	Kalni_Goyar	Karwar		
489	15.419	74.332	Euphorbiaceae	*Mallotus philippensis*	Joida	Supa		
490	14.879	74.569	Euphorbiaceae	*Mallotus philippensis*	Gidgar	Yellapur		
491	15.192	74.855	Fabaceae	*Acacia auriculiformis*	Kudalgi	Haliyal		
492	14.843	74.260	Fabaceae	*Acacia catechu*	Karwar	Karwar		
493	15.351	74.823	Fabaceae	*Albizia lebbeck*	Magvad	Haliyal		
494	15.278	74.806	Fabaceae	*Albizia odoratissima*	Golehalli	Haliyal		
495	15.134	74.537	Fabaceae	*Albizia odoratissima*	Desaivada	Supa		

496	15.225	74.633	Fabaceae	*Alysicarpus vaginalis*	Dandeli	Haliyal	E	NE
497	15.179	74.829	Fabaceae	*Alysicarpus vaginalis*	Tattigere	Haliyal	E	NE
498	14.996	74.331	Fabaceae	*Alysicarpus vaginalis*	Badpolli	Supa	E	NE
499	15.266	74.582	Fabaceae	*Alysicarpus vaginalis*	Mavalinge	Supa	E	NE
500	15.231	74.767	Fabaceae	*Bauhinia foveolata*	Sambrani	Haliyal		
501	15.135	74.538	Fabaceae	*Bauhinia foveolata*	Desaivada	Supa		
502	15.192	74.855	Fabaceae	*Bauhinia racemosa*	Kudalgi	Haliyal		
503	15.351	74.823	Fabaceae	*Bauhinia racemosa*	Magvad	Haliyal		
504	15.230	74.768	Fabaceae	*Bauhinia racemosa*	Sambrani	Haliyal		
505	15.135	74.538	Fabaceae	*Bauhinia racemosa*	Desaivada	Supa		
506	15.277	74.806	Fabaceae	*Butea monosperma*	Golehalli	Haliyal		
507	15.192	74.856	Fabaceae	*Butea monosperma*	Kudalgi	Haliyal		
508	15.277	74.806	Fabaceae	*Cassia fistula*	Golehalli	Haliyal		
509	14.920	74.201	Fabaceae	*Cassia fistula*	Gopishetta	Karwar		
510	15.011	74.590	Fabaceae	*Cassia fistula*	Kattige	Yellapur		
511	15.030	74.636	Fabaceae	*Cassia fistula*	Nagarkan	Yellapur		
512	15.225	74.633	Fabaceae	*Crotolaria filipes*	Dandeli	Haliyal	E	NE
513	15.179	74.829	Fabaceae	*Crotolaria filipes*	Tattigere	Haliyal	E	NE
514	14.996	74.331	Fabaceae	*Crotolaria filipes*	Badpolli	Supa	E	NE
515	15.266	74.582	Fabaceae	*Crotolaria filipes*	Mavalinge	Supa	E	NE
516	15.192	74.855	Fabaceae	*Dalbergia latifolia*	Kudalgi	Haliyal		
517	15.351	74.823	Fabaceae	*Dalbergia latifolia*	Magvad	Haliyal		
518	15.230	74.768	Fabaceae	*Dalbergia latifolia*	Sambrani	Haliyal		
519	15.332	74.712	Fabaceae	*Dalbergia latifolia*	Yadoga	Haliyal		
520	14.957	74.291	Fabaceae	*Dalbergia latifolia*	Goyar	Karwar		
521	15.134	74.536	Fabaceae	*Dalbergia latifolia*	Desaivada	Supa		
522	15.419	74.332	Fabaceae	*Dalbergia latifolia*	Joida	Supa		
523	15.045	74.836	Fabaceae	*Dalbergia latifolia*	Kiruvatti	Yellapur		
524	15.032	74.636	Fabaceae	*Dalbergia latifolia*	Nagarkan	Yellapur		
525	15.163	74.336	Fabaceae	*Derris scandens*	Kushavali	Supa		
526	15.011	74.590	Fabaceae	*Erythrina variegata*	Kattige	Yellapur		
527	15.011	74.590	Fabaceae	*Pongamia pinnata*	Kattige	Yellapur		
528	14.693	74.340	Fabaceae	*Pterocarpus marsupium*	Kattangadde	Ankola		
529	14.879	74.569	Fabaceae	*Pterocarpus marsupium*	Gidgar	Yellapur		
530	15.011	74.590	Fabaceae	*Saraca asoca*	Kattige	Yellapur		
531	15.351	74.823	Fabaceae	*Xylia xylocarpa*	Magvad	Haliyal		
532	14.920	74.201	Fabaceae	*Xylia xylocarpa*	Gopishetta	Karwar		
533	14.957	74.291	Fabaceae	*Xylia xylocarpa*	Goyar	Karwar		
534	15.134	74.536	Fabaceae	*Xylia xylocarpa*	Desaivada	Supa		
535	15.212	74.337	Fabaceae	*Xylia xylocarpa*	Gavni	Supa		
536	15.419	74.332	Fabaceae	*Xylia xylocarpa*	Joida	Supa		

537	14.893	74.549	Fabaceae	*Xylia xylocarpa*	Shivpura	Supa		
538	14.879	74.569	Fabaceae	*Xylia xylocarpa*	Gidgar	Yellapur		
539	15.019	74.682	Fabaceae	*Xylia xylocarpa*	Hulimundgi	Yellapur		
540	15.066	74.705	Fabaceae	*Xylia xylocarpa*	Lalguli	Yellapur		
541	14.771	74.235	Gentianaceae	*Hoppea fastigiata*	Amdalli	Ankola	E	LC
542	14.805	74.289	Gentianaceae	*Hoppea fastigiata*	Chittakula	Karwar	E	LC
543	14.911	74.194	Gentianaceae	*Hoppea fastigiata*	Hankon	Karwar	E	LC
544	14.856	74.241	Gentianaceae	*Hoppea fastigiata*	Sailwada	Karwar	E	LC
545	15.290	74.388	Gentianaceae	*Hoppea fastigiata*	Bazarkunang	Supa	E	LC
546	15.242	74.288	Gentianaceae	*Hoppea fastigiata*	Diggie	Supa	E	LC
547	15.103	74.466	Gentianaceae	*Hoppea fastigiata*	Doodlimala	Supa	E	LC
548	14.920	74.201	Lamiaceae	*Callicarpa tomentosa*	Gopishetta	Karwar		
549	14.771	74.235	Lamiaceae	*Pogostemon erectum*	Amdalli	Ankola	E	NE
550	14.805	74.289	Lamiaceae	*Pogostemon erectum*	Chittakula	Karwar	E	NE
551	14.911	74.194	Lamiaceae	*Pogostemon erectum*	Hankon	Karwar	E	NE
552	14.856	74.241	Lamiaceae	*Pogostemon erectum*	Sailwada	Karwar	E	NE
553	15.290	74.388	Lamiaceae	*Pogostemon erectum*	Bazarkunang	Supa	E	NE
554	15.242	74.288	Lamiaceae	*Pogostemon erectum*	Diggie	Supa	E	NE
555	15.103	74.466	Lamiaceae	*Pogostemon erectum*	Doodlimala	Supa	E	NE
556	15.277	74.806	Lamiaceae	*Tectona grandis*	Golehalli	Haliyal		
557	15.192	74.855	Lamiaceae	*Tectona grandis*	Kudalgi	Haliyal		
558	15.351	74.823	Lamiaceae	*Tectona grandis*	Magvad	Haliyal		
559	15.230	74.768	Lamiaceae	*Tectona grandis*	Sambrani	Haliyal		
560	15.332	74.712	Lamiaceae	*Tectona grandis*	Yadoga	Haliyal		
561	14.920	74.201	Lamiaceae	*Tectona grandis*	Gopishetta	Karwar		
562	15.134	74.536	Lamiaceae	*Tectona grandis*	Desaivada	Supa		
563	15.011	74.590	Lamiaceae	*Tectona grandis*	Kattige	Yellapur		
564	15.045	74.836	Lamiaceae	*Tectona grandis*	Kiruvatti	Yellapur		
565	15.065	74.706	Lamiaceae	*Tectona grandis*	Lalguli	Yellapur		
566	15.032	74.636	Lamiaceae	*Tectona grandis*	Nagarkan	Yellapur		
567	15.354	74.362	Lamiaceae	*Vitex altissima*	Castlerock	Karwar		
568	14.920	74.201	Lamiaceae	*Vitex altissima*	Gopishetta	Karwar		
569	14.981	74.299	Lamiaceae	*Vitex altissima*	Kalni_Goyar	Karwar		
570	15.396	74.319	Lamiaceae	*Vitex altissima*	Castlerock_IB	Supa		
571	15.212	74.337	Lamiaceae	*Vitex altissima*	Gavni	Supa		
572	15.418	74.328	Lamiaceae	*Vitex altissima*	Ivolli	Supa		
573	15.010	74.649	Lamiaceae	*Vitex altissima*	Balekodlu	Yellapur		
574	15.020	74.676	Lamiaceae	*Vitex altissima*	Hasrapal	Yellapur		
575	15.000	74.646	Lamiaceae	*Vitex altissima*	Hosmane	Yellapur		
576	15.019	74.683	Lamiaceae	*Vitex altissima*	Hulimundgi	Yellapur		
577	15.030	74.636	Lamiaceae	*Vitex altissima*	Nagarkan	Yellapur		

578	14.693	74.340	Lauraceae	*Actinodaphne angustifolia*	Kattangadde	Ankola	E	EN
579	15.010	74.650	Lauraceae	*Actinodaphne hookeri*	Balekodlu	Yellapur	E/WG	T
580	15.019	74.682	Lauraceae	*Actinodaphne wightiana*	Hulimundgi	Yellapur	E	EN
581	14.999	74.646	Lauraceae	*Alseodaphne semicarpifolia*	Hosmane	Yellapur		
582	15.030	74.636	Lauraceae	*Alseodaphne semicarpifolia*	Nagarkan	Yellapur		
583	15.418	74.331	Lauraceae	*Beilschmiedia dalzellii*	Castlerock	Supa	E/WG	NE
584	15.163	74.336	Lauraceae	*Beilschmiedia dalzellii*	Kushavali	Supa	E/WG	NE
585	15.011	74.649	Lauraceae	*Beilschmiedia dalzellii*	Balekodlu	Yellapur	E/WG	NE
586	15.020	74.677	Lauraceae	*Beilschmiedia dalzellii*	Hasrapal	Yellapur	E/WG	NE
587	15.000	74.646	Lauraceae	*Beilschmiedia dalzellii*	Hosmane	Yellapur	E/WG	NE
588	15.019	74.682	Lauraceae	*Beilschmiedia dalzellii*	Hulimundgi	Yellapur	E/WG	NE
589	15.418	74.332	Lauraceae	*Cinnamomum malabatrum*	Castlerock	Supa	E/WG	EN
590	15.212	74.337	Lauraceae	*Cinnamomum malabatrum*	Gavni	Supa	E/WG	EN
591	15.418	74.328	Lauraceae	*Cinnamomum malabatrum*	Ivolli	Supa	E/WG	EN
592	15.419	74.332	Lauraceae	*Cinnamomum malabatrum*	Joida	Supa	E/WG	EN
593	15.011	74.649	Lauraceae	*Cinnamomum malabatrum*	Balekodlu	Yellapur	E/WG	EN
594	15.020	74.677	Lauraceae	*Cinnamomum malabatrum*	Hasrapal	Yellapur	E/WG	EN
595	15.001	74.646	Lauraceae	*Cinnamomum malabatrum*	Hosmane	Yellapur	E/WG	EN
596	15.019	74.683	Lauraceae	*Cinnamomum malabatrum*	Hulimundgi	Yellapur	E/WG	EN
597	15.030	74.636	Lauraceae	*Cinnamomum malabatrum*	Nagarkan	Yellapur	E/WG	EN
598	15.212	74.337	Lauraceae	*Cinnamomum verum*	Gavni	Supa	E/WG	NE
599	15.163	74.336	Lauraceae	*Cinnamomum verum*	Kushavali	Supa	E/WG	NE
600	15.011	74.590	Lauraceae	*Cinnamomum verum*	Kattige	Yellapur	E/WG	NE
601	14.981	74.299	Lauraceae	*Litsea floribunda*	Kalni_Goyar	Karwar		
602	15.163	74.336	Lauraceae	*Litsea floribunda*	Kushavali	Supa		
603	14.879	74.569	Lauraceae	*Litsea floribunda*	Gidgar	Yellapur		
604	15.020	74.677	Lauraceae	*Litsea floribunda*	Hasrapal	Yellapur		
605	15.225	74.633	Lauraceae	*Litsea laevigata*	Dandeli	Haliyal	E	NE
606	15.179	74.829	Lauraceae	*Litsea laevigata*	Tattigere	Haliyal	E	NE
607	14.996	74.331	Lauraceae	*Litsea laevigata*	Badpolli	Supa	E	NE
608	15.418	74.328	Lauraceae	*Litsea laevigata*	Ivolli	Supa	E	NE
609	15.163	74.336	Lauraceae	*Litsea laevigata*	Kushavali	Supa	E	NE
610	15.266	74.582	Lauraceae	*Litsea laevigata*	Mavalinge	Supa	E	NE
611	15.419	74.332	Lauraceae	*Persea macrantha*	Joida	Supa	E/WG	NE
612	14.693	74.340	Lecythidiaceae	*Careya arborea*	Kattangadde	Ankola		
613	15.332	74.712	Lecythidiaceae	*Careya arborea*	Yadoga	Haliyal		
614	15.352	74.364	Lecythidiaceae	*Careya arborea*	Castlerock	Karwar		
615	14.920	74.201	Lecythidiaceae	*Careya arborea*	Gopishetta	Karwar		
616	14.957	74.291	Lecythidiaceae	*Careya arborea*	Goyar	Karwar		
617	14.843	74.260	Lecythidiaceae	*Careya arborea*	Karwar	Karwar		
618	14.893	74.549	Lecythidiaceae	*Careya arborea*	Shivpura	Supa		

619	14.879	74.569	Lecythidiaceae	*Careya arborea*	Gidgar	Yellapur		
620	15.065	74.705	Lecythidiaceae	*Careya arborea*	Lalguli	Yellapur		
621	14.771	74.235	Lentibulariaceae	*Utricularia reticulata*	Amdalli	Ankola	E	LC
622	15.266	74.606	Lentibulariaceae	*Utricularia reticulata*	Dandeli	Haliyal	E	LC
623	15.179	74.829	Lentibulariaceae	*Utricularia reticulata*	Tattigere	Haliyal	E	LC
624	14.805	74.289	Lentibulariaceae	*Utricularia reticulata*	Chittakula	Karwar	E	LC
625	14.911	74.194	Lentibulariaceae	*Utricularia reticulata*	Hankon	Karwar	E	LC
626	14.856	74.241	Lentibulariaceae	*Utricularia reticulata*	Sailwada	Karwar	E	LC
627	14.996	74.331	Lentibulariaceae	*Utricularia reticulata*	Badpolli	Supa	E	LC
628	15.290	74.388	Lentibulariaceae	*Utricularia reticulata*	Bazarkunang	Supa	E	LC
629	15.242	74.288	Lentibulariaceae	*Utricularia reticulata*	Diggie	Supa	E	LC
630	15.103	74.466	Lentibulariaceae	*Utricularia reticulata*	Doodlimala	Supa	E	LC
631	15.266	74.582	Lentibulariaceae	*Utricularia reticulata*	Mavalinge	Supa	E	LC
632	14.920	74.201	Loganiaceae	*Strychnos nuxvomica*	Gopishetta	Karwar		
633	14.843	74.260	Loganiaceae	*Strychnos nuxvomica*	Karwar	Karwar		
634	14.893	74.549	Loganiaceae	*Strychnos nuxvomica*	Shivpura	Supa		
635	15.009	74.650	Loganiaceae	*Strychnos nuxvomica*	Balekodlu	Yellapur		
636	14.879	74.569	Loganiaceae	*Strychnos nuxvomica*	Gidgar	Yellapur		
637	15.011	74.590	Loganiaceae	*Strychnos nuxvomica*	Kattige	Yellapur		
638	14.771	74.235	Lythraceae	*Ammannia baccifera*	Amdalli	Ankola	E	LC
639	14.805	74.289	Lythraceae	*Ammannia baccifera*	Chittakula	Karwar	E	LC
640	14.911	74.194	Lythraceae	*Ammannia baccifera*	Hankon	Karwar	E	LC
641	14.856	74.241	Lythraceae	*Ammannia baccifera*	Sailwada	Karwar	E	LC
642	15.290	74.388	Lythraceae	*Ammannia baccifera*	Bazarkunang	Supa	E	LC
643	15.242	74.288	Lythraceae	*Ammannia baccifera*	Diggie	Supa	E	LC
644	15.103	74.466	Lythraceae	*Ammannia baccifera*	Doodlimala	Supa	E	LC
645	15.225	74.633	Lythraceae	*Lagerstroemia microcarpa*	Dandeli	Haliyal	E	NE
646	15.179	74.829	Lythraceae	*Lagerstroemia microcarpa*	Tattigere	Haliyal	E	NE
647	14.957	74.291	Lythraceae	*Lagerstroemia microcarpa*	Goyar	Karwar	E	NE
648	14.981	74.299	Lythraceae	*Lagerstroemia microcarpa*	Kalni_Goyar	Karwar	E	NE
649	15.000	74.367	Lythraceae	*Lagerstroemia microcarpa*	Anshighat	Supa	E	NE
650	14.996	74.331	Lythraceae	*Lagerstroemia microcarpa*	Badpolli	Supa	E	NE
651	15.417	74.332	Lythraceae	*Lagerstroemia microcarpa*	Castlerock	Supa	E	NE
652	15.134	74.536	Lythraceae	*Lagerstroemia microcarpa*	Desaivada	Supa	E	NE
653	15.212	74.337	Lythraceae	*Lagerstroemia microcarpa*	Gavni	Supa	E	NE
654	15.418	74.328	Lythraceae	*Lagerstroemia microcarpa*	Ivolli	Supa	E	NE
655	15.419	74.332	Lythraceae	*Lagerstroemia microcarpa*	Joida	Supa	E	NE
656	15.266	74.582	Lythraceae	*Lagerstroemia microcarpa*	Mavalinge	Supa	E	NE
657	14.893	74.549	Lythraceae	*Lagerstroemia microcarpa*	Shivpura	Supa	E	NE
658	14.999	74.646	Lythraceae	*Lagerstroemia microcarpa*	Hosmane	Yellapur	E	NE
659	15.045	74.836	Lythraceae	*Lagerstroemia microcarpa*	Kiruvatti	Yellapur	E	NE

660	15.065	74.706	Lythraceae	*Lagerstroemia microcarpa*	Lalguli	Yellapur	E	NE
661	15.030	74.636	Lythraceae	*Lagerstroemia microcarpa*	Nagarkan	Yellapur	E	NE
662	14.771	74.235	Lythraceae	*Rotala indica*	Amdalli	Ankola	E	LC
663	14.805	74.289	Lythraceae	*Rotala indica*	Chittakula	Karwar	E	LC
664	14.911	74.194	Lythraceae	*Rotala indica*	Hankon	Karwar	E	LC
665	14.856	74.241	Lythraceae	*Rotala indica*	Sailwada	Karwar	E	LC
666	15.290	74.388	Lythraceae	*Rotala indica*	Bazarkunang	Supa	E	LC
667	15.242	74.288	Lythraceae	*Rotala indica*	Diggie	Supa	E	LC
668	15.103	74.466	Lythraceae	*Rotala indica*	Doodlimala	Supa	E	LC
669	14.771	74.235	Lythraceae	*Rotala macrandra*	Amdalli	Ankola	E	LC
670	14.805	74.289	Lythraceae	*Rotala macrandra*	Chittakula	Karwar	E	LC
671	14.911	74.194	Lythraceae	*Rotala macrandra*	Hankon	Karwar	E	LC
672	14.856	74.241	Lythraceae	*Rotala macrandra*	Sailwada	Karwar	E	LC
673	15.290	74.388	Lythraceae	*Rotala macrandra*	Bazarkunang	Supa	E	LC
674	15.242	74.288	Lythraceae	*Rotala macrandra*	Diggie	Supa	E	LC
675	15.103	74.466	Lythraceae	*Rotala macrandra*	Doodlimala	Supa	E	LC
676	14.771	74.235	Lythraceae	*Rotala malamphuzensis*	Amdalli	Ankola	E	LC
677	14.805	74.289	Lythraceae	*Rotala malamphuzensis*	Chittakula	Karwar	E	LC
678	14.911	74.194	Lythraceae	*Rotala malamphuzensis*	Hankon	Karwar	E	LC
679	14.856	74.241	Lythraceae	*Rotala malamphuzensis*	Sailwada	Karwar	E	LC
680	15.290	74.388	Lythraceae	*Rotala malamphuzensis*	Bazarkunang	Supa	E	LC
681	15.242	74.288	Lythraceae	*Rotala malamphuzensis*	Diggie	Supa	E	LC
682	15.103	74.466	Lythraceae	*Rotala malamphuzensis*	Doodlimala	Supa	E	LC
683	14.771	74.235	Lythraceae	*Rotala rotundifolia*	Amdalli	Ankola	E	LC
684	14.805	74.289	Lythraceae	*Rotala rotundifolia*	Chittakula	Karwar	E	LC
685	14.911	74.194	Lythraceae	*Rotala rotundifolia*	Hankon	Karwar	E	LC
686	14.856	74.241	Lythraceae	*Rotala rotundifolia*	Sailwada	Karwar	E	LC
687	15.290	74.388	Lythraceae	*Rotala rotundifolia*	Bazarkunang	Supa	E	LC
688	15.242	74.288	Lythraceae	*Rotala rotundifolia*	Diggie	Supa	E	LC
689	15.103	74.466	Lythraceae	*Rotala rotundifolia*	Doodlimala	Supa	E	LC
690	15.045	74.836	Malphigiaceae	*Hiptage benghalensis*	Kiruvatti	Yellapur		
691	15.351	74.823	Malvaceae	*Grewia tiliifolia*	Magvad	Haliyal		
692	14.920	74.201	Malvaceae	*Grewia tiliifolia*	Gopishetta	Karwar		
693	14.957	74.291	Malvaceae	*Grewia tiliifolia*	Goyar	Karwar		
694	15.134	74.536	Malvaceae	*Grewia tiliifolia*	Desaivada	Supa		
695	14.994	74.547	Malvaceae	*Grewia tiliifolia*	Shivpura	Supa		
696	15.065	74.705	Malvaceae	*Grewia tiliifolia*	Lalguli	Yellapur		
697	14.981	74.299	Malvaceae	*Pterospermum diversifolium*	Kalni_Goyar	Karwar		
698	15.212	74.337	Malvaceae	*Sterculia guttata*	Gavni	Supa		
699	15.225	74.633	Melastomataceae	*Memecylon talbotianum*	Dandeli	Haliyal	E	NE
700	15.179	74.829	Melastomataceae	*Memecylon talbotianum*	Tattigere	Haliyal	E	NE

701	14.996	74.331	Melastomataceae	*Memecylon talbotianum*	Badpolli	Supa	E	NE
702	15.266	74.582	Melastomataceae	*Memecylon talbotianum*	Mavalinge	Supa	E	NE
703	15.354	74.362	Melastomataceae	*Memecylon umbellatum*	Castlerock	Karwar		
704	15.396	74.319	Melastomataceae	*Memecylon umbellatum*	Castlerock_IB	Supa		
705	15.212	74.337	Melastomataceae	*Memecylon umbellatum*	Gavni	Supa		
706	15.418	74.328	Melastomataceae	*Memecylon umbellatum*	Ivolli	Supa		
707	14.981	74.299	Meliaceae	*Aglaia elaeagnoidea*	Kalni_Goyar	Karwar	E	LC
708	15.396	74.319	Meliaceae	*Aglaia elaeagnoidea*	Castlerock_IB	Supa	E	LC
709	15.212	74.337	Meliaceae	*Aglaia elaeagnoidea*	Gavni	Supa	E	LC
710	15.418	74.328	Meliaceae	*Aglaia elaeagnoidea*	Ivolli	Supa	E	LC
711	15.163	74.336	Meliaceae	*Aglaia elaeagnoidea*	Kushavali	Supa	E	LC
712	15.020	74.677	Meliaceae	*Aglaia elaeagnoidea*	Hasrapal	Yellapur	E	LC
713	15.001	74.646	Meliaceae	*Aglaia elaeagnoidea*	Hosmane	Yellapur	E	LC
714	15.419	74.332	Meliaceae	*Aphanamixis polystachya*	Joida	Supa		
715	15.163	74.336	Meliaceae	*Aphanamixis polystachya*	Kushavali	Supa		
716	15.020	74.677	Meliaceae	*Dysoxylum binectariferum*	Hasrapal	Yellapur		
717	15.418	74.328	Meliaceae	*Dysoxylum malabaricum*	Ivolli	Supa	E	NE
718	15.163	74.336	Meliaceae	*Dysoxylum malabaricum*	Kushavali	Supa	E	NE
719	15.020	74.677	Meliaceae	*Dysoxylum malabaricum*	Hasrapal	Yellapur	E	NE
720	15.396	74.319	Meliaceae	*Reinwardtiodendron anamalaiense*	Castlerock_IB	Supa		
721	15.020	74.677	Meliaceae	*Reinwardtiodendron anamalaiense*	Hasrapal	Yellapur		
722	15.212	74.337	Meliaceae	*Trichilia connaroides*	Gavni	Supa		
723	15.396	74.319	Meliaceae	*Walsura trifoliolata*	Castlerock_IB	Supa		
724	14.693	74.340	Moraceae	*Artocarpus gomezianus*	Kattangadde	Ankola		
725	14.957	74.291	Moraceae	*Artocarpus gomezianus*	Goyar	Karwar		
726	14.981	74.299	Moraceae	*Artocarpus gomezianus*	Kalni_Goyar	Karwar		
727	15.010	74.650	Moraceae	*Artocarpus gomezianus*	Balekodlu	Yellapur		
728	15.019	74.682	Moraceae	*Artocarpus gomezianus*	Hulimundgi	Yellapur		
729	15.225	74.633	Moraceae	*Artocarpus heterophyllus*	Dandeli	Haliyal	E	NE
730	15.179	74.829	Moraceae	*Artocarpus heterophyllus*	Tattigere	Haliyal	E	NE
731	14.996	74.331	Moraceae	*Artocarpus heterophyllus*	Badpolli	Supa	E	NE
732	15.396	74.319	Moraceae	*Artocarpus heterophyllus*	Castlerock_IB	Supa	E	NE
733	15.266	74.582	Moraceae	*Artocarpus heterophyllus*	Mavalinge	Supa	E	NE
734	15.225	74.633	Moraceae	*Artocarpus hirsutus*	Dandeli	Haliyal	E	NE
735	15.179	74.829	Moraceae	*Artocarpus hirsutus*	Tattigere	Haliyal	E	NE
736	14.996	74.331	Moraceae	*Artocarpus hirsutus*	Badpolli	Supa	E	NE
737	15.266	74.582	Moraceae	*Artocarpus hirsutus*	Mavalinge	Supa	E	NE
738	15.020	74.676	Moraceae	*Artocarpus hirsutus*	Hasrapal	Yellapur	E	NE
739	15.019	74.682	Moraceae	*Artocarpus hirsutus*	Hulimundgi	Yellapur	E	NE
740	15.418	74.328	Moraceae	*Ficus arnottiana*	Ivolli	Supa		

741	15.332	74.712	Moraceae	*Ficus bengalensis*	Yadoga	Haliyal		
742	14.693	74.340	Moraceae	*Ficus drupacea*	Kattangadde	Ankola		
743	15.011	74.590	Moraceae	*Ficus exasperata*	Kattige	Yellapur		
744	15.000	74.646	Moraceae	*Ficus microcarpa*	Hosmane	Yellapur		
745	15.212	74.337	Moraceae	*Ficus nervosa*	Gavni	Supa		
746	15.163	74.336	Moraceae	*Ficus nervosa*	Kushavali	Supa		
747	15.351	74.823	Moraceae	*Ficus racemosa*	Magvad	Haliyal		
748	15.163	74.336	Moraceae	*Ficus racemosa*	Kushavali	Supa		
749	15.011	74.590	Moraceae	*Ficus religiosa*	Kattige	Yellapur		
750	14.981	74.299	Myristicaceae	*Knema attenuata*	Kalni_Goyar	Karwar	E/WG	LC
751	15.000	74.367	Myristicaceae	*Knema attenuata*	Anshighat	Supa	E/WG	LC
752	15.396	74.319	Myristicaceae	*Knema attenuata*	Castlerock_IB	Supa	E/WG	LC
753	15.020	74.677	Myristicaceae	*Knema attenuata*	Hasrapal	Yellapur	E/WG	LC
754	15.019	74.683	Myristicaceae	*Knema attenuata*	Hulimundgi	Yellapur	E/WG	LC
755	15.396	74.319	Myristicaceae	*Myristica dactyloides*	Castlerock_IB	Supa		
756	15.418	74.328	Myristicaceae	*Myristica dactyloides*	Ivolli	Supa		
757	15.163	74.336	Myristicaceae	*Myristica dactyloides*	Kushavali	Supa		
758	15.225	74.633	Myristicaceae	*Myristica malabarica*	Dandeli	Haliyal	E	VU
759	15.179	74.829	Myristicaceae	*Myristica malabarica*	Tattigere	Haliyal	E	VU
760	14.996	74.331	Myristicaceae	*Myristica malabarica*	Badpolli	Supa	E	VU
761	15.163	74.336	Myristicaceae	*Myristica malabarica*	Kushavali	Supa	E	VU
762	15.266	74.582	Myristicaceae	*Myristica malabarica*	Mavalinge	Supa	E	VU
763	15.020	74.677	Myristicaceae	*Myristica malabarica*	Hasrapal	Yellapur	E	VU
764	15.011	74.590	Myrtaceae	*Syzygium aromaticum*	Kattige	Yellapur		
765	14.693	74.340	Myrtaceae	*Syzygium cumini*	Kattangadde	Ankola		
766	15.352	74.364	Myrtaceae	*Syzygium cumini*	Castlerock	Karwar		
767	15.212	74.337	Myrtaceae	*Syzygium cumini*	Gavni	Supa		
768	15.418	74.328	Myrtaceae	*Syzygium cumini*	Ivolli	Supa		
769	15.163	74.336	Myrtaceae	*Syzygium cumini*	Kushavali	Supa		
770	15.009	74.650	Myrtaceae	*Syzygium cumini*	Balekodlu	Yellapur		
771	15.066	74.705	Myrtaceae	*Syzygium cumini*	Lalguli	Yellapur		
772	15.031	74.636	Myrtaceae	*Syzygium cumini*	Nagarkan	Yellapur		
773	15.396	74.319	Myrtaceae	*Syzygium gardneri*	Castlerock_IB	Supa	E/WG/ SL	NE
774	15.020	74.676	Myrtaceae	*Syzygium gardneri*	Hasrapal	Yellapur	E/WG/ SL	NE
775	14.981	74.299	Myrtaceae	*Syzygium hemesphericum*	Kalni_Goyar	Karwar		
776	15.212	74.337	Myrtaceae	*Syzygium hemesphericum*	Gavni	Supa		
777	15.212	74.337	Myrtaceae	*Syzygium laetum*	Gavni	Supa	E/WG	NE
778	15.212	74.337	Myrtaceae	*Syzygium zeylanicum*	Gavni	Supa		
779	14.771	74.235	Nymphaeaceae	*Nymphaea nouchali*	Amdalli	Ankola	E	LC
780	15.266	74.606	Nymphaeaceae	*Nymphaea nouchali*	Dandeli	Haliyal	E	LC

781	15.179	74.829	Nymphaeaceae	*Nymphaea nouchali*	Tattigere	Haliyal	E	LC
782	14.805	74.289	Nymphaeaceae	*Nymphaea nouchali*	Chittakula	Karwar	E	LC
783	14.911	74.194	Nymphaeaceae	*Nymphaea nouchali*	Hankon	Karwar	E	LC
784	14.856	74.241	Nymphaeaceae	*Nymphaea nouchali*	Sailwada	Karwar	E	LC
785	14.996	74.331	Nymphaeaceae	*Nymphaea nouchali*	Badpolli	Supa	E	LC
786	15.290	74.388	Nymphaeaceae	*Nymphaea nouchali*	Bazarkunang	Supa	E	LC
787	15.242	74.288	Nymphaeaceae	*Nymphaea nouchali*	Diggie	Supa	E	LC
788	15.103	74.466	Nymphaeaceae	*Nymphaea nouchali*	Doodlimala	Supa	E	LC
789	15.266	74.582	Nymphaeaceae	*Nymphaea nouchali*	Mavalinge	Supa	E	LC
790	15.352	74.364	Oleaceae	*Olea dioica*	Castlerock	Karwar		
791	14.981	74.299	Oleaceae	*Olea dioica*	Kalni_Goyar	Karwar		
792	15.396	74.319	Oleaceae	*Olea dioica*	Castlerock_IB	Supa		
793	15.212	74.337	Oleaceae	*Olea dioica*	Gavni	Supa		
794	15.418	74.328	Oleaceae	*Olea dioica*	Ivolli	Supa		
795	15.163	74.336	Oleaceae	*Olea dioica*	Kushavali	Supa		
796	15.009	74.650	Oleaceae	*Olea dioica*	Balekodlu	Yellapur		
797	15.020	74.677	Oleaceae	*Olea dioica*	Hasrapal	Yellapur		
798	14.999	74.646	Oleaceae	*Olea dioica*	Hosmane	Yellapur		
799	15.019	74.683	Oleaceae	*Olea dioica*	Hulimundgi	Yellapur		
800	15.030	74.636	Oleaceae	*Olea dioica*	Nagarkan	Yellapur		
801	15.354	74.362	Phyllanthaceae	*Aporosa cardiosperma*	Castlerock	Karwar		
802	14.843	74.260	Phyllanthaceae	*Aporosa cardiosperma*	Karwar	Karwar		
803	15.212	74.337	Phyllanthaceae	*Aporosa cardiosperma*	Gavni	Supa		
804	15.009	74.650	Phyllanthaceae	*Aporosa cardiosperma*	Balekodlu	Yellapur		
805	15.018	74.683	Phyllanthaceae	*Aporosa cardiosperma*	Hulimundgi	Yellapur		
806	15.030	74.636	Phyllanthaceae	*Aporosa cardiosperma*	Nagarkan	Yellapur		
807	15.332	74.712	Phyllanthaceae	*Bridelia crenulata*	Yadoga	Haliyal		
808	15.066	74.705	Phyllanthaceae	*Emblica officinalis*	Lalguli	Yellapur		
809	15.212	74.337	Phyllanthaceae	*Glochidion ellipticum*	Gavni	Supa		
810	15.030	74.636	Phyllanthaceae	*Glochidion zeylanicum*	Nagarkan	Yellapur		
811	15.352	74.364	Phyllanthaceae	*Phyllanthus emblica*	Castlerock	Karwar		
812	14.843	74.260	Phyllanthaceae	*Phyllanthus emblica*	Karwar	Karwar		
813	14.771	74.235	Poaceae	*Coix-lacryma Jobi*	Amdalli	Ankola	E	NE
814	14.805	74.289	Poaceae	*Coix-lacryma Jobi*	Chittakula	Karwar	E	NE
815	14.911	74.194	Poaceae	*Coix-lacryma Jobi*	Hankon	Karwar	E	NE
816	14.856	74.241	Poaceae	*Coix-lacryma Jobi*	Sailwada	Karwar	E	NE
817	15.290	74.388	Poaceae	*Coix-lacryma Jobi*	Bazarkunang	Supa	E	NE
818	15.242	74.288	Poaceae	*Coix-lacryma Jobi*	Diggie	Supa	E	NE
819	15.103	74.466	Poaceae	*Coix-lacryma Jobi*	Doodlimala	Supa	E	NE
820	15.225	74.633	Poaceae	*Dactyloctenium aegyptium*	Dandeli	Haliyal	E	NE
821	15.179	74.829	Poaceae	*Dactyloctenium aegyptium*	Tattigere	Haliyal	E	NE

822	14.996	74.331	Poaceae	*Dactyloctenium aegyptium*	Badpolli	Supa	E	NE
823	15.266	74.582	Poaceae	*Dactyloctenium aegyptium*	Mavalinge	Supa	E	NE
824	14.771	74.235	Poaceae	*Ischemum molle*	Amdalli	Ankola	E	LC
825	14.805	74.289	Poaceae	*Ischemum molle*	Chittakula	Karwar	E	LC
826	14.911	74.194	Poaceae	*Ischemum molle*	Hankon	Karwar	E	LC
827	14.856	74.241	Poaceae	*Ischemum molle*	Sailwada	Karwar	E	LC
828	15.290	74.388	Poaceae	*Ischemum molle*	Bazarkunang	Supa	E	LC
829	15.242	74.288	Poaceae	*Ischemum molle*	Diggie	Supa	E	LC
830	15.103	74.466	Poaceae	*Ischemum molle*	Doodlimala	Supa	E	LC
831	15.396	74.319	Putranjivaceae	*Drypetes venusta*	Castlerock_IB	Supa		
832	15.212	74.337	Putranjivaceae	*Drypetus oblongifolia*	Gavni	Supa		
833	15.278	74.806	Rhamnaceae	*Scutia myrtina*	Golehalli	Haliyal		
834	15.192	74.855	Rhamnaceae	*Scutia myrtina*	Kudalgi	Haliyal		
835	15.352	74.364	Rhamnaceae	*Scutia myrtina*	Castlerock	Karwar		
836	14.843	74.260	Rhamnaceae	*Scutia myrtina*	Karwar	Karwar		
837	14.957	74.291	Rhamnaceae	*Ziziphus rugosa*	Goyar	Karwar		
838	15.418	74.332	Rhizophoraceae	*Carallia brachiata*	Castlerock	Supa		
839	15.212	74.337	Rhizophoraceae	*Carallia brachiata*	Gavni	Supa		
840	15.352	74.364	Rubiaceae	*Catunaregam spinosa*	Castlerock	Karwar		
841	14.843	74.260	Rubiaceae	*Catunaregam spinosa*	Karwar	Karwar		
842	15.009	74.650	Rubiaceae	*Catunaregam spinosa*	Balekodlu	Yellapur		
843	15.019	74.683	Rubiaceae	*Catunaregam spinosa*	Hulimundgi	Yellapur		
844	15.031	74.636	Rubiaceae	*Catunaregam spinosa*	Nagarkan	Yellapur		
845	14.693	74.340	Rubiaceae	*Haldina cordifolia*	Kattangadde	Ankola		
846	15.230	74.768	Rubiaceae	*Haldina cordifolia*	Sambrani	Haliyal		
847	15.332	74.712	Rubiaceae	*Haldina cordifolia*	Yadoga	Haliyal		
848	14.920	74.201	Rubiaceae	*Haldina cordifolia*	Gopishetta	Karwar		
849	14.843	74.260	Rubiaceae	*Haldina cordifolia*	Karwar	Karwar		
850	14.893	74.549	Rubiaceae	*Haldina cordifolia*	Shivpura	Supa		
851	15.066	74.705	Rubiaceae	*Haldina cordifolia*	Lalguli	Yellapur		
852	14.693	74.340	Rubiaceae	*Ixora brachiata*	Kattangadde	Ankola	E	NE
853	15.225	74.633	Rubiaceae	*Ixora brachiata*	Dandeli	Haliyal	E	NE
854	15.179	74.829	Rubiaceae	*Ixora brachiata*	Tattigere	Haliyal	E	NE
855	14.981	74.299	Rubiaceae	*Ixora brachiata*	Kalni_Goyar	Karwar	E	NE
856	14.996	74.331	Rubiaceae	*Ixora brachiata*	Badpolli	Supa	E	NE
857	15.212	74.337	Rubiaceae	*Ixora brachiata*	Gavni	Supa	E	NE
858	15.418	74.328	Rubiaceae	*Ixora brachiata*	Ivolli	Supa	E	NE
859	15.266	74.582	Rubiaceae	*Ixora brachiata*	Mavalinge	Supa	E	NE
860	15.009	74.650	Rubiaceae	*Ixora brachiata*	Balekodlu	Yellapur	E	NE
861	14.999	74.646	Rubiaceae	*Ixora brachiata*	Hosmane	Yellapur	E	NE
862	15.030	74.636	Rubiaceae	*Ixora brachiata*	Nagarkan	Yellapur	E	NE

863	15.418	74.331	Rubiaceae	*Ixora pavetta*	Castlerock	Supa		
864	15.011	74.590	Rubiaceae	*Ixora pavetta*	Kattige	Yellapur		
865	15.419	74.332	Rubiaceae	*Meyna laxiflora*	Joida	Supa		
866	15.065	74.705	Rubiaceae	*Meyna laxiflora*	Lalguli	Yellapur		
867	15.134	74.537	Rubiaceae	*Meyna spinosa*	Desaivada	Supa		
868	15.351	74.823	Rubiaceae	*Mitragyna parviflora*	Magvad	Haliyal		
869	15.134	74.537	Rubiaceae	*Mitragyna parviflora*	Desaivada	Supa		
870	15.030	74.636	Rubiaceae	*Mitragyna parviflora*	Nagarkan	Yellapur		
871	15.277	74.806	Rubiaceae	*Morinda tomentosa*	Golehalli	Haliyal		
872	15.354	74.362	Rubiaceae	*Psydrax umbellata*	Castlerock	Karwar	E	EN
873	15.352	74.364	Rubiaceae	*Wendlandia thyrsoidea*	Castlerock	Karwar		
874	15.011	74.590	Rutaceae	*Citrus aurantium*	Kattige	Yellapur		
875	15.419	74.332	Rutaceae	*Murraya paniculata*	Joida	Supa		
876	14.981	74.299	Rutaceae	*Zanthoxylum rhetsa*	Kalni_Goyar	Karwar		
877	15.417	74.332	Salicaceae	*Casearia championii*	Castlerock	Supa		
878	15.419	74.332	Salicaceae	*Casearia championii*	Joida	Supa		
879	15.020	74.677	Salicaceae	*Casearia tomentosa*	Hasrapal	Yellapur		
880	15.418	74.332	Salicaceae	*Flacourtia montana*	Castlerock	Supa	E/WG	NE
881	15.212	74.337	Salicaceae	*Flacourtia montana*	Gavni	Supa	E/WG	NE
882	15.419	74.332	Salicaceae	*Flacourtia montana*	Joida	Supa	E/WG	NE
883	15.163	74.336	Salicaceae	*Flacourtia montana*	Kushavali	Supa	E/WG	NE
884	15.010	74.650	Salicaceae	*Flacourtia montana*	Balekodlu	Yellapur	E/WG	NE
885	15.000	74.646	Salicaceae	*Flacourtia montana*	Hosmane	Yellapur	E/WG	NE
886	15.019	74.682	Salicaceae	*Flacourtia montana*	Hulimundgi	Yellapur	E/WG	NE
887	15.351	74.823	Salicaceae	*Flacourtia ramontchi*	Magvad	Haliyal		
888	15.230	74.768	Salicaceae	*Flacourtia ramontchi*	Sambrani	Haliyal		
889	15.332	74.712	Salicaceae	*Flacourtia ramontchi*	Yadoga	Haliyal		
890	14.981	74.299	Sapindaceae	*Dimocarpus longan*	Kalni_Goyar	Karwar	E/WG	LRNT
891	15.000	74.367	Sapindaceae	*Dimocarpus longan*	Anshighat	Supa	E/WG	LRNT
892	15.396	74.319	Sapindaceae	*Dimocarpus longan*	Castlerock_IB	Supa	E/WG	LRNT
893	15.212	74.337	Sapindaceae	*Dimocarpus longan*	Gavni	Supa	E/WG	LRNT
894	15.163	74.336	Sapindaceae	*Dimocarpus longan*	Kushavali	Supa	E/WG	LRNT
895	15.417	74.332	Sapindaceae	*Harpullia imbricata*	Castlerock	Supa		
896	14.981	74.299	Sapindaceae	*Lepisanthes tetraphylla*	Kalni_Goyar	Karwar		
897	15.030	74.636	Sapindaceae	*Lepisanthes tetraphylla*	Nagarkan	Yellapur		
898	14.879	74.569	Sapindaceae	*Sapindus laurifolia*	Gidgar	Yellapur		
899	15.011	74.590	Sapindaceae	*Sapindus trifoliata*	Kattige	Yellapur		
900	14.693	74.340	Sapindaceae	*Schleichera oleosa*	Kattangadde	Ankola		
901	15.278	74.806	Sapindaceae	*Schleichera oleosa*	Golehalli	Haliyal		

902	15.332	74.712	Sapindaceae	*Schleichera oleosa*	Yadoga	Haliyal		
903	14.920	74.201	Sapindaceae	*Schleichera oleosa*	Gopishetta	Karwar		
904	15.010	74.650	Sapindaceae	*Schleichera oleosa*	Balekodlu	Yellapur		
905	14.879	74.569	Sapindaceae	*Schleichera oleosa*	Gidgar	Yellapur		
906	14.999	74.646	Sapindaceae	*Schleichera oleosa*	Hosmane	Yellapur		
907	15.030	74.636	Sapindaceae	*Schleichera oleosa*	Nagarkan	Yellapur		
908	15.020	74.676	Sapotaceae	*Chrysophyllum roxburghii*	Hasrapal	Yellapur		
909	15.277	74.806	Sapotaceae	*Madhuca latifolia*	Golehalli	Haliyal		
910	15.351	74.823	Sapotaceae	*Madhuca latifolia*	Magvad	Haliyal		
911	14.843	74.260	Sapotaceae	*Madhuca latifolia*	Karwar	Karwar		
912	15.045	74.836	Sapotaceae	*Madhuca latifolia*	Kiruvatti	Yellapur		
913	14.981	74.299	Sapotaceae	*Madhuca longifolia*	Kalni_Goyar	Karwar		
914	15.212	74.337	Sapotaceae	*Mimusops elengi*	Gavni	Supa		
915	15.163	74.336	Sapotaceae	*Mimusops elengi*	Kushavali	Supa		
916	15.020	74.677	Sapotaceae	*Mimusops elengi*	Hasrapal	Yellapur		
917	15.019	74.682	Sapotaceae	*Mimusops elengi*	Hulimundgi	Yellapur		
918	15.396	74.319	Sapotaceae	*Palaquim ellipticum*	Castlerock_IB	Supa		
919	14.693	74.340	Sapotaceae	*Xantolis tomentosa*	Kattangadde	Ankola		
920	15.277	74.806	Sapotaceae	*Xantolis tomentosa*	Golehalli	Haliyal		
921	14.920	74.201	Sapotaceae	*Xantolis tomentosa*	Gopishetta	Karwar		
922	15.418	74.331	Sapotaceae	*Xantolis tomentosa*	Castlerock	Supa		
923	14.999	74.646	Sapotaceae	*Xantolis tomentosa*	Hosmane	Yellapur		
924	15.032	74.636	Sapotaceae	*Xantolis tomentosa*	Nagarkan	Yellapur		
925	14.771	74.235	Scrophulariaceae	*Lindernia crustacea*	Amdalli	Ankola	E	LC
926	14.805	74.289	Scrophulariaceae	*Lindernia crustacea*	Chittakula	Karwar	E	LC
927	14.911	74.194	Scrophulariaceae	*Lindernia crustacea*	Hankon	Karwar	E	LC
928	14.856	74.241	Scrophulariaceae	*Lindernia crustacea*	Sailwada	Karwar	E	LC
929	15.290	74.388	Scrophulariaceae	*Lindernia crustacea*	Bazarkunang	Supa	E	LC
930	15.242	74.288	Scrophulariaceae	*Lindernia crustacea*	Diggie	Supa	E	LC
931	15.103	74.466	Scrophulariaceae	*Lindernia crustacea*	Doodlimala	Supa	E	LC
932	14.981	74.299	Simarubiaceae	*Ailanthus malabarica*	Kalni_Goyar	Karwar		
933	14.920	74.201	Simarubiaceae	*Ailanthus triphysa*	Gopishetta	Karwar		
934	15.352	74.364	Symplocaceae	*Symplocos racemosa*	Castlerock	Karwar	E/WG	NE
935	15.212	74.337	Symplocaceae	*Symplocos racemosa*	Gavni	Supa	E/WG	NE
936	15.418	74.328	Symplocaceae	*Symplocos racemosa*	Ivolli	Supa	E/WG	NE
937	15.163	74.336	Symplocaceae	*Symplocos racemosa*	Kushavali	Supa	E/WG	NE
938	15.019	74.682	Symplocaceae	*Symplocos racemosa*	Hulimundgi	Yellapur	E/WG	NE

*Endemism: E-Endemic; *Status: EN-Endangered; NE-Not Evaluated; LC-Least Conceren; VU-Vulnerable; LTNR- Near Threatened; T- Threatened.

Annexure 2

Annexure 2: Village wise ESR across three districts of Kali basin.

District: UTTARA KANNADA			
ESR - 1 (190)			
SNO	**TAUK NAME**	**VILLAGE NAME**	**AREA (Ha)**
1	Supa	Akheti	1497.72
2	Supa	Amagaon	4550.16
3	Supa	Amarde	206.86
4	Supa	Ambeli	3032.70
5	Supa	Ambolli	17833.86
6	Supa	Amshet	826.52
7	Supa	Anamod	2064.92
8	Supa	Anashi	25313.04
9	Supa	Asu	1674.12
10	Supa	Asulli	6048.26
11	Supa	Atle	1378.44
12	Supa	Aveda	883.70
13	Supa	Aveda Poppal Wadi	1152.90
14	Supa	Avurli	1299.86
15	Supa	Badgund	863.48
16	Supa	Badpoli	1853.89
17	Supa	Bamanawadi	323.74
18	Supa	Bandoda	450.73
19	Supa	Bapeli	421.25
20	Supa	Bazar Kunang	2272.99
21	Supa	Bedasgadde	188.75
22	Supa	Bidoli	4566.94
23	Supa	Birampali	2543.35
24	Supa	Birkhol	13502.07
25	Supa	Boregali	263.45
26	Supa	Bori	641.70
27	Supa	Chafer	1325.39
28	Supa	Chandawadi	1063.29
29	Supa	Chapakhand	262.81
30	Supa	Chapali	3045.81
31	Supa	Chapoli (A)	142.28
32	Supa	Chapoli (Kalsai)	2708.93
33	Supa	Chinchkhand	121.66
34	Supa	Deriye	701.38
35	Supa	Devulli (Joida)	4286.35

36	Supa	Devulli (Tinai)	765.95
37	Supa	Diggi	1505.96
38	Supa	Durg	2606.55
39	Supa	Durgi	305.58
40	Supa	Gangoda	7511.26
41	Supa	Gavegali	2044.59
42	Supa	Ghvane	230.60
43	Supa	Godashet	768.01
44	Supa	Gund	11326.02
45	Supa	Hebbal	1214.19
46	Supa	Hudasa	4621.98
47	Supa	Iliye Dabe	898.46
48	Supa	Ivoli	2204.94
49	Supa	Jagalbet	442.15
50	Supa	Joida	1712.88
51	Supa	Kalambuli	2384.12
52	Supa	Kalamkhand	10586.67
53	Supa	Kalasai	2933.28
54	Supa	Kamra	1672.02
55	Supa	Karambal	960.89
56	Supa	Karanjoida	3391.19
57	Supa	Kariyadi	680.35
58	Supa	Kasarle	595.88
59	Supa	Kasarwadi	259.46
60	Supa	Katel	641.46
61	Supa	Kateli (Kumbar Wada)	1634.70
62	Supa	Kavale	4213.03
63	Supa	Khodli	1993.40
64	Supa	Kodthalli	1185.68
65	Supa	Konda (Haliyal)	487.31
66	Supa	Kondapa	879.77
67	Supa	Konshet	809.53
68	Supa	Kumbeli	2596.44
69	Supa	Kumbral	201.89
70	Supa	Kunagini	307.99
71	Supa	Kundal	3798.42
72	Supa	Kurandi	620.00
73	Supa	Kuveshi	1939.79
74	Supa	Mavalinge	689.80
75	Supa	Miras Kumbeli	512.03
76	Supa	Nagari	865.90

77	Supa	Nagoda	777.43
78	Supa	Nandigadde	144.96
79	Supa	Neturge	1947.03
80	Supa	Nigundi	2703.84
81	Supa	Nujji	6582.22
82	Supa	Palada	1264.27
83	Supa	Panjeli	1568.45
84	Supa	Payaswadi	7216.18
85	Supa	Phansoli	955.56
86	Supa	Pisose	311.29
87	Supa	Pradhani	627.67
88	Supa	Pusheli	532.17
89	Supa	Rangarook	3069.00
90	Supa	Reservoir (Supa)	16874.19
91	Supa	Samjoida	402.40
92	Supa	Sangave	1396.29
93	Supa	Sannamaga	815.47
94	Supa	Shevali	1964.30
95	Supa	Shindholi	488.74
96	Supa	Shiroli	4242.32
97	Supa	Shivapur	416.84
98	Supa	Terali	3578.16
99	Supa	Timbholi	703.45
100	Supa	Tinai Khand	86.05
101	Supa	Tulasgeri	700.86
102	Supa	Ulavi	848.46
103	Supa	Usoda	4361.08
104	Supa	Vadkal	788.27
105	Supa	Vaijagaon	599.78
106	Supa	Vaini	994.20
107	Supa	Varande	462.44
108	Supa	Varlewadi	3622.08
109	Supa	Vatala	798.57
110	Supa	Velif Kumbeli	1850.04
111	Supa	Viral	562.87
112	Supa	Viranjol	1018.91
113	Supa	Virnoli	2226.50
114	Supa	Wada	396.60
115	Supa	Yeramukh	2106.45
116	Supa	Zalawali	4769.55
117	Haliyal	Ambewadi	1171.95

118	Haliyal	Ambikanagara (CT)	133.20
119	Haliyal	Amga	2249.44
120	Haliyal	Badakanshirda	1801.01
121	Haliyal	Dandeli	1227.95
122	Haliyal	Gobral	5185.13
123	Haliyal	Gutti	974.09
124	Haliyal	Haregali	5605.07
125	Haliyal	Hosakumbarkop	870.56
126	Haliyal	Jamaga	9011.71
127	Haliyal	Kegdal	693.95
128	Haliyal	Kulgi	1533.51
129	Haliyal	Vincholli	5804.29
130	Haliyal	Vitnal	543.28
131	Ankola	Gule	2573.00
132	Ankola	Kendige	2298.57
133	Ankola	Lakkeguli	788.58
134	Ankola	Mallani	2264.73
135	Ankola	Sheveguli	3109.63
136	Ankola	Shikliturli	868.36
137	Ankola	Gule	2573.00
138	Ankola	Kendige	2298.57
139	Yellapur	Angod	2210.94
140	Yellapur	Baginkatta	256.40
141	Yellapur	Balagar	1327.15
142	Yellapur	Baraballi	598.59
143	Yellapur	Baragadde	221.28
144	Yellapur	Bare	2344.37
145	Yellapur	Beegar	234.62
146	Yellapur	Belegeri	612.91
147	Yellapur	Benadaguli	366.16
148	Yellapur	Bisgod	571.61
149	Yellapur	Chimanalli	722.98
150	Yellapur	Dehalli	1067.39
151	Yellapur	Geral	621.23
152	Yellapur	Gotguli	420.62
153	Yellapur	Hiriyal	609.59
154	Yellapur	Honagadde	372.61
155	Yellapur	Hukkali	351.09
156	Yellapur	Kalache	5145.26
157	Yellapur	Kanur	1542.55
158	Yellapur	Kattige	8077.31

159	Yellapur	Kodsalli	386.42
160	Yellapur	Lingadabailu	531.22
161	Yellapur	Mavinamane	17456.92
162	Yellapur	Nagarakhan	1518.88
163	Yellapur	Savagadde	577.79
164	Yellapur	Targar	301.58
165	Yellapur	Vajralli	648.55
166	Yellapur	Lalguli	15270.48
167	Karwar	Balemane	13196.34
168	Karwar	Bargal	435.99
169	Karwar	Bhaire	2525.97
170	Karwar	Devakar	12747.17
171	Karwar	Devalmakki	526.78
172	Karwar	Gotegali	3458.19
173	Karwar	Goyar	2546.23
174	Karwar	Hartuga	1764.20
175	Karwar	Kadiye	288.39
1756	Karwar	Kadra	11645.48
177	Karwar	Kaiga	3449.60
178	Karwar	Kamargaon	1503.71
179	Karwar	Katar	395.15
180	Karwar	Kerwadi	543.41
181	Karwar	Kuchegar	1826.68
182	Karwar	Lande	2282.78
183	Karwar	Maigini	1525.07
184	Karwar	Mallapur	1256.70
185	Karwar	Naitisavar	250.99
186	Karwar	Nivli	178.91
187	Karwar	Shirve	2722.18
188	Karwar	Ulga	576.99
189	Karwar	Virje	2211.38
190	Karwar	Wailwada	285.37
ESR - 2 (45)			
SNO	**TAUK NAME**	**VILLAGE NAME**	**AREA (Ha)**
1	Supa	Donshet	3817.58
2	Supa	Kudalgaon	5403.46
3	Supa	Malamba	3187.46
4	Supa	Ramnagar	25593.29
5	Supa	Shingargaon	13036.67
6	Haliyal	Adikehosur	1503.94
7	Haliyal	Basawalli	341.19

8	Haliyal	Chimnalli	470.45
9	Haliyal	Chinaginkop	296.50
10	Haliyal	Dodkop	710.92
11	Haliyal	Donshirgur	286.92
12	Haliyal	Handli	352.89
13	Haliyal	Harnoda	221.97
14	Haliyal	Harwalli	923.75
15	Haliyal	Jatga	829.88
16	Haliyal	Jatgahosur	1262.75
17	Haliyal	Kalbhavi	196.54
18	Haliyal	Kariyampali	488.05
19	Haliyal	Kesrodaga	418.60
20	Haliyal	Kumbarkop	390.03
21	Haliyal	Mainal	2397.25
22	Haliyal	Malawad	400.29
23	Haliyal	Malwad	538.31
24	Haliyal	Modalgera	1013.66
25	Haliyal	Mundki	301.69
26	Haliyal	Nandigadda	1259.37
27	Haliyal	Ramapur (Haliyal)	407.63
28	Haliyal	Rayapattan	429.01
29	Haliyal	Singatgeri	1329.58
30	Haliyal	Adikehosur	1503.94
31	Haliyal	Basawalli	341.19
32	Haliyal	Chimnalli	470.45
33	Haliyal	Chinaginkop	296.50
34	Ankola	Berde	1108.32
35	Ankola	Varilbena	443.87
36	Yellapur	Kannadagal	3238.68
37	Yellapur	Kannigeri	2329.71
38	Yellapur	Kolikeri	1076.81
39	Karwar	Amadalli	2474.88
40	Karwar	Belur	1425.22
41	Karwar	Bolshitta	258.74
42	Karwar	Ghadasai	450.03
43	Karwar	Gopashitta	1119.02
44	Karwar	Nagekove	4326.12
45	Karwar	Siddar	1384.15
ESR - 3 (48)			
SNO	**TAUK NAME**	**VILLAGE NAME**	**AREA (Ha)**
1	Haliyal	Addigera	7894.27

2	Haliyal	Agasalkatta	423.08
3	Haliyal	Ajga0N	463.24
4	Haliyal	Ajminal	482.91
5	Haliyal	Alur	1951.04
6	Haliyal	Bedarshirgur	1385.21
7	Haliyal	Berde	1108.32
8	Haliyal	Bhagawati	4961.30
9	Haliyal	Bhimanalli	825.78
10	Haliyal	Bidrolli	222.66
11	Haliyal	Bommanalli (Haliyal)	1418.18
12	Haliyal	Bukkankoppa	93.13
13	Haliyal	Chotakanshirda	745.33
14	Haliyal	Dandeli(Rural)	54.87
15	Haliyal	Domagera	812.22
16	Haliyal	Gardolli	1004.19
17	Haliyal	Hampehalli	1312.68
18	Haliyal	Heggarnikotebavi	161.10
19	Haliyal	Hosur (Haliyal)	421.29
20	Haliyal	Janaga	1802.34
21	Haliyal	Jawalli	415.41
22	Haliyal	Kalginatti (kalginkopp)	250.65
23	Haliyal	Kattinhakkal	377.03
24	Haliyal	Kawalwad	4237.64
25	Haliyal	Kerwad (Dandeli)	444.42
26	Haliyal	Machapur	1696.22
27	Haliyal	Malawadi	355.72
28	Haliyal	Mavinkop	2269.63
29	Haliyal	Narnalli	737.86
30	Haliyal	Nilwani	397.18
31	Haliyal	Pala (Haliyal)	667.92
32	Haliyal	Sambrani	1238.08
33	Ankola	Nellurkanchinbail	1081.68
34	Ankola	Sakalbena	1998.39
35	Yellapur	Donagar	793.37
36	Yellapur	Hamsana Gadde	768.41
37	Yellapur	Hutakmane	412.37
38	Yellapur	Shigepal	37.65
39	Yellapur	Shistamudi	596.77
40	Yellapur	Tatagar	503.57
41	Yellapur	Kanchanahalli	75226.59
42	Karwar	Angadi	944.050274

43	Karwar	Arga	2176.60034
44	Karwar	Chendiye	880.953762
45	Karwar	Hankon	1166.92052
46	Karwar	Makheri	110.826305
47	Karwar	Shirwad	1952.23383
48	Karwar	Todur	1536.38921
ESR - 4 (78)			
SNO	**TAUK NAME**	**VILLAGE NAME**	**AREA (Ha)**
1	Haliyal	Aversa	284.88
2	Haliyal	Belekeri	232.56
3	Haliyal	Harwada	467.92
4	Haliyal	Hattikeri	257.43
5	Haliyal	Alolli	203.53
6	Haliyal	Ammankop	281.12
7	Haliyal	Antrolli	927.42
8	Haliyal	Arlwad	185.02
9	Haliyal	Arshingeri	123.34
10	Haliyal	Bablikop	117.21
11	Haliyal	Baloga	129.57
12	Haliyal	Belwatgi	1577.86
13	Haliyal	Bhanasageri	463.81
14	Haliyal	Bogur	2712.35
15	Haliyal	Buzurkanchanalli	929.12
16	Haliyal	Channapur	535.79
17	Haliyal	Chibbalgeri	410.96
18	Haliyal	Dongrikop	315.86
19	Haliyal	Dusagi	3132.53
20	Haliyal	Gadagera	508.17
21	Haliyal	Ghadiyal	5449.13
22	Haliyal	Golehalli	559.40
23	Haliyal	Guledkop	3544.83
24	Haliyal	Gundolli	707.68
25	Haliyal	Guttibail	125.08
26	Haliyal	Haliyal (TP)	1587.30
27	Haliyal	Halsi	225.74
28	Haliyal	Havagi	285.10
29	Haliyal	Homnalli	201.82
30	Haliyal	Hunswad	492.47
31	Haliyal	Jogankop	240.50
32	Haliyal	Kalasapur	198.01
33	Haliyal	Kalginkop	715.73

34	Haliyal	Karlkatta	509.50
35	Haliyal	Kerwad (Haliyal)	733.84
36	Haliyal	Kesrolli	543.20
37	Haliyal	Khamdolli	357.44
38	Haliyal	Khurd Kanchanalli	323.14
39	Haliyal	Kurigadde (Haliyal)	515.67
40	Haliyal	Kyatangera	385.96
41	Haliyal	Madnalli	253.01
42	Haliyal	Magwad	6519.48
43	Haliyal	Malwadi	355.72
44	Haliyal	Mangalawad	290.22
45	Haliyal	Mugadkop	229.41
46	Haliyal	Mundwad	290.92
47	Haliyal	Murkwad	570.29
48	Haliyal	Muttalmuri	1767.09
49	Haliyal	Nagshetikop	222.98
50	Haliyal	Niralagi	310.24
51	Haliyal	Pura (Haliyal)	123.33
52	Haliyal	Satnalli	169.96
53	Haliyal	Shivapur (Haliyal)	11090.28
54	Haliyal	Siddapur (Haliyal)	249.12
55	Haliyal	Tatwanagi	5010.13
56	Haliyal	Tegnalli	417.10
57	Haliyal	Tergaon	2712.83
58	Ankola	Aversa	284.88
59	Ankola	Belekeri	232.56
60	Ankola	Harwada	467.92
61	Ankola	Hattikeri	257.43
62	Yellapur	Hosalli	1477.41
63	Yellapur	Kiravatti	21402.55
64	Yellapur	Yellapur (TP)	7309.28
65	Karwar	Arav	1137.64
66	Karwar	Halgejoog	52.164
67	Karwar	Hankonjoog	58.184
68	Karwar	Hosali	157.95
69	Karwar	Hotegali	754.94
70	Karwar	Kadwad	700.93
71	Karwar	Kanasgiri	183.96
72	Karwar	Karwar (CMC+OG)	3810.26
73	Karwar	Kinnar	771.41
74	Karwar	Kolage	736.74

75	Karwar	Madhewada	277.244
76	Karwar	Majali	1278.83
77	Karwar	Mudgeri	161.29
78	Karwar	Sawantwada	366.03
District: BELGAUM			
ESR - 1 (13)			
SNO	**TAUK NAME**	**VILLAGE NAME**	**AREA (Ha)**
1	Khanapur	Akrali	23084.75
2	Khanapur	Chapali	4616.95
3	Khanapur	Devulli (Tinai)	3010.31
4	Khanapur	Durg	4616.95
5	Khanapur	Hemadge	6863.85
6	Khanapur	Kirvale	1068.26
7	Khanapur	Mohiset	1273.93
8	Khanapur	Palada	1314.26
9	Khanapur	Payaswadi	7627.26
10	Khanapur	Rangarook	3431.92
11	Khanapur	Varlewadi	3431.92
12	Khanapur	Warkhad	6020.63
ESR - 2 (25)			
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Khanapur	Anagadi	441.28
2	Khanapur	Bammankop	231.80
3	Khanapur	Bastwad	507.74
4	Khanapur	Bhatevd	204.35
5	Khanapur	Bijagarni	533.90
6	Khanapur	Devarvadi	532.85
7	Khanapur	Ghotgali	808.24
8	Khanapur	Gundpi	521.33
9	Khanapur	Halga	666.60
10	Khanapur	Halshi	1640.74
11	Khanapur	Kapol	1852.94
12	Khanapur	Kirpoa	2389.65
13	Khanapur	Kudalgaon	1194.82
14	Khanapur	Kumbharde	2657.85
15	Khanapur	Malamba	1328.92
16	Khanapur	Mendegali	297.02
17	Khanapur	Merde	837.07
18	Khanapur	Nagargali	4075.78
19	Khanapur	Ramnagar	7076.13
20	Khanapur	Sagri	343.43

21	Khanapur	Shindoli K	177.96
22	Khanapur	Shingatgei	0.00
23	Khanapur	Siwatwadi	641.40
24	Khanapur	Sulegali	355.84
25	Khanapur	Tarwad	570.61
		ESR - 3 (27)	
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Khanapur	Bhalke B	292.85
2	Khanapur	Bhishathatti	234.84
3	Khanapur	Bhulke K	187.47
4	Khanapur	Chinchewadi	426.18
5	Khanapur	Diggegali	423.80
6	Khanapur	Gharli	1157.26
7	Khanapur	Ghose B	340.02
8	Khanapur	Ghose K	2295.09
9	Khanapur	Halsal	489.88
10	Khanapur	Hatarwad	767.75
11	Khanapur	Jatge	233.30
12	Khanapur	Kadagal	398.58
13	Khanapur	Kamatge	775.77
14	Khanapur	Karanjal	557.36
15	Khanapur	Karjagi	1354.07
16	Khanapur	Kir Halasli	740.53
17	Khanapur	Macholi	301.56
18	Khanapur	Manjarpai	212.18
19	Khanapur	Mundwad Pimple	1466.00
20	Khanapur	Padalvadi	364.51
21	Khanapur	Patali	237.14
22	Khanapur	Satnali	376.22
23	Khanapur	Shimpewadi	419.77
24	Khanapur	Shindoli B	256.40
25	Khanapur	Sivthan	409.24
26	Khanapur	Tavargati	1171.17
27	Khanapur	Watare	1114.23
		ESR - 4 (20)	
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Khanapur	Avratbail	838.17
2	Khanapur	Balgund	930.23
3	Khanapur	Bharnki	968.57
4	Khanapur	Chankibail	1243.94
5	Khanapur	Chunchwad	1250.17

6	Khanapur	Ghashloli	427.64
7	Khanapur	Godgeri	357.20
8	Khanapur	Godholi	631.47
9	Khanapur	Golihalli	2216.90
10	Khanapur	Gundoli	852.44
11	Khanapur	Karikatti	197.72
12	Khanapur	Kerwad	2029.77
13	Khanapur	Linganmath	396.90
14	Khanapur	Mangenkop	322.21
15	Khanapur	Maskenhat	500.88
16	Khanapur	Pura	443.05
17	Khanapur	Surapur	1394.15
18	Bailhongal	Basarkat	3254.75
19	Bailhongal	Degaon	697.52
20	Bailhongal	Kulvalli	4365.52
District: DHARWAD			
ESR - 2 (3)			
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Dharwad	Kawalwad	2466.79
2	Dharwad	Mavinkop	1491.99
3	Dharwad	Tattigeri	560.48
ESR - 3 (2)			
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Dharwad	Hampehalli	3398.30
2	Dharwad	Kanchanahalli	1697.34
ESR - 4 (103)			
SNO	**TAUK NAME**	**VILLAGE NAME**	
1	Dharwad	Amboli	339.12
2	Dharwad	Antrolli	1158.13
3	Dharwad	Aravatagi	577.92
4	Dharwad	Asundi	576.68
5	Dharwad	Balgeri	1027.04
6	Dharwad	Bandur	601.69
7	Dharwad	Basvapur	522.04
8	Dharwad	Belur	935.71
9	Dharwad	Benachi	2191.18
10	Dharwad	Bogur	1621.11
11	Dharwad	Budangud	176.03
12	Dharwad	Devagiri	790.11
13	Dharwad	Dharwar	1393.44
14	Dharwad	Dhopenhatti	779.52
15	Dharwad	Dori	629.59

16	Dharwad	Durgadkeri	2066.70
17	Dharwad	Dusagi	1532.26
18	Dharwad	Galagi	1005.59
19	Dharwad	Gangshatikop	192.52
20	Dharwad	Ghadiyal	1507.47
21	Dharwad	Gugigatti	446.94
22	Dharwad	Guledkop	3292.86
23	Dharwad	Gulladkop	380.26
24	Dharwad	Hasarambi	1652.14
25	Dharwad	Heggeri	386.80
26	Dharwad	Hindasgeri	980.29
27	Dharwad	Holtikoti	1443.25
28	Dharwad	Honnapur	396.55
29	Dharwad	Hosval	302.89
30	Dharwad	Hulikeri	598.08
31	Dharwad	Jiglihand	636.71
32	Dharwad	Kadabgatti	775.67
33	Dharwad	Kadlikop	2238.07
34	Dharwad	Kallapur	94.47
35	Dharwad	Kamalapur	407.14
36	Dharwad	Kambarganvi	1425.80
37	Dharwad	Kandli	2121.25
38	Dharwad	Karlekop	940.00
39	Dharwad	Kedanhatti	565.18
40	Dharwad	Kiravatti	1739.19
41	Dharwad	Kirvati	0.00
42	Dharwad	Kivandibai	4632.52
43	Dharwad	Kogilgeri	680.78
44	Dharwad	Kotumachagi	402.72
45	Dharwad	Kotur	1579.94
46	Dharwad	Kudalgi	7400.38
47	Dharwad	Kulvalli	0.00
48	Dharwad	Kumbarkoppa	1211.82
49	Dharwad	Magwad	2736.58
50	Dharwad	Mandihal	1186.51
51	Dharwad	Masalikatti	1681.45
52	Dharwad	Mavinkoppa	937.99
53	Dharwad	Mommigatti	1150.51
54	Dharwad	Mugadi	1381.80
55	Dharwad	Murakatti	764.92
56	Dharwad	Muttalmuri	1888.52

57	Dharwad	Niralgi	515.18
58	Dharwad	Purvarg Dyamankop	987.72
59	Dharwad	Ragikalapur	3040.85
60	Dharwad	Ramapur	815.70
61	Dharwad	Sangameshwar	1863.01
62	Dharwad	Sangtikoppa	1546.67
63	Dharwad	Shiddapur	140.30
64	Dharwad	Shivapur (Haliyal)	3265.52
65	Dharwad	Singanhalli	587.09
66	Dharwad	Surapur	0.00
67	Dharwad	Tatwanagi	1326.28
68	Dharwad	Tegur	1316.61
69	Dharwad	Tergaon	1158.13
70	Dharwad	Udavnagalvi	2609.75
71	Dharwad	Varav Naglavi	1129.54
72	Dharwad	Venkatapur	379.23
73	Dharwad	Virapur	246.59
74	Kalghatgi	Baichvad	663.01
75	Kalghatgi	Basavankoppa	324.19
76	Kalghatgi	Begur	441.98
77	Kalghatgi	Benchi	399.49
78	Kalghatgi	Bhatikop	864.11
79	Kalghatgi	Biranhal	357.04
80	Kalghatgi	Dimbavalli	462.34
81	Kalghatgi	Galagi	1005.59
82	Kalghatgi	Gangshatikop	192.52
83	Kalghatgi	Hasarambi	826.07
84	Kalghatgi	Hatkinhal	237.04
85	Kalghatgi	Hulkoppa	842.23
86	Kalghatgi	Hullambi	702.00
87	Kalghatgi	Ichanhalli	754.36
88	Kalghatgi	Jiglihand	636.71
89	Kalghatgi	Kalkundi	459.94
90	Kalghatgi	Kandli	1060.62
91	Kalghatgi	Karlekop	940.00
92	Kalghatgi	Konnaikanhatti	249.25
93	Kalghatgi	Kotimam	212.84
94	Kalghatgi	Kudalgi	2466.79
95	Kalghatgi	Masalikatti	560.48
96	Kalghatgi	Na	1337.86
97	Kalghatgi	Purvarg Dyamankop	493.86

98	Kalghatgi	Rangapur	64.14
99	Kalghatgi	Sangameshwar	931.51
100	Kalghatgi	Sangtikoppa	1546.67
101	Kalghatgi	Sulekatti	538.10
102	Kalghatgi	Tersikoppa	602.46
103	Kalghatgi	Tumrikoppa	480.68

DISTRICT NAME		**UTTARA KANNADA**		**BELGAUM**		**DHARWAD**	
SNO	**ESR TYPE**	**AREA (Ha)**	**NUMBER OF VILLAGES**	**AREA (Ha)**	**NUMBER OF VILLAGES**	**AREA (Ha)**	**NUMBER OF VILLAGES**
1	ESR 1	460306.53	190	49718.79	13	0	0
2	ESR 2	93838.59	45	29215.16	25	4519.3	3
3	ESR 3	134486.52	48	17003.17	27	5095.6	2
4	ESR 4	103451.24	48	21550.78	20	109665.9	103
TOTAL		792082.88	331	117487.9	85	119280.8	108

Annexure 3

Annexure 3: Villages (ESR-1) covered in KTR region across taluks.

SNO	VILLAGE NAME	Area (Ha)	ESR_TYPE	TALUK
1	Ambikanagara (CT)	133.11	1	Haliyal
2	Amga	2247.68	1	Haliyal
3	Badakanshirda	1799.65	1	Haliyal
4	Gutti	973.20	1	Haliyal
5	Jamaga	1800.96	1	Haliyal
6	Kegdal	693.27	1	Haliyal
7	Kulgi	1532.39	1	Haliyal
8	Kumbarkop	49.98	1	Haliyal
9	Vincholli	1933.25	1	Haliyal
10	Balemane	4395.73	1	Karwar
11	Gotegali	3455.86	1	Karwar
12	Goyar	2544.58	1	Karwar
13	Kadra	3879.24	1	Karwar
14	Kamargaon	1502.69	1	Karwar
15	Lande	2281.25	1	Karwar
16	Akheti	1496.72	1	Supa
17	Amagaon	1515.55	1	Supa
18	Ambeli	3030.56	1	Supa
19	Ambolli	5940.37	1	Supa
20	Anamod	2063.57	1	Supa
21	Anashi	8431.89	1	Supa
22	Asulli	6044.19	1	Supa
23	Atle	1377.55	1	Supa
24	Aveda Poppal Wadi	1152.13	1	Supa
25	Avurli	1298.81	1	Supa
26	Badpoli	1852.58	1	Supa
27	Bandoda	450.36	1	Supa
28	Bazar Kunang	2271.42	1	Supa
29	Bedasgadde	188.62	1	Supa
30	Bidoli	4563.65	1	Supa
31	Birampali	2541.39	1	Supa
32	Birkhol	4497.41	1	Supa
33	Chafer	1324.35	1	Supa
34	Chapoli (Kalsai)	2706.98	1	Supa
35	Chinchkhand	121.58	1	Supa
36	Deriye	700.86	1	Supa
37	Devulli (Joida)	255.12	1	Supa

38	Diggi	1505.03	1	Supa
39	Gangoda	2501.88	1	Supa
40	Gavegali	2042.78	1	Supa
41	Godashet	767.44	1	Supa
42	Gund	2829.47	1	Supa
43	Hebbal	1213.28	1	Supa
44	Hudasa	1539.56	1	Supa
45	Ivoli	2203.48	1	Supa
46	Kalambuli	2382.57	1	Supa
47	Kalamkhand	1762.93	1	Supa
48	Kalasai	2931.27	1	Supa
49	Karambal	960.25	1	Supa
50	Karanjoida	3388.80	1	Supa
51	Kariyadi	679.83	1	Supa
52	Katel	641.04	1	Supa
53	Kateli (Kumbar Wada)	1633.58	1	Supa
54	Kavale	1403.25	1	Supa
55	Khodli	1991.93	1	Supa
56	Kodthalli	1184.86	1	Supa
57	Kumbarkop	49.98	1	Supa
58	Kumbeli	864.87	1	Supa
59	Kunagini	307.75	1	Supa
60	Kundal	3795.89	1	Supa
61	Kuveshi	1938.48	1	Supa
62	Mavalinge	689.11	1	Supa
63	Nandigadde	144.84	1	Supa
64	Neturge	648.49	1	Supa
65	Nigundi	2702.02	1	Supa
66	Nujji	6577.78	1	Supa
67	Palada	1281.54	1	Supa
68	Phansoli	954.78	1	Supa
69	Pisose	311.08	1	Supa
70	Rangarook	1022.33	1	Supa
71	Sangave	1395.67	1	Supa
72	Sannamaga	814.87	1	Supa
73	Shevali	1962.68	1	Supa
74	Shiroli	847.94	1	Supa
75	Shivapur	416.53	1	Supa
76	Terali	3575.71	1	Supa
77	Tulasgeri	700.36	1	Supa
78	Ulavi	1056.81	1	Supa

79	Vadkal	787.73	1	Supa
80	Varlewadi	1206.53	1	Supa
81	Vatala	798.05	1	Supa
82	Viral	562.45	1	Supa
83	Viranjol	1018.24	1	Supa
84	Virnoli	2224.88	1	Supa
85	Yeramukh	2105.00	1	Supa
86	Zalawali	4766.35	1	Supa
Total area		162140.31		

Annexure 4

Annexure 4: ESR wise villages covered in KTR 10 km buffer region.

GP_ID	VILLAGE_NAME	Area	ESR_TYPE	TALUK	DISTRICT NAME
1	Akrali	4612.25	1	Khanapur	Belgaum
2	Hemadge	3428.37	1	Khanapur	Belgaum
3	Mohiset	1272.64	1	Khanapur	Belgaum
4	Warkhad	3007.23	1	Khanapur	Belgaum
5	Kendige	2297.03	1	Ankola	Uttara Kannada
6	Sheveguli	3107.46	1	Ankola	Uttara Kannada
7	Shikliturli	867.74	1	Ankola	Uttara Kannada
8	Ambewadi	1171.11	1	Haliyal	Uttara Kannada
9	Dandeli	1226.90	1	Haliyal	Uttara Kannada
10	Gobral	1036.23	1	Haliyal	Uttara Kannada
11	Haregali	1120.19	1	Haliyal	Uttara Kannada
12	Hosakumbarkop	869.92	1	Haliyal	Uttara Kannada
13	Vitnal	542.83	1	Haliyal	Uttara Kannada
14	Bhaire	2524.33	1	Karwar	Uttara Kannada
15	Devakar	4245.95	1	Karwar	Uttara Kannada
16	Devalmakki	526.45	1	Karwar	Uttara Kannada
17	Hartuga	1762.93	1	Karwar	Uttara Kannada
18	Kadiye	288.19	1	Karwar	Uttara Kannada
19	Kaiga	3447.18	1	Karwar	Uttara Kannada
20	Katar	394.89	1	Karwar	Uttara Kannada
21	Kerwadi	543.08	1	Karwar	Uttara Kannada
22	Kuchegar	1825.38	1	Karwar	Uttara Kannada
23	Maigini	1524.02	1	Karwar	Uttara Kannada
24	Mallapur	1255.87	1	Karwar	Uttara Kannada
25	Shirve	2720.37	1	Karwar	Uttara Kannada
26	Ulga	576.64	1	Karwar	Uttara Kannada
27	Virje	2209.84	1	Karwar	Uttara Kannada
28	Amarde	206.65	1	Supa	Uttara Kannada
29	Asu	557.60	1	Supa	Uttara Kannada
30	Aveda	883.03	1	Supa	Uttara Kannada
31	Badgund	862.84	1	Supa	Uttara Kannada
32	Baginkatta	256.30	1	Supa	Uttara Kannada
33	Bamanawadi	323.49	1	Supa	Uttara Kannada
34	Bapeli	420.92	1	Supa	Uttara Kannada
35	Boregali	263.27	1	Supa	Uttara Kannada
36	Bori	641.26	1	Supa	Uttara Kannada
37	Chandawadi	1062.53	1	Supa	Uttara Kannada
38	Chapakhand	262.60	1	Supa	Uttara Kannada

39	Chapali	1014.55	1	Supa	Uttara Kannada
40	Chapoli (A)	142.18	1	Supa	Uttara Kannada
41	Devulli (Tinai)	4283.36	1	Supa	Uttara Kannada
42	Durg	868.23	1	Supa	Uttara Kannada
43	Durgi	305.41	1	Supa	Uttara Kannada
44	Ghvane	230.42	1	Supa	Uttara Kannada
45	Gotguli	420.30	1	Supa	Uttara Kannada
46	Hukkali	350.79	1	Supa	Uttara Kannada
47	Iliye Dabe	897.72	1	Supa	Uttara Kannada
48	Jagalbet	441.85	1	Supa	Uttara Kannada
49	Joida	1711.67	1	Supa	Uttara Kannada
50	Kamra	1670.92	1	Supa	Uttara Kannada
51	Kasarle	595.46	1	Supa	Uttara Kannada
52	Kasarwadi	259.31	1	Supa	Uttara Kannada
53	Konda (Haliyal)	486.95	1	Supa	Uttara Kannada
54	Kondapa	879.24	1	Supa	Uttara Kannada
55	Konshet	808.97	1	Supa	Uttara Kannada
56	Kumbarkop	49.98	1	Supa	Uttara Kannada
57	Kumbarkop	49.98	1	Supa	Uttara Kannada
58	Kumbral	201.69	1	Supa	Uttara Kannada
59	Kurandi	619.50	1	Supa	Uttara Kannada
60	Nagari	865.26	1	Supa	Uttara Kannada
61	Nagoda	776.83	1	Supa	Uttara Kannada
62	Panjeli	1567.35	1	Supa	Uttara Kannada
63	Payaswadi	1442.15	1	Supa	Uttara Kannada
64	Pradhani	627.20	1	Supa	Uttara Kannada
65	Pusheli	531.82	1	Supa	Uttara Kannada
66	Samjoida	402.14	1	Supa	Uttara Kannada
67	Shindholi	488.38	1	Supa	Uttara Kannada
68	Timbholi	702.99	1	Supa	Uttara Kannada
69	Tinai Khand	85.99	1	Supa	Uttara Kannada
70	Usoda	871.54	1	Supa	Uttara Kannada
71	Vaijagaon	599.34	1	Supa	Uttara Kannada
72	Vaini	993.48	1	Supa	Uttara Kannada
73	Varande	462.11	1	Supa	Uttara Kannada
74	Wada	396.29	1	Supa	Uttara Kannada
75	Angod	2209.31	1	Yellapur	Uttara Kannada
76	Balagar	1326.18	1	Yellapur	Uttara Kannada
77	Baraballi	598.15	1	Yellapur	Uttara Kannada
78	Baragadde	221.13	1	Yellapur	Uttara Kannada
79	Bare	2342.66	1	Yellapur	Uttara Kannada

80	Beegar	234.44	1	Yellapur	Uttara Kannada
81	Belegeri	612.41	1	Yellapur	Uttara Kannada
82	Bisgod	571.18	1	Yellapur	Uttara Kannada
83	Chimanalli	722.38	1	Yellapur	Uttara Kannada
84	Dehalli	1066.50	1	Yellapur	Uttara Kannada
85	Geral	620.76	1	Yellapur	Uttara Kannada
86	Hiriyal	609.20	1	Yellapur	Uttara Kannada
87	Kalache	2570.48	1	Yellapur	Uttara Kannada
88	Kanur	513.86	1	Yellapur	Uttara Kannada
89	Kattige	2690.43	1	Yellapur	Uttara Kannada
90	Kodsalli	386.09	1	Yellapur	Uttara Kannada
91	Lalguli	5086.14	1	Yellapur	Uttara Kannada
92	Lingadabailu	530.78	1	Yellapur	Uttara Kannada
93	Mavinamane	5814.85	1	Yellapur	Uttara Kannada
94	Nagarakhan	1517.71	1	Yellapur	Uttara Kannada
95	Savagadde	577.35	1	Yellapur	Uttara Kannada
96	Targar	301.36	1	Yellapur	Uttara Kannada
97	Vajralli	648.01	1	Yellapur	Uttara Kannada
98	Adikehosur	340.91	2	Haliyal	Uttara Kannada
99	Ajgarni	1107.47	2	Haliyal	Uttara Kannada
100	Badashirgur	296.17	2	Haliyal	Uttara Kannada
101	Balshettikop	710.36	2	Haliyal	Uttara Kannada
102	Chimnalli	352.62	2	Haliyal	Uttara Kannada
103	Donshirgur	161.04	2	Haliyal	Uttara Kannada
104	Handli	829.22	2	Haliyal	Uttara Kannada
105	Harnoda	1261.75	2	Haliyal	Uttara Kannada
106	Kalbhavi	418.30	2	Haliyal	Uttara Kannada
107	Kariyampali	389.72	2	Haliyal	Uttara Kannada
108	Kesrodaga	2395.44	2	Haliyal	Uttara Kannada
109	Mainal	400.01	2	Haliyal	Uttara Kannada
110	Malawad	537.94	2	Haliyal	Uttara Kannada
111	Rayapattan	1328.56	2	Haliyal	Uttara Kannada
112	Bolshitta	258.58	2	Karwar	Uttara Kannada
113	Ghadasai	449.76	2	Karwar	Uttara Kannada
114	Gopashitta	1118.33	2	Karwar	Uttara Kannada
115	Donshet	762.98	2	Supa	Uttara Kannada
116	Kudalgaon	1079.91	2	Supa	Uttara Kannada
117	Malamba	1061.68	2	Supa	Uttara Kannada
118	Ramnagar	1967.36	2	Supa	Uttara Kannada
119	Shingargaon	1860.90	2	Supa	Uttara Kannada
120	Shingatgei	0.00	2	Supa	Uttara Kannada

121	Kannadagal	3236.33	2	Yellapur	Uttara Kannada
122	Kannigeri	2327.82	2	Yellapur	Uttara Kannada
123	Kolikeri	1075.98	2	Yellapur	Uttara Kannada
124	Watare	1113.11	3	Khanapur	Belgaum
125	Addigera	2629.36	3	Haliyal	Uttara Kannada
126	Agasalkatta	422.74	3	Haliyal	Uttara Kannada
127	Alur	1949.62	3	Haliyal	Uttara Kannada
128	Bedarshirgur	1384.15	3	Haliyal	Uttara Kannada
129	Bhagawati	1652.63	3	Haliyal	Uttara Kannada
130	Bhimanalli	825.15	3	Haliyal	Uttara Kannada
131	Bommanalli (Haliyal)	1417.14	3	Haliyal	Uttara Kannada
132	Bukkankoppa	93.08	3	Haliyal	Uttara Kannada
133	Gardolli	1003.43	3	Haliyal	Uttara Kannada
134	Hosur (Haliyal)	420.92	3	Haliyal	Uttara Kannada
135	Kalginatti (Kalginkopp)	250.39	3	Haliyal	Uttara Kannada
136	Kerwad (Dandeli)	444.16	3	Haliyal	Uttara Kannada
137	Machapur	1694.88	3	Haliyal	Uttara Kannada
138	Malawadi	1363.53	3	Haliyal	Uttara Kannada
139	Narnalli	737.21	3	Haliyal	Uttara Kannada
140	Nilwani	396.88	3	Haliyal	Uttara Kannada
141	Sambrani	1237.12	3	Haliyal	Uttara Kannada
142	Tatgera	551.62	3	Haliyal	Uttara Kannada
143	Thakkar Basapur	194.37	3	Haliyal	Uttara Kannada
144	Hankon	1166.23	3	Karwar	Uttara Kannada
145	Chotakanshirda	744.76	3	Supa	Uttara Kannada
146	Dandeli(Rural)	54.84	3	Supa	Uttara Kannada
147	Shistamudi	596.31	3	Supa	Uttara Kannada
148	Donagar	792.81	3	Yellapur	Uttara Kannada
149	Hamsana Gadde	767.81	3	Yellapur	Uttara Kannada
150	Hutakmane	412.00	3	Yellapur	Uttara Kannada
151	Kanchanahalli	8351.91	3	Yellapur	Uttara Kannada
152	Gadagera	507.81	4	Haliyal	Uttara Kannada
153	Halgejoog	52.09	4	Karwar	Uttara Kannada
154	Hankonjoog	58.15	4	Karwar	Uttara Kannada
155	Kirvati	0.00	4	Supa	Uttara Kannada
Total Area			172033.6		

SNO	**ESR TYPE**	**AREA (Ha)**
1	**ESR-1**	113018.23
2	**ESR-2**	25729.16
3	**ESR-3**	32668.15
4	**ESR-4**	618.09
TOTAL AREA		172033.6

Annexure 6

Ecological Status of Kali River Flood Plain

Sahyadri Conservation Series: 8

ENVIS Technical Report: **29,**

October 2008

Environmental Information System [ENVIS]
Centre for Ecological Sciences,
Indian Institute of Science,
Bangalore - 560012, INDIA

Web: http://ces.iisc.ernet.in/hpg/envis
http://ces.iisc.ernet.in/energy/
http://ces.iisc.ernet.in/biodiversity

Email: cestvr@ces.iisc.ernet.in,

Ecological Status of Kali River Flood Plain

Tables

Figures

ECOLOGICAL STATUS OF KALI RIVER FLOOD PLAIN

1.0 **Summary**

The Western Ghats (Sahayadri Hills) of India also known as is identified as one of the richest regions in terms of biodiversity and it is often referred to as a "biodiversity hotspot"(Daniels, 2003). The Western Ghats is the source of 38 east flowing and 37 west flowing river systems. The ecosystem has experienced tumultuous changes due to river valley and other developmental projects in the last 60 years. Inventorying and monitoring the biodiversity and ecology of river basins would help in the formulation and implementation of appropriate conservation and management strategies in the Western Ghats. This report documents the biodiversity and ecological significance of the flood plains of Kali river basin

Nearly **45 endemic** to **Western Ghats** and **73 endemic** plants to both **Western Ghats** and **Sri Lanka** were recorded from the study area. Plants such as *Aristalochia indica, Arundinella metzii, Canthium parviflorum, Smithia hirsuta, Flacourtia Montana, Geissaspis cristata, Crotalaria lutescens. Rhynchospora wightiana, Trees such as Artocarpus heterophyllus, Artocarpus hirsute, Caryota urens, Garcinia indica, Holigarna arnotiana, Hopea ponga, Hydnocarpus laurifolia, Ixora brachiata, Lagerstroemia microcarapa, Litsea laevigata, Mammea suriga, Mangifera indica, Memecylon talbotianum, Myristica malabarica, Polyalthia fragrans* etc., are endemic to Western Ghats. Many of the plants such as *Hemidesmus indicus, Cassia fistula, Pongamia pinnata, Nothopodytes nimmoniana, Embelia ribes, Rauvolfia serpentina* etc., are medicinal plants**.** The water quality of the streams in the Kali flood plain region is in pristine condition. The Salinity level decreases gradually from the downstream to upstream in these streams. In terms of organic pollution the stream water quality was found to be good for the whole stretch. The total dissolved solids increases during the November month; it may be attributed by the excess water discharged from the paddy field during the cultivation. The phosphate and nitrate levels are recorded in very meager level. The freshwater zone of these streams supports unique stream flora and fauna,

among which most are endemic odonates to Western Ghats like *Euphaea fraseri, Euphaea dispar*. The existing water quality also supports lot of unique aquatic organisms ranging diatoms, aquatic insects, reptiles and birds. Among the 20 species of anurans recorded, nearly 45% are endemic to the Western Ghats. The place records the presence of once **thought to be extinct species** of frog **(*Philautus cf.leucorhinus*)** while one of the recorded species of frog belongs to **vulnerable (*Philautus tuberohumerus*)** and **three** belong to **near threatened category (*Ramanella montana, Clinotarsus curtipes, Sylvirana temporalis*).** 50 birds belonging to 13 different orders and 31 different families were recorded from the study area. One of the near threatened birds which is endemic to Western Ghats – the Malabar pied hornbill (Anthracoceros coronatus) was observed in the region. Indian peafowl (Pavo Cristatus) which belongs to the Scheduled I of protected animals according to the **Wild life protection act 1972** was observed in the region. Six major dams across the river, a nuclear power plant and the paper and sugar industries on its bank have already caused tremendous loss of the biodiversity in the region. Any further development be it a hydro electricity project or any thermal power plant in the district is likely to cause a lot of damage to the left over biodiversity as well as it will harm the fish production capacity of the region.

A large scale removal of mangroves in swampy area (74.18767° N, 14.88362° E) is noticed near Hankon jog within 100 meters from the flow of river. This activity is a violation of CRZ 1991 (amended in 2001) as the region falls within the prohibited activities. As per the Clause (d) of sub-rule (3) of Rule 5 of the Environment (Protection) Rules, 1986, rules 5(3)(d) of the environment (protection) rules, 1986 and also CRZ 1991, the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) upto 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL are mandated as Coastal Regulation Zone (CRZ). CRZ 1991 (amended in 2001) prohibits land reclamation, bunding or disturbing the natural course of sea water or dumping of ash or any wastes from thermal power stations.

This study re-affirms 'hottest hotspot' status of the Western Ghats, a repository of biological wealth of rare kind, both in its aquatic and terrestrial ecosystems and indicates strongly the need for adoption of holistic eco-system management for conservation of particularly the rare and endemic fauna of the Western Ghats. The premium should be on conservation of the remaining evergreen and semi-evergreen forests, which are vital for the perenniality of streams and sustenance of biodiversity. Through appropriate management there still exists a chance to restore the lost natural evergreen to semi-evergreen forests. Considering the ecological significance and rich biodiversity, entire district be declared as an *Eco-sensitive region* as per sub-section (1) with clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) and clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 in concurrence with the provisions of the Indian Forests Act, 1927 (16 of 1927) and Forest (Conservation) Act, 1980 (69 of 1980) the Wildlife (Protection) Act, 1972 (53 of 1972) and also Biological diversity act 2002.

ECOLOGICAL STATUS OF KALI RIVER FLOOD PLAIN

2.0 Introduction

Ecological status of an area is determined by assessing the biodiversity of a region, the environmental conditions prevailing there and their interaction. It represents the overall health and sensitivity of an ecosystem. Ecological status assessment becomes essential for arriving at an appropriate conservation and sustainable management strategies. This assessment is done by evaluating the components along with its functional abilities of an ecosystem. This includes the assessment of species diversity, their abundance, and threats to their habitat by anthropogenic activities (like mining, dam construction, making of road or railway lines, spread of gas pipelines, building of an industry) which may alter the physical, chemical and biological integrity of the system (Ali *et al*, 2007, Ramachandra *et al*, 2006). An attempt has been made to assess the ecological status of flood plains of Kali river in the Central Western Ghats, India considering bioindicators, assessment of water quality and land cover.

Birds serve as a good ecological indicator as they inhabit almost every kind of habitat, they are at the top of food chain and thus vulnerable to bioaccumulation of toxic chemicals, they have representatives feeding on full range of animal diets (from insectivores to frugivores). For a healthy number and range of species a diverse ecosystem is needed, a lower number than expected number or range of species in an environment indicates poor ecological diversity. Amphibians are typically living at the interface between terrestrial and aquatic habitats. They are the only vertebrate group with dual life stages (*i.e.,* tadpoles and adults) and considered as biological indicators for their sensitivity and response to very small changes in the surrounding environment. New species are discovered at much higher rate in the past two decades, paradoxically, they are on decline globally. Habitat destruction and overexploitation are the major threat for amphibians, apart from *Chytrid* fungus and other synergistic effects of human induced changes. Considering these aspects, it was felt that monitoring amphibian diversity and their distribution would provide an insight on the prevailing conditions of an ecosystem and its health, which in turn helps in prioritizing the region for immediate conservation and management action in the Western Ghats, India.

2.1 **India - A Mega Diversity Country: Glance of biodiversity**

A region with vast reservoir of floral and faunal diversity is often referred as hotspots of biodiversity. The presence of two of the world's biodiversity hotspots in the vast terrain makes India one of the top 10 **mega diversity countries** in the world. India's biodiversity constitute 7% of the world's flora and 6.5% of the fauna spread in the 10 biogeographic areas namely Trans- Himalaya, Himalaya, Desert, Semi Arid, Gangetic Plains, Western Ghats, Deccan Plateau, Coast and Andaman and Nicobar Islands. (Jafar and Rehman 2008). There are about 614 species of amphibians and reptiles, 1225 species of birds and 350 species of mammals in India. Among which 173 species of mammals, 75 species of birds and 208 species of reptiles are considered threatened. With 1.0287 billion populations (year 2001) the human density of India reached 325 individuals per square kilometer (21.3 % rise from the previous year), the population of India is projected to be between 1.4 to 1.5 billion by the year 2050. With this rapid increase in population the pressure on the natural resources is bound to increase at the same time for the sustenance of life conservation of the natural resources should also be given a priority. The large demand for the land and the socio economic issues is posing challenges in declaring an area as protected. Hence, the focus now is to protect the areas with high biodiversity or which are inhabited by rare or threatened organisms, or have unique habitat or under threat to destruction.

2.2 **Western Ghats: Hottest Hotspot of Biodiversity**

The Western Ghats, is a chain of mountains, stretching north south along the western peninsular India for about 1,600 km, harbours rich flora and fauna is **one among 34 global biodiversity hotspots** (Myers, *et al.*, 2000, Sreekantha *et al.*, 2007). Various forest types such as tropical evergreen, semi-evergreen, moist and dry deciduous and high altitude sholas mingle with natural and manmade grasslands, savannas and scrub, in addition to, agriculture, plantation crops, tree monocultures, river valley projects, mining areas and many other land-uses. Over 4,000 species of flowering plants (38% endemics), 330 butterflies (11% endemics), 289 fishes (41% endemics), 135 amphibians (75% endemics), 156 reptiles (62% endemics), 508 birds (4% endemics) and 120 mammals (12% endemics) are among the known biodiversity of the Western Ghats (Daniels, 2003., Babu, *et al.*, 2004., Dahanukar *et al.*, 2004., Gururaja, 2004., Sreekantha, *et al.*, 2007). Table 1 lists the number of organisms found in Western Ghats with their endemism status.

Table 1. List of organisms found in Western Ghats with their endemism percentage.

Group	Total	Endemic Species	% Endemism
Angiosperm	4000	1500	38
Butterflies	330	37	11
Fishes	289	118	41
Amphibians	135	101	75
Reptiles	156	97	62
Birds	508	19	4
Mammals	120	14	12

This rich biodiversity coupled with higher endemism could be attributed to the humid tropical climate, topographical and geological characteristics, and geographical isolation (Arabian Sea to the west and the semiarid Deccan Plateau to the east). The Western Ghats forms an important watershed for the entire peninsular India, being the source of 37 west flowing rivers and three major east flowing rivers and their numerous tributaries. The four major rivers (Kali, Bedthi, Aghanashini and Sharavathi) of Uttara Kannada district of Karnataka together account for 92 fish species. However, these ecosystems have been, experiencing tumultuous changes due to unplanned developmental activities, especially during the last century. The drainage basin of River Kali is one such biodiversity rich region in the Western Ghats of Uttar Kannada district, which has been over exploited for the production of energy.

2.3 **Uttara Kannada district, Central Western Ghats: Land of local Biodiversity hotspot**

Uttar Kannada is the Northern most of the three coastal districts of Karnataka state namely – Mangalore, Udupi and Uttar Kannada. Uttar Kannada is one of the least populated districts of the state. According to the census of India 2001 Karnataka had a population of 52,850,562 of which 1,353,644 comes from Uttar Kannada. The district extends north south to a maximum of 180 km. and west- east to a maximum of 110 km. Lying between 13°55' -15°32' N latitude and 74° 05'- 75° 05'south longitude the districts covers an area of about 10,291 sq. km. of which 6502 sq.km comes under dense forest and 1305 sq.km comes under open forest. (State of forest report – 2001) 75.86 % of the district is covered by forest which makes it the richest forest district of Karnataka. The district boasts of its 140 km of coast line (which is the most populated part of the district) which is also producer of large amount of coconuts. Of the five National Park and twenty-one Sanctuaries present in Karnataka, Uttar Kannada has three of them respectively, namely- **Anshi National Park** (250 sq.km), **Dandeli Wild life sanctuary** (475.02 sq.km) and **Attiveri Bird Sanctuary** (2.23. sq.km). The district is blessed with large number of Perennial Rivers and many small seasonal hill streams which make the fresh water supply to the district apart from being home to many of the aquatic organisms like diatoms, fishes, bivalves, and crabs etc. which make the livelihood of a large proportion of the coastal population. Kali, Gangavati-Bedthi, Aghanashini and Sharavathi are the west flowing rivers perennial rivers of Uttar Kannada which merge in Arabian Sea while Varada River flows eastwards and joins the Tunga River. Sixty percent of the Western Ghats (one of the 34 biological hotspots of the world) – lies in Karnataka of which a large chunk is situated in Uttar Kannada District. Sreekantha *et al* (2007) reported **two new species of fish** from the genus *Schistura Mcclelland* in the southern most river (Sharavati) of the district. The tropical climate of Uttar Kannada has well defined monsoon period from June to October. The few localities towards coast line experience annual precipitation of 500 cm while the eastern parts may have the precipitation just above 100 cm with the average rainfall over the district being 250 cm. The winters are not that severe but summers are dry and very humid.

The primary cause of the decay of biological diversity in Uttar Kannada is the habitat destruction that inevitably resulted from the expansion of human population and human activities. Bombay gazetteer (1883) mentions of more or less dense forest growth in the hill tops, slopes and many of the Karwar valleys. The best forests were on the slopes and in the valleys facing the Kali river. However large areas of coastal forests have vanished with remnants of scrub lands. Little interior hills are covered with highly disturbed stunted deciduous forests revealing their massive exploitation by industries. Huge mangrove areas which had earlier covered the Kali estuarine areas and backwaters until Kadra or even further are now isolated in small patches except in some areas such as Kanasgeri, Asnoti and Hankon. Hankon has one of the finest and large mangrove vegetation with large trees of *Sonneratia ceseolaris* and *Avicinnia officinalis* reaching a height of 15 m. Mangroves are extremely important breeding grounds and feeding areas for shrimp and fish. Despite their great economic value, mangroves are often cleared for rice cultivation and commercial shrimp and prawn hatcheries, particularly in South- East Asia, where as much as 15% of the mangrove areas have been removed for aquaculture. Mangroves have also been severely degraded by over collecting wood for fuel, particularly charcoal production, construction poles, and timber through the region. Hence in the face of dwindling mangrove vegetation, and the surrounding forest vegetation, the study on t mangroves and other coastal vegetation focus on biodiversity and conservation aspects of these threatened habitats and their vegetation.

This endeavour focuses on the assessment of the ecological status of flood plains of Kali river basin considering large scale land cover changes in recent times in the region, while highlighting the environmental legislations towards the conservation of ecologically sensitive regions.

2.4 **Conservation Endeavour in India**

Traditionally India has a long history of conservation that is evident by the fact that India has the longest living civilization which inhabited the earth ever. The nature is worshiped in some form or the other throughout India. The 5000 year old history of civilization is a testimony of the sustainable development being practiced in India. Even legally the first conservation act came as early as 1897- The Indian Fisheries Act, followed by The Indian Forest Act- 1927, The wild life (protection) act -1972, The forest conservation act – 1980 and The Environment (protection) act- 1986. The first ever national park in India was established in the year 1935 in the foothills of Himalaya now known as Corbet National Park. At present India has around 94 national park and around 502 wild life sanctuaries. The wild life protection act (1972) describes the guidelines for declaring an area as a national park or sanctuary. Conservation provisions as per the prevailing acts are listed in table 2.

Table 2: **Acts and policies in India for protecting environment and wildlife**

Sr. No.	Act	Provisions
1	The Wildlife (Conservation) Act, 1972	Prohibits hunting of wild animals, their young ones as well as their eggs Prohibits the picking, uprooting, destroying, damaging, possessing of any plant in a protected area Can declare any area with high ecological significance as a national park, sanctuary or a closed area
2	The Biological Diversity Act, 2002	Prior approval needed from National Biodiversity Authority for collection of biological materials occurring in India as well as for its commercial utilization. Prior approval from NBA needed before applying for intellectual property rights on products pertaining to Biological diversity. The NBA advices the concerned state government in selection of areas with immense biological diversity as National Heritage Site.
3	Forest (Conservation) Act, 1980	Without the permission of the Central government, no State government or any other authority can : ➢ Declare that any reserved forest shall cease to be reserved. ➢ Issue permit for use of forest land for non-forest purpose. ➢ Assign any forest land by way of lease or otherwise to any private person, authority, corporation, agency or any other organization, not owned, managed or controlled by government. ➢ Clear off natural trees from a forest land for the purpose of reafforestation.
4	Water (Control and Prevention of Pollution) Act, 1974	It is based on the **"Polluter pays"** principle. The Pollution Control Boards performs the following functions : ➢ Inspects sewage and effluents as well as the efficiency of the

		sewage treatment plants. ➢ Lay down or modifies existing effluent standards for the sewage. ➢ Lay down standards of treatment of effluent and sewage to be discharged into any particular stream. ➢ Notify certain industries to either stop, restrict or modify their procedures if the present procedure is deteriorating the water quality of streams.
5	Wetlands (Conservation and Management) Rules, 2008	**Prohibited Activities** ➢ Conversion of wetland to non-wetland use ➢ Reclamation of wetlands ➢ Solid waste dumping and discharge of untreated effluents. **Regulated activities** ➢ Withdrawal of water, diversion or interruption of sources ➢ Treated effluent discharges – industrial/domestic/agro-chemical. ➢ Plying of motorized boats ➢ Dredging ➢ Constructions of permanent nature within 50 m ➢ Activity which interferes with the normal run-off and related ecological processes – upto 200 m
6	Declaration of Coastal stretches as "CRZ", 1991	**Prohibited activities :** ➢ Setting up of new industries and expansion of existing industries in the CRZ. ➢ Discharge of untreated wastes and effluents from industries, cities or towns and other human settlements. ➢ Dumping of city or town waste for the purposes of landfilling. ➢ Land reclamation and disturbing the natural course of sea water. ➢ Mining of sands, rocks and other substrata materials, except those rare minerals not available outside the CRZ areas and exploration and extraction of Oil and Natural Gas. ➢ Harvesting or drawal of ground water and construction of mechanisms thereof within 200 m of HTL; in the 200m to 500m zone it shall be permitted only when done manually through ordinary wells. ➢ Any construction activity between the Low Tide Line and High Tide Line.

7	National Environment Policy, 2006	The principal objectives of NEP includes : ➢ Protection and conservation of critical ecological systems and resources, and invaluable natural and man made heritage. ➢ Ensuring judicious use of environmental resources to meet the needs and aspirations of the present and future generations. ➢ It emphasizes the "Polluter Pays" principle, which states the polluter should, in principle, bear the cost of pollution, with due regard to the public interest.
8	Eco – sensitive zones	Industries shall be located only with in the Industrial estates and strictly as per the guidelines issued by the concerned state government. As far as possible, no fresh mining lease shall be granted in the eco sensitive zone. However, quarrying and mining are totally banned in the core area of the eco sensitive zone. Tourism activities shall be as per a tourism development plan prepared by the Department of Tourism. The sites of natural heritage in the zone would be identified and plans for conserving in the natural setting would be made. All the gene pools in the zone would be preserved.
9	The Environment (Protection) Act, 1986	Lays down standards for the quality of environment in its various aspects. Laying down standards for discharge of environmental pollutants from various sources and no persons shall discharge any pollutant in excess of such standards. Restrictions of areas in which industries, operations or processes shall not be carried out or carried out subject to certain safeguards.
10	National Water Policy, 2002	Water is a scarce and precious national resource and requires to be conserved and management. Watershed management through extensive soil conservation, catchment-area treatment, preservation of forests and increasing the forest cover and the construction of check-dams should be promoted. The water resources should be conserved by retention practices such as rain water harvesting and prevention of pollution.

As a follow up to the Convention on Biological Diversity (1993) to which India is a party among 180 odd nations, Government of India passed Biological Diversity Act 2002. Under this act every local body- a municipality or Gram Panchayat needs to have a

Biodiversity management committee (BMC) which is supposed to maintain people's biodiversity register (PBR) enlisting all the species of that area. This will help in making the biodiversity data base at the grass root level (http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue15/index.htm).

Biosphere reserves: The programme of Biosphere Reserve was initiated under the 'Man & Biosphere' (MAB) programme by UNESCO in 1971. Biosphere Reserves are areas of terrestrial and coastal ecosystems promoting solutions to reconcile the conservation of biodiversity with its sustainable use. They are internationally recognized, nominated by National Governments and remain under sovereign jurisdiction of the states where they are located. Biosphere Reserves serve in some ways as 'living laboratories' for testing out and demonstrating integrated management of land, water and biodiversity (http://wgbis.ces.iisc.ernet.in/biodiversity/sdev/index.htm, UNESCO, 2005., IUCN, 1979). As of today 531 biosphere reserves have been setup in 105 countries all over the world of which 14 fall in Indian Territory. Each Biosphere Reserve is intended to fulfill three basic functions, which are complementary and mutually reinforcing a conservation function (to contribute to the conservation of landscapes, ecosystems, species and genetic variation), a development function - to foster economic and human development which is socio-culturally and ecologically sustainable, a logistic function - to provide support for research, monitoring, education and information exchange related to local, national and global issues of conservation and development (UNESCO, 2005; http://ces.iisc.ernet.in/envis/sdev/bios.htm)

Some of the international treaties which are obligatory pertaining to ecologically fragile regions

Ramsar Convention: Under the convention on wetlands (**Ramsar, Iran – 1971**) interest was shown by many nations in protecting the wetland ecosystem of high conservation value. As of January 2008, there are 25 Ramsar Sites in India covering 6, 77,131 ha. 135 potential sites were identified in India which can be declared as Ramsar sites. (Islam and Rahamani, 2008)

IBA: The selection of Important Bird Areas (IBAs) has been a particularly effective way of identifying conservation priorities. IBAs are the programme initiated by Bird Life

International. IBAs are key sites for conservation – small enough to be conserved in their entirety and often already part of a protected-area network, if significant numbers of one or more globally threatened species of birds, are one of a set of sites that together hold a suite of restricted-range species or biome-restricted species and have exceptionally large numbers of migratory or congregatory species. A site is recognized as an IBA, based on the occurrence of key bird species that are vulnerable to global extinction or whose populations are otherwise irreplaceable. An IBA must be amenable to conservation action and management. Of the 466 IBAs in India, 435 support globally threatened species, 208 have restricted range species, and 123 have biome restricted species, while 141 qualify as IBAs because they hold large congregations of water birds or migratory birds.

3.0 **Study Area**

The ecological status assessment was carried out in the flood Plains of Kali River, Uttar Kannada district, Karnataka state, India (figure 1). The catchment basin of River Kali lies between 74° 05’ 7.63” to 74° 57’ 39.05” East longitude and 14° 43’ 11.8” to 15° 33’ 44.9” North latitude and the river basin extends over an area of 4943.43 sq. km. and covers the entire taluks of Supa, Haliyal, Karwar and partially covers the district of Ankola and Yellapur from the Uttar Kannada District. The Karwar beaches receive the water from the river. Karwar is a tourist’s destination famous for its long serene beaches. Karwar is the northern most coastal town of Karnataka and is also the district headquarters of Uttar Kannada. The taluk has a population of 72,852 of which majority have fishing as their source of living.

Kali river extending to a length of 184 kilometer earlier originated near the village Diggi in Supa taluk, as Karihole. The drainage network in the Kali river basin is given in Figure 2. After the construction of the dam near Supa, the entire region has disappeared and the taluk, which was once Supa, is now submerged in the reservoir. Two branches of the main stream - the Pandri and the Ujli originated in the extreme north. The two streams join at Supa, about 32 km, in the south east of the source of Pandri. Later the stream Tattihalla also joins it (the Tattihalla is a stream with a winding southerly course of about 56 km to the north of Haliyal). Near the confluence of these streams is the stepped

Lalguli falls. Below its meeting with the Tattihalla, the Kali flows 16 km west where it is joined on the right by the Nujji, which originates from the southeast course of about 40 km from Goa. The Kaneri and the Vaki are its two tributaries. Kaneri originates near the village Kundal in the Supa taluk. Vaki starts near Nujji in the same taluk, takes a southeast direction and finally joins Kali near Tulasgeri. Near Kadra, Thananala (originating from Goa) joins the river. In all, the catchment area of the river is about 5,104 sq. km and the annual river discharge is 6,537 million cu. M. There are four major dam projects on this river now - the Supa reservoir near the headwaters, the Bommanhalli reservoir near the Dandeli forests, the Kodasalli dam near Ganeshgudi and finally, one at Kadra, which is the part of the Kaiga nuclear project and the other two minor dams being at Kaneri and Tattihala. The six dams together generate 1200 MW of electricity and an additional 400 MW are generated by the Kaiga power plant. The river Kali has paper mill at Dandeli which discharges a majority of its effluents into the river apart from a sugar mill which draws water from the river. Mean annual rainfall for Kali river basin from 1901-1987, is given in Figure 3. Contour of 3427 mm representing maximum rainfall are found near the coastal region and average rainfall of 2207 mm toward the centre of the basin and least rainfall of 925 mm toward the plains. The seasonality (most of the annual rain pouring down during June - September leaving the remaining months relatively dry) is caused by the moisture-laden southwestern monsoon winds encountering the steep Western Ghats, and, in contrast, the northeastern monsoon is dry. Thus, the humidity varies from 55% during dry months to 99% during monsoon months. Annual rainfall measured during the last 87 years is in the range 850 -3200 mm. Figure 4 gives the land use in the Kali river basin and the related details in Percentages is given in Table 3. The region has 35% evergreen to semi-evergreen forests.

Table 3: **Land use details (in percent)**

River basin\LU	ACC	AFL	DEF	EGF	EPL	OBL	SOR	SSG	SMS	TPL	WAB
Kali	9.3	5.9	6.6	35.0	6.5	11.3	0.4	5.9	2.4	14.0	2.7

Where-Agriculture/Fallow Land: AFL, Areca/Coconut/Cashew: ACC, Exotic Plantation: EPL, Teak Plantation: TPL, Evergreen Forest: EGF, Deciduous Forest: DEF, Scrub Savannas/ Grasslands: SSG, Settlements: SMS, Open/Barren Land: OBL, Sand/Oyster/Dry River Bed/Prawn Culture/Salt pans: SOR, Water Bodies: WAB

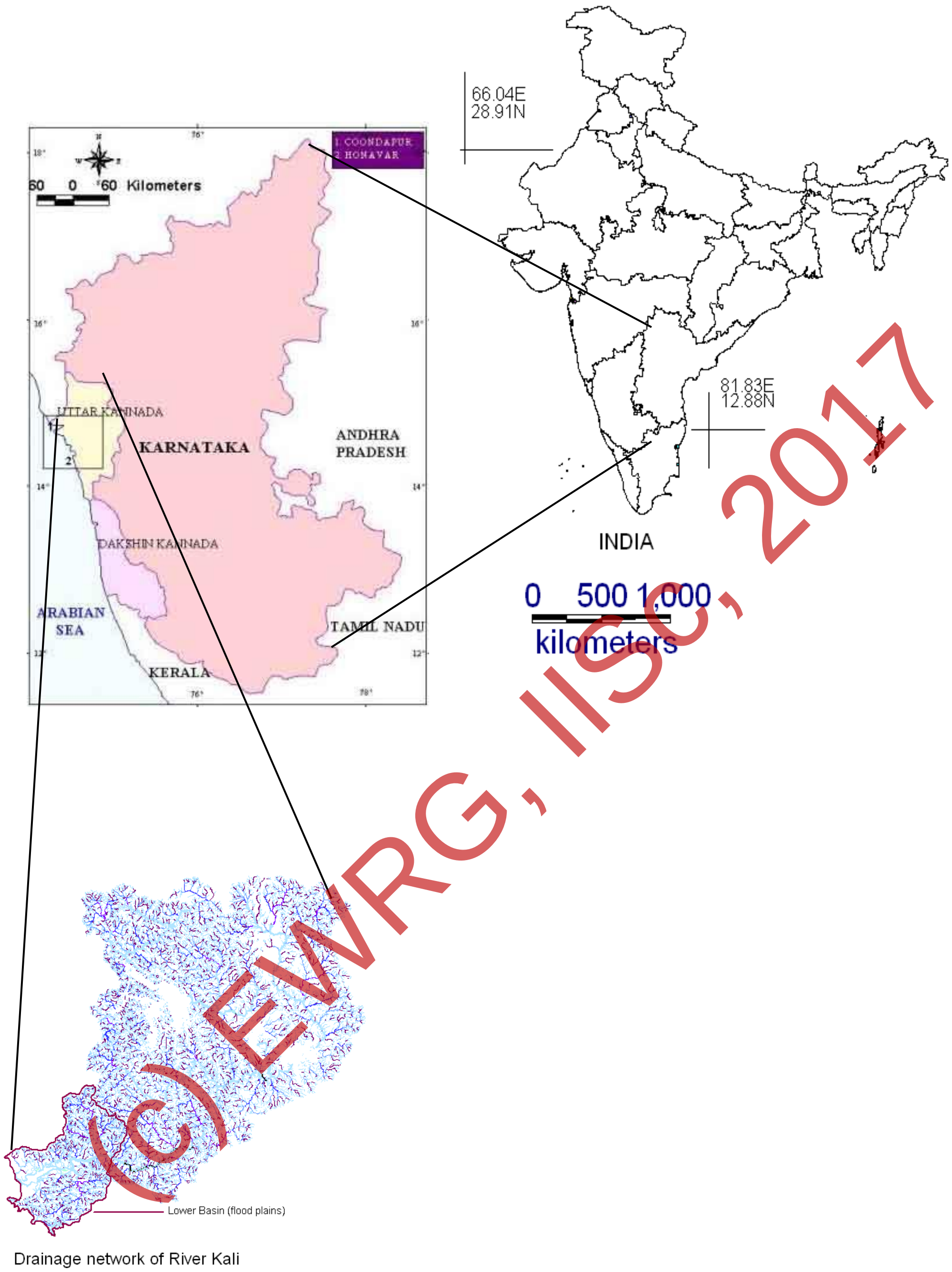


Figure 1: Study Area - Flood plains of Kali River.

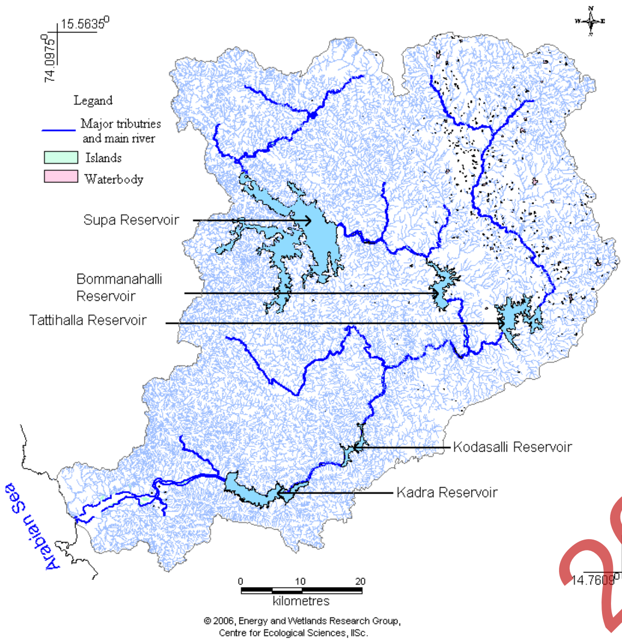


Figure 2 : Drainage Network in Kali River Basin

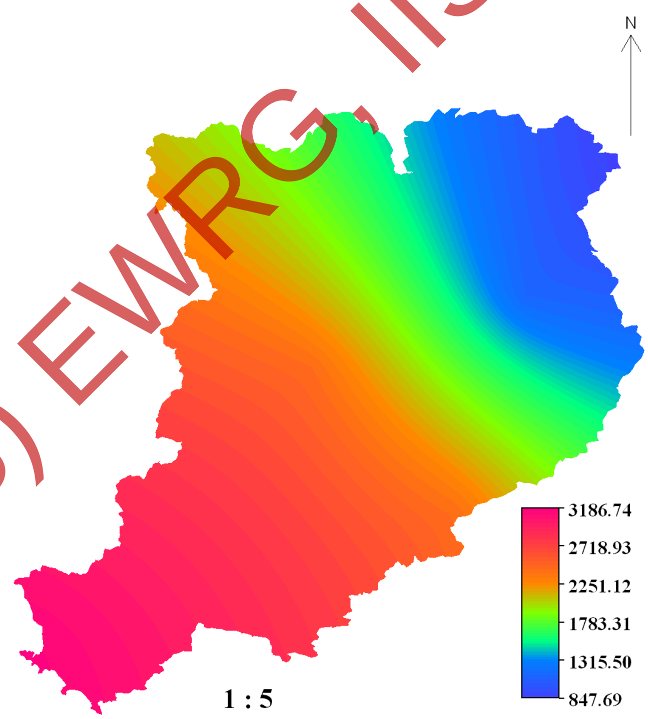


Figure 3 : Mean annual rainfall for Kali river basin from 1901-1987

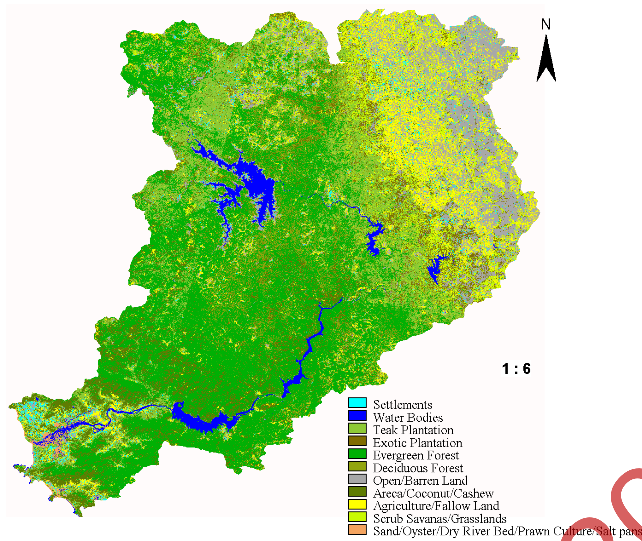


Figure 4 : Land cover classification of Kali River Basin

Figure 5 shows a part of Kali river as seen from Hankon village. The river records the presesnce of around 133 water birds as well as aquatic organisms. **Bhat** (2001) has reported an endangered fish species *Horabagrus brachysoma* from the River Kali near Kadra Dam. The fish has been reported only from Kali and Aghanashini basin and in the south it's record comes only from Kerala skipping the two southern coastal districts of Karnataka. The place also marks the upper distribution limit for many of the endemic birds and amphibians of Western Ghats.

Considering the ecological status of the river Kali the proposed seventh dam near Dandeli for generating 18 MW electricity was kept in abeyance. The withdrawl of water by Bharat Sugar mills situated downstream to Dandeli was protested by local people and an NGO. (http://www.indiaenvironmentportal.org.in/node/38942). The West Coast Paper Mill established in the year 1955 having approved production capacity of 1, 19,500 tones per annum is one of the biggest polluter of River Kali. (http://www.narmada.org/related.issues/kali/workshop/wcpm.dossier.html). Figure 6 gives the evidence of illegal sand mining along the bank of River Kali.

Figure 5: Kali River Basin ()

.

Figure 6: Sandminig at Chandewadi

Source: Parisarama Samrakshana Kendra

4.0 **Methods**

To assess the ecological importance of the region, a study was undertaken covering vegetation, aquatic ecosystems, amphibians and birds:

Vegetation: Random opportunistic survey covering different habitats were visited including mangroves. The plants collected were identified according the Hooker's system of classification. Rare plants were photographed and/or pressed for herbarium collection. The location of the area was recorded using a Global Positioning System (GPS).

Aquatic Ecosystem: A standard method was used for water sampling. Water samples were collected in polyethylene bottles 0.5m below the surface at ten sample sites along the river stream (Figure 7) in all seasons (during 2007). All glass and plastic ware used for sampling and analyses were rinsed with distilled water. All lab measurements were performed within the threshold limit day of respective parameters. EXTECH combined electrode probe were used for determination pH, Water temperature, conductivity and Total dissolved solids, Thermo Orion Nitrates Ion Selective Electrode used for NO3 determinations, Secomam spectrophotometer were used for Phospahtes and Sulphates determinations, Systronics Flame Photometer was used for sodium and potassium determination. All reagents were analytical grade and it is supplied by the instrument makers or prepared as per the Americam Public Health Association Standard Methods. Standard methods (APHA, 1998) were used for determination of free carbon-di oxide, dissolved oxygen, alkalinity, chlorides, total hardness, calcium hardness, magnesium hardness on site and analysis of phosphates, sulphates, sodium, and potassium on lab.

Amphibian diversity: Systematic surveys were carried out in 10 sampling localities of the Kali river catchment in all seasons (during 2007-08). Visual encounters, calls, tadpoles, foam nests, spawn are used to record the amphibians in the field. Two man hours of searching is made using torch lights between 19:00-20:00 hr, by walking across the streams, forest floors, gleaning leaf litters, prodding bushes, wood logs, rock crevices etc. All the species encountered are identified up to species level (if not up to genus level) using the keys of Bossuyt and Dubois (2001) and Daniels (2005). Opportunistic encounters are also recorded to enlist the species of the region.

Bird diversity: Birds were observed from 8:00 am to 10:00 am in the morning and 4:00 pm to 6:00 pm in the evening. Birds seen or heard were recorded. An Olympus 10X 50 binocular was used and Field guide for Birds of Indian Subcontinent was referred for identification of birds.

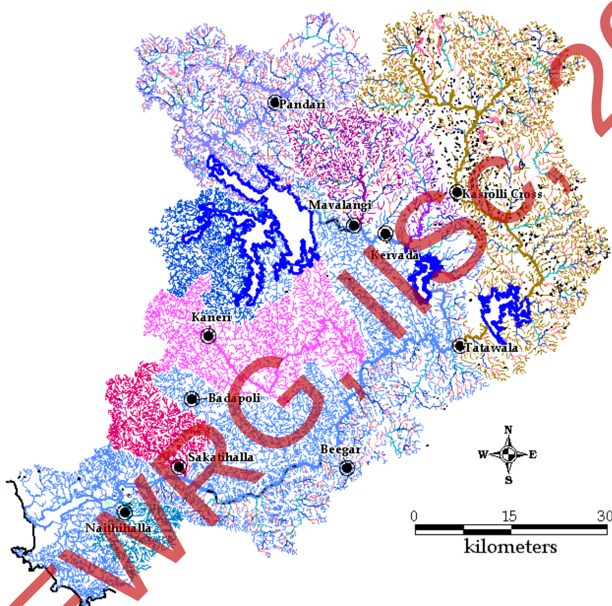


Figure 7: Sampling sites in Kali River Basin

5.0 **Results and Discussion**

Hill tops, slopes and many of the Karwar valleys were covered with a more or less dense forest growth (Bombay gazetteer, 1883). The best forests were on the slopes and in the valleys facing the Kali River. The study area (flood plains of Kali) falls within **25** km from the boundary of Anshi Dandeli Tiger reserve (which is the third for the state of Karnataka). Anshi Dandeli Tiger reserve is spread over an area of approximately 825 sq. km and encloses Anshi National park (250 sq. km) and Dandeli Wild Life Sanctuary. Black Panther a melanistic variety of leopard (*Panthera Pardus*) has also been reported from this region (Unpublished record). A group of Hanuman Langur *(Semnopitheaus entellus)* was observed near to the Hankon Village.

The different types of vegetation covered during the study include Coastal interior vegetation belt, tropical moist deciduous forests, tropical semi evergreen forests, tropical evergreen forest, scrub land, grass land, wetlands, and wasteland and open fields. Now large areas of coastal forests have vanished with remnants of scrub lands. Little interior hills are covered with highly disturbed stunted deciduous forests revealing their massive exploitation for fuel wood, grazing and timber. Huge **mangrove areas** which had earlier covered the Kali estuary and backwaters up till Kadra or even further are now isolated in small patches except in some areas such as **Kanasgeri, Asnoti and Hankon. Hankon** has one of the finest and large mangrove vegetation with good population of large trees such as ***Avicinnia officinalis*** and ***Sonneratia ceseolaris*** reaching to a height of 15 m.

5.1 **Vegetation**

From the opportunistic study of vegetation from the area, one species of fern, 78 species of herbs belonging to 23 families, 26 species of shrubs belonging to 15 families, 11 species belonging to 8 families of climbers, and 67 species of tree from 33 families were recorded (tables 4,5,6,7 and 8). Table 4 lists shrubs, Table5 lists herbs, Table 6 lists trees, Table 7 lists climbers and Table 8 lists fern found during the sampling. Some of the rare and threatened plants from the study area are listed in Table 9.

Table 4: Shrubs of Kali flood plains

Sr. no.	Family	Genus	Species
1	Acanthaceae	*Acanthus*	*ilicifolius*
2	Acanthaceae	*Strobilanthus*	*heyneanus*
3	Annonaceae	*Artabotrys*	*zeylanica*
4	Apocynaceae	*Carissa*	*carandas*
5	Apocynaceae	*Rauvolfia*	*serpetina*
6	Asteraceae	*Eupatorium*	*odoratum*
7	Campanulaceae	*Lobelia*	*nicotianifolia*
8	Euphorbiaceae	*Breynia*	*retusa*
9	Euphorbiceae	*Bridelia*	*scandens*
10	Faboideae	*Desmodium*	*laxiflorum*
11	Faboideae	*Tephrosia*	*pulcherrima*
12	Flacourtiaceae	*Flacourtia*	*indica*
13	Moraceae	*Ficus*	*tinctoria*
14	Myrsinaceae	*Aegiceras*	*corniculatum*
15	Myrsinaceae	*Embelia*	*ribes*
16	Papilionaceae	*Crotalaria*	*retusa*
17	Papilionaceae	*Crotalaria*	*lutescens*
18	Papilionaceae	*Crotalaria*	*lutescens*
19	Rhamnaceae	*Ziziphus*	*oenoplia*
20	Rubiaceae	*Canthium*	*parviflorum*
21	Rubiaceae	*Ixora*	*coccinea*
22	Rubiaceae	*Ixora*	*coccinea*
23	Tiliaceae	*Grewia*	*microcos*
24	Tiliaceae	*Triumfetta*	*rhomboidea*
25	Verbenaceae	*Clerodendrum*	*inerme*
26	Verbenaceae	*Clerodendrum*	*paniculatum*

Table 5: Herbs of Kali flood plains

Sr. No.	Family	Genus	Species
1	Acanthaceae	*Justica*	*simplex*
2	Alismataceae	*Weisneria*	*triandra*
3	Araceae	*Theriophonum*	*dalzellii*
4	Asteraceae	*Epaltes*	*divaricata*
5	Asteraceae	*Spaeranthus*	*indicus*
6	Asteraceae	*Tricholepis*	*glaberrima*
7	Asteraceae	*Vernonia*	*divergens*
8	Caesalpinieae	*Cassia*	*tora*
9	Campanulaceae	*Lobelia*	*alsinoides*
10	Cyperaceae	*Fimbristylis*	*ferruginea*
11	Cyperaceae	*Rhynchospora*	*wightiana*

12	Cyperaceae	*Rhynchospora*	*wightiana*
13	Cyperaceae	*Cyperus*	*iria*
14	Cyperaceae	*Cyperus*	*compressus*
15	Cyperaceae	*Cyperus*	*malaccensis*
16	Cyperaceae	*Cyperus*	*halpan*
17	Cyperaceae	*Cyperus*	*difformis*
18	Cyperaceae	*Eleocharis*	*acutangula*
19	Cyperaceae	*Fimbristylis*	*bisumbellata*
20	Cyperaceae	*Fimbristylis*	*tetragona*
21	Cyperaceae	*Fimbristylis*	*dichotoma*
22	Cyperaceae	*Fuirena*	*ciliaris*
23	Cyperaceae	*Kyllinga*	*melanosperma*
24	Cyperaceae	*Mariscus*	*javanicus*
25	Cyperaceae	*Pycreus*	*stramineus*
26	Cyperaceae	*Pycreus*	*pumilus*
27	Cyperaceae	*Pycreus*	*sanguinolentus*
28	Cyperaceae	*Pycreus*	*polystachyos*
29	Cyperaceae	*Schoenoplectus*	*lateriflorus*
30	Euphorbiaceae	*Phyllanthus*	*urinaria*
31	Euphorbiaceae	*Phyllanthus*	*simplex*
32	Euphorbiaceae	*Euphorbia*	*notoptera*
33	Euphorbiaceae	*Phyllanthus*	*urinaria*
34	Euphorbiaceae	*Phyllanthus*	*emblica*
35	Fabiodeae	*Smithia*	*hirsuta*
36	Faboideae	*Alysicarpus*	*vaginalis*
37	Faboideae	*Desmodium*	*triflorum*
38	Faboideae	*Mimosa*	*pudica*
39	Faboideae	*Zornia*	*gibbosa*
40	Gentianaceae	*Canscora*	*decurrens*
41	Gentianaceae	*Hoppea*	*dichotoma*
42	Hydrocharitaceae	*Blyxa*	*aubertii*
43	Lamiaceae	*Leucas*	*lavandulifolia*
44	Lamiaceae	*Ocimum*	*canum*
45	Lentibulariaceae	*Utricularia*	*reticulata*
46	Malvaceae	*Sida*	*acuta*
47	Malvaceae	*Urena*	*lobata*
48	Nymphaceae	*Nymphaea*	*nouchali*
49	Nymphaceae	*Nymphaea*	*nouchali*
50	Onagraceae	*Ludwigia*	*perennis*
51	Orchidaceae	*Rhynchostylis*	*retusa*
52	Papilionaceae	*Geissaspis*	*cristata*
53	Papilionaceae	*Crotalaria*	*filipes*
54	Papilionaceae	*Geissaspis*	*cristata*
55	Poaceae	*Arundinella*	*metzii*

56	Poaceae	*Dactyloctenium*	*aegyptium*
57	Poaceae	*Dimeria*	*ornithopoda*
58	Poaceae	*Eragrostis*	*uniloides*
59	Poaceae	*Ischaemum*	*indicum*
60	Poaceae	*Oplismenus*	*burmanii*
61	Poaceae	*Paspalum*	*scrobiculatum*
62	Poaceae	*Porteresia*	*coarctata*
63	Poaceae	*Pseudanthistiria*	*umbellata*
64	Poaceae	*Zoysia*	*matrella*
65	Poaceae	*Dimeria*	*hohenackeri*
66	Poaceae	*Glyphochloa*	*acuminata var. acuminata*
67	Poaceae	*Isacne*	*globosa*
68	Poaceae	*Sporobolus*	*virginicus*
69	Portulacaceae	*Portulaca*	*oleracea*
70	Rubiaceae	*Hedyotis*	*herbacea*
71	Rubiaceae	*Spermacoce*	*articularis*
72	Rubiaceae	*Spermacoce*	*verticillata*
73	Scrophulariaceae	*Bacopa*	*monnieri*
74	Scrophulariaceae	*Centranthera*	*indica*
75	Scrophulariaceae	*Lindernia*	*tenuifolia*
76	Scrophulariaceae	*Lindernia*	*crustacea*
77	Scrophulariaceae	*Striga*	*lutea*
78	Sphenocleaceae	*Sphenoclea*	*Zeylanica*

Table 6: Tree species of Kali flood plains

Sr. No.	**Family**	**Genus**	**Species**
1	Anacardiaceae	Buchanania	lanzan
2	Anacardiaceae	Lannea	coromandelica
3	Anacardiaceae	Holigarna	arnotiana
4	Anacardiaceae	Mangifera	indica
5	Annonaceae	Polyalthia	fragrans
6	Apocynaceae	Alstonia	scholaris
7	Apocynaceae	Holarrhena	antidysenterica
8	Arecaceae	Caryota	urens
9	Bignoniaceae	Dolichondrone	spathaceae
10	Bombacaceae	Bombax	ceiba
11	Boraginaceae	Cordia	myxa
12	Clusiaceae	Calophyllum	inophyllum
13	Clusiaceae	Garcinia	indica
14	Clusiaceae	Mammea	suriga
15	Combretaceae	Terminalia	bellirica
16	Combretaceae	Terminalia	alata
17	Combretaceae	Terminalia	paniculata

18	Dillleniaceae	Dillenia	pentagyna
19	Dipterocarpaceae	Hopea	ponga
20	Ebenaceae	Diospyros	montana
21	Elaeocarpaceae	Elaeocarpus	serratus
22	Euphorbiaceae	Excoecaria	agallocha
23	Euphorbiaceae	Sapium	insigne
24	Euphorbiaceae	Trewia	nudiflora
25	Euphorbiaceae	Aporosa	lindleyana
26	Euphorbiaceae	Bridelia	crenulata
27	Euphorbiaceae	Macaranga	peltata
28	Euphorbiaceae	Mallotus	philippensis
29	Faboideae	Pongamia	pinnata
30	Faboideae	Cassia	fistula
31	Faboideae	Xylia	xylocarpa
32	Flacourtiaceae	Flacourtia	montana
33	Flacourtiaceae	Casearia	rubescens
34	Flacourtiaceae	Hydnocarpus	laurifolia
35	Icacinaceae	Nothapodytes	foetida
36	Lauraceae	Litsea	laevigata
37	Lecythidaceae	Barringtonia	acutangula
38	Lecythidaceae	Careya	arborea
39	Leeaceae	Leea	indica
40	Loganiaceae	Strychnos	nux-vomica
41	Lythraceae	Lagerstroemia	microcarapa
42	Melastomataceae	Memecylon	talbotianum
43	Moraceae	Ficus	hisda
44	Moraceae	Ficus	drupacea
45	Moraceae	Artocarpus	heterophyllus
46	Moraceae	Artocarpus	hirsuta
47	Moraceae	Ficus	arnottiana
48	Moraceae	Streblus	asper
49	Myristicaceae	Myristica	malabarica
50	Myrtaceae	Avicinnia	officinalis
51	Myrtaceae	Syzygium	cumini
52	Myrtaceae	Syzygium	caryophyllatum
53	Oleaceae	Olea	dioica
54	Rhizophoraceae	Kandelia	candel
55	Rhizophoraceae	Rhizophora	mucronata
56	Rhizophoraceae	Rhizophora	apiculata
57	Rhizophoraceae	Carallia	brachiata
58	Rubiaceae	Randia	dumetorum
59	Rubiaceae	Ixora	arborea
60	Rubiaceae	Ixora	brachiata

61	Sapindaceae	Sapindus	laurifolia
62	Sapindaceae	Schleichera	oleosa
63	Sapotaceae	Madhuca	neriifolia
64	Sapotaceae	Mimusops	elengi
65	Sonneratiaceae	Sonneratia	caseolaris
66	Tiliaceae	Grewia	tiliaefolia
67	Verbenaceae	Vitex	altissima

Table 7: Climbers in Kali flood plains

Sr. No.	Family	Genus	Speies
1	Apocynaceae	Ichnocarpus	frutescens
2	Aristolochiaceae	Aristalochia	indica
3	Asclepiadaceae	Gymnema	sylvestre
4	Asclepiadaceae	Hemidesmus	indicus
5	Caesalpiniaceae	Moullava	spicata
6	Faboideae	Derris	scandens
7	Faboideae	Derris	trifoliate
8	Faboideae	Dalbergia	horrida
9	Liliaceae	Gloriosa	superba
10	Piperaceae	Piper	nigrum
11	Smilacaceae	Smilax	zeylanica

Table 8: Ferns of Kali flood plains

Sr. No	Family	Genus	Species
1	Pteridophytes	*Acrosticum*	*aureum*

Table 9: Some of the rare and threatened plants: (R-Rare, TH- Threatened, R-Rare, VU- Vulnerable, EN-Endangered (Red data list, FRLHT priority list)

Species	Status
Buchania lanzan	R
Clitoria ternatea	TH
Curculigo orchioides	VU
Embelia ribes	R
Garcinia indica	VU
Gloriosa superba	R

Gymnema sylvestre	VU
Myristica malabarica	EN
Nothopodytes nimmoniana	VU
Piper nigrum	VU
Rauvolfia serpentina	EN

Nearly **45 endemic** to **Western Ghats** and **73 endemic** plants to both **Western Ghats** and **Sri Lanka** were recorded from the study area. Plants such as *Aristalochia indica* (Figure 8), *Arundinella metzii*, *Canthium parviflorum*, *Smithia hirsuta*, *Flacourtia Montana*, *Geissaspis cristata*, *Crotalaria lutescens. Rhynchospora wightiana*, *Trees such as Artocarpus heterophyllus*, *Artocarpus hirsute*, *Caryota urens*, *Garcinia indica*, *Holigarna arnotiana*, *Hopea ponga*, *Hydnocarpus laurifolia*, *Ixora brachiata*, *Lagerstroemia microcarapa*, *Litsea laevigata*, *Mammea suriga*, *Mangifera indica*, *Memecylon talbotianum*, *Myristica malabarica*, *Polyalthia fragrans* etc., are endemic to Western Ghats. Many of the plants such as *Hemidesmus indicus*, *Cassia fistula*, *Pongamia pinnata*, *Nothopodytes nimmoniana*, *Embelia ribes*, *Rauvolfia serpentina* etc., are medicinal plants.

Figure 8: *Aristalochia indica*-Important medicinal plant (Photo:GRR)

5.2 **Mangrove destruction**

A large scale removal of mangroves in swampy area (74.18767° N, 14.88362° E) near Hankon jog was noticed. The area is a marshy land as can be seen and is well within 100 meters from the flow of river. The remote sensing image (Figure 9), toposheet (Figure 10) given below indicate the location and the scale of destruction. Authorities need to intervene immediately considering the ecological importance of mangroves (nesting site for fishes, flood prevention, protection from cyclones, tsunami, etc.). A recently **chopped down tree** of ***Avicinia*** of around 15 meter height (figure 11 and 12) were seen at the place. This activity is a violation of CRZ 1991 (amended in 2001) as the region falls within the prohibited activities. As per the Clause (d) of sub-rule (3) of Rule 5 of the Environment (Protection) Rules, 1986, rules 5(3)(d) of the environment (protection) rules, 1986 and also CRZ 1991, the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 metres from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL are mandated as Coastal Regulation Zone (CRZ). CRZ 1991 (amended in 2001) prohibits land reclamation, bunding or disturbing the natural course of sea water or dumping of ash or any wastes from thermal power stations.

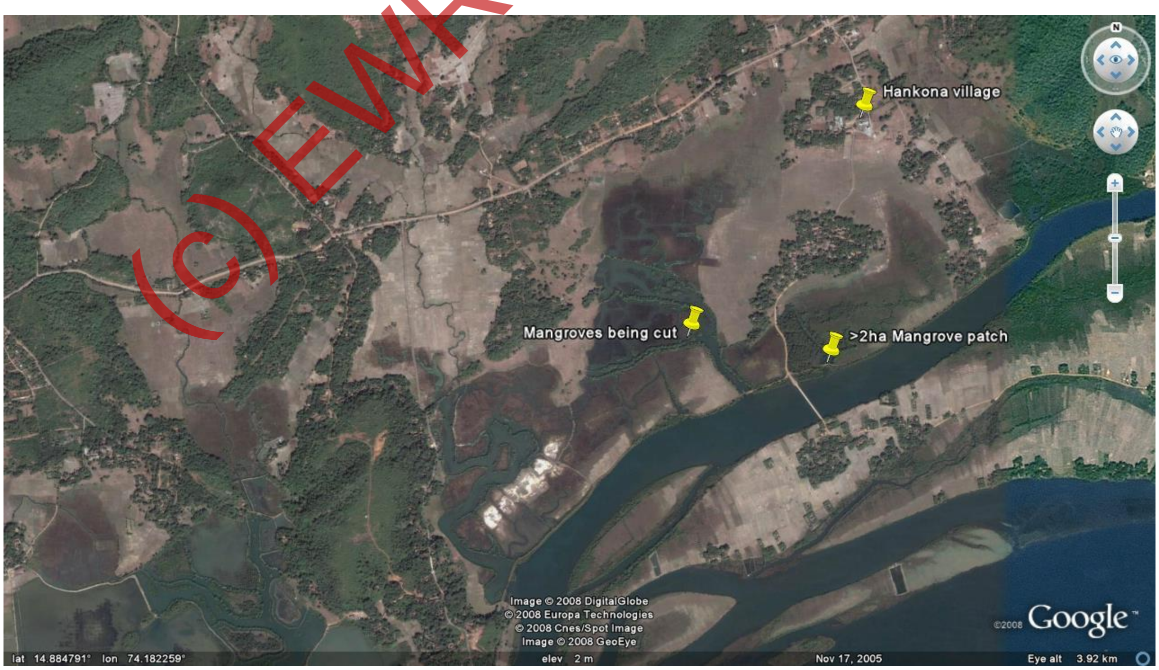


Figure 9: Location of mangrove destruction (http:// earth.google.com)

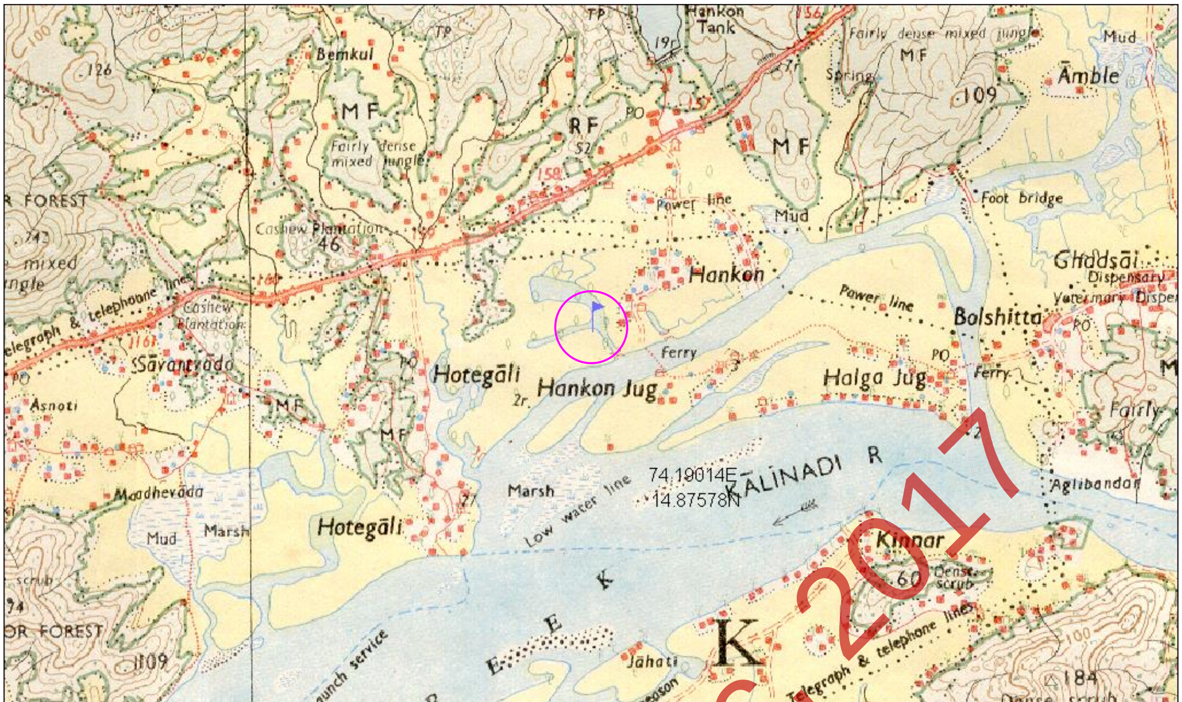


Figure 10: Location where rampant destruction of mangroves is in progress

Figure 11: Mangrove destruction near the village Hankon (Photo GRR)

Figure 12 : A Mangrove tree (*Avicinnia officinalis)* being cut

5.3 **Water Quality**

The water quality of the streams in the Kali flood plain region is in pristine condition. Tables 10 and 11 provide the water quality values for the monthly samples collected from two different locations in the basin. The Salinity level decreases gradually from the downstream to upstream in these streams. In terms of organic pollution the stream water quality was found to be good for the whole stretch. The total dissolved solids increases during the November month; it may be attributed by the excess water discharged from the paddy field during the cultivation. The phosphate and nitrate levels are recorded in very meager level. The freshwater zone of these streams supports unique stream flora and fauna, among which most **odonates** are **endemic** to **Western Ghats** like *Euphaea fraseri*, *Euphaea dispar*. The existing water quality also supports lot of unique aquatic organisms ranging diatoms, aquatic insects, reptiles and birds.

Table 10: The water quality values for each month during the study period (2007) in Naithihole.

[All the values are in mg/L except pH, EC (µS/cm), T (°C)]

NAITHIHOLE	February	March	April	May	June	July	August	September	Oct 07	Nov 07	Dec07	Jan 08
pH	7.64	7.77	7.43	7.32	8.57	8.13	7.93	7.48	7.68	7.72	7.09	7.01
Water Temperature	32.70	32.50	32.70	32.53	33.50	28.35	28.60	27.80	27.80	28.20	27.20	27.90
Conductivity	102.87	101.67	102.87	662.00	459.00	89.30	91.70	105.20	157.00	688.00	113.80	131.20
Dissolved Solids	71.93	71.10	71.93	461.67	358.00	126.75	132.40	150.60	227.00	984.00	165.40	189.50
Free Carbon -di oxide	7.63	12.32	9.97	3.52	7.04	4.11	3.52	3.52	7.04	7.04	5.28	5.28
Alkalinity	36.00	48.00	47.20	44.00	44.53	26.67	26.00	32.00	24.00	140.00	32.00	28.00
Chlorides	24.03	20.02	12.21	22.36	50.06	16.42	13.01	18.02	14.02	13.88	12.28	12.01
Total Hardness	31.33	32.00	32.67	42.67	35.33	21.33	16.00	24.00	24.00	26.00	24.00	28.00
Calcium Hardness	4.81	4.81	7.48	7.21	8.02	4.01	3.21	4.28	4.01	3.21	4.01	3.21
Magnesium Hardness	6.47	6.63	6.15	8.65	6.67	4.23	3.12	4.81	4.88	5.56	4.88	6.05
Dissolved Oxygen	6.19	6.68	4.38	6.87	8.11	8.11	7.71	7.30	6.90	5.73	8.11	7.30
Phosphate	0.01	0.02	0.12	0.02	0.04	0.02	0.00	0.01	0.21	0.14	0.02	0.11
Sulphate	4.18	3.81	5.39	3.74	3.61	1.76	27.45	10.57	18.77	31.06	25.50	2.55
Sodium	7.39	8.72	9.33	14.80	18.33	14.93	10.49	7.82	7.43	11.30	4.58	7.49
Potassium	0.28	0.59	2.17	4.20	5.19	0.50	0.80	0.29	0.39	1.30	0.41	0.21
Nitrate	0.22	0.18	1.84	0.92	0.25	2.40	1.49	1.93	1.93	1.33	1.46	1.94

Table 11: **The water quality values for each month during the study period (2007) in Sakthihalla. [All the values are in mg/L except pH, EC (µS/cm), T (°C)]**

SAKATIHALLA	February	March - June	July	August	September	October	November	December	January 2008
pH	8.19	DRY STREAMS	8.24	7.88	7.75	8.10	7.59	7.60	6.83
Water Temperature	29.93		26.90	28.60	26.10	29.00	27.30	27.90	29.30
Conductivity	249.33		50.70	91.70	112.60	109.90	623.00	108.20	98.20
Dissolved Solids	124.00		74.00	132.70	155.30	157.30	893.00	153.00	140.50
Free Carbon -di oxide	7.04		7.04	3.52	5.28	7.04	8.80	3.52	3.52
Alkalinity	31.47		30.00	21.33	23.47	28.00	120.00	20.00	20.00
Chlorides	17.49		14.35	10.14	14.02	16.42	11.82	12.41	16.02
Total Hardness	20.00		16.00	16.00	20.00	16.00	20.00	20.00	20.00
Calcium Hardness	3.21		4.81	2.94	3.21	3.21	3.21	4.01	6.41
Magnesium Hardness	4.10		2.73	3.19	4.10	3.12	4.10	3.90	3.32
Dissolved Oxygen	6.19		9.68	7.30	7.30	6.65	5.84	7.71	7.30
Phosphate	0.03		0.00	0.01	0.00	0.28	0.12	0.02	0.11
Sulphate	5.54		0.00	0.00	4.74	28.88	7.46	57.64	6.42
Sodium	13.92		10.60	7.35	4.95	5.45	9.50	12.27	14.35
Potassium	0.32		0.21	0.50	0.20	0.29	1.20	0.52	0.52

5.4 **Amphibian diversity**

In the present study, 20 species represented by seven families were recorded in the study area. Dicroglossidae represented highest number of species (7) followed by Microhylidae (3) and Rhacophoridae (3). Table 11 depicts the species diversity in the catchment with their Global Amphibian Assessment status (GAA). Similar studies in Bedthi (33 species), Aghanashini (28 species) and Sharavathi (45 species) show higher species diversity in this region, highlighting the need for appropriate management strategies to conserve these biodiversity rich ecosystems in central Western Ghats.

Among the 20 species recorded, nearly 45% of them are endemic to the Western Ghats. The place records the presence of once thought to be extinct species of frog (*Philautus cf.leucorhinus)* while one of the recorded species of frog belongs to vulnerable (*Philautus tuberohumerus*) and three belong to near threatened category (*Ramanella montana, Clinotarsus curtipes, Sylvirana temporalis).* It is interesting note that 13 species are least concerned, while only one vulnerable and three are near threatened. This could be due to prevailing dominant vegetation cover (dry-moist deciduous) providing suitable habitat for more common and generalist species. Figure 12 provides some of amphibians recorded from the area.

Table 12: Amphibian species recorded from Kali River Catchment.

Species	Endemic to Western Ghats	GAA
Family: Bufonidae		
Duttaphrynus melanostictus		LC
Duttaphrynus stomaticus		LC
Family: Microhylidae		
Sub-family: Microhylinae		
Microhyla ornate		LC
Microhyla rubra		LC
Ramanella Montana	+	NT
Family: Ranixalidae		
Indirana beddomii	+	LC
Indirana semipalmatus	+	LC
Family: Dicroglossidae		
Sub-family: Dicroglossinae		
Euphlyctis cyanophlyctis		LC
Fejervarya sahyadris	+	LC
Fejervarya rufescens	+	LC
Fejervarya sp.		
Hoplobatrachus tigerinus		LC
Sphaerotheca breviceps		LC
Sphaerotheca leucorhynchus	+	DD
Family: Rhacophoridae		
Sub-family: Rhacophorinae		
Philautus cf.leucorhinus	+	EX
Philautus tuberohumerus	+	VU
Polypedates maculates		LC
Family: Nyctibatrachidae		
Nyctibatrachus cf. petraeus	+	LC
Family: Ranidae		
Clinotarsus curtipes		NT
Sylvirana temporalis		NT

Note: GAA – Global amphibian assessment, EX- Extinct, VU- Vulnerable, NT- Near threatened, LC- Least concerned, DD- Data deficient.

Castle rock wrinkled frog *Nyctibatrachus petraeus*

Cricket frog *Fejervarya caprata*

Bull frog *Hoplobatrachus tigerinus*

Jerdon's narrow mouthed frog *Ramanella montana*

Figure 13: Anurans recorded from the study area (Photo: KVG)**.**

5.5 **Avian Diversity**

The survey recorded 50 birds belonging to 13 different orders and 31 different families (Table 13). Order Passeriformes dominated with 18 species followed by order Ciconiiformes and order Coraciiformes with each of them being represented by 6 species. One of the near threatened birds which is endemic to Western Ghats – the Malabar pied hornbill *(Anthracoceros coronatus)* was observed in the region. Indian peafowl (Pavo Cristatus) which belongs to the **Scheduled I** of **protected animals** according to the Wild life protection act 1972 was observed in the region.

Table 13: Birds of Kali river flood plains

Sr. No.	Common Name	Scientific Name	Family
Order:	**Accipitridae**		
1	Crected Serpant Eagle	*Spilornis cheela*	Falconiformes
Order:	**Anseriformes**		
1	Lesser whistling duck	*Dendrocygna javanica*	Anatidae
Order:	**Apodiformes**		
1	House swift	*Apus nipalensis*	Apodidae
Order:	**Charadriiformes**		
1	Oriental Plover	*Charadrius veredus*	Charadriidae
2	Red wattled Lapwing	*Vanellus indicus*	Charadriidae
3	Indian river tern	*Sterna aurantia*	Laridae
4	Wood sandpiper	*Tringa glareola*	Scolopacidae
5	Curlew (Unidentified)		Scolopacidae
Order:	**Ciconiiformes**		
1	Cattle egret	*Bubulcus ibis*	Ardeidae
2	Great egret	*Casmerodius albus*	Ardeidae
3	Grey Heron	*Ardea cinerea*	Ardeidae
4	Indian pond heron	*Ardeola grayii*	Ardeidae
5	Little egret	*Egretta garzetta*	Ardeidae
6	Malaysian Night Heron	*Gorsachius melanolophus*	Ardeidae
Order:	**Columbiformes**		
1	Rock pigeon	Columba livia	Columbidae
2	Spotted dove	Streptopelia chinensis	Columbidae
Order:	**Coraciiformes**		
1	Pied Kingfisher	*Ceryle rudis*	Alcedinidae
2	White-breasted kingfisher	*Halcyon smyrnensis*	Alcedinidae
3	Malabar pied Hornbill ***	*Anthracoceros coronatus*	Bucerotidae
4	Blue tailed Bee-eater **	*Merops philippinus*	Meropidae
5	Chestnut-headed Bee-eater	*Merops leschenaulti*	Meropidae
6	Green bee-eater	*Merops Orientalis*	Meropidae
Order:	**Cuculiformes**		
1	Asian koel	*Eudynamys scolopaceus*	Cuculidae
2	Greater Coucal	*Centropus sinensis*	Cuculidae
Order:	**Falconiformes**		
1	Black kite	*Milvus migrans*	Accipitridae
2	Brahminy Kite	*Haliastur indus*	Accipitridae
3	Eurasian marsh Harrier	*Circus aeruginosus*	Accipitridae

Order	Gruiformes		
1	White Breasted Water hen	*Amaurornis phoenicurus*	Rallidae
Order:	**Passeriformes**		
1	Common Iora	*Aegithina tiphia*	Aegithinidae
2	Ashy prinia	*Prinia Socialis*	Cisticolidae
3	House Crow	*Corvus splendens*	Corvidae
4	Jungle Crow	*Corvus levaillantii*	Corvidae
5	Black Drongo	*Dicrurus macrocercus*	Dicruridae
6	White-rumped Munia	*Lonchura striata*	Estrildidae
7	Common Swallow (unidentified)		Hirundinidae
8	Long tailed Shrike	*Lanius schach*	Laniidae
9	Pipit		Motacillidae
10	Oriental Magpie-Robin	*Copsychus saularis*	Muscicapidae
11	Pied bushchat	*Saxicola caprata*	Muscicapidae
12	Puple rumped Sunbird	*Nectarinia zeylonica*	Nectariniidae
13	Eurasian Golden Oriole	*Oriolus oriolus*	Oriolidae
14	Red vented Bulbul	*Pycnonotus cafer*	Pycnonotidae
15	Common Myna	*Acridotheres tristis*	Sturnidae
16	Rosy Starling	*Sturnus roseus*	Sturnidae
17	Reed Warbler (Un id.)		
18	Wagtail (unidentified)		
Order:	**Pelecaniformes**		
1	Indian cormorant	*Phalacrocorax fuscicollis*	Phalacrocoracidae
2	Little Cormorant	*Phalacrocorax niger*	Phalacrocoracidae
Order:	**Psittaciformes**		
1	Plum headed parakeet	*Psittacula cyanocephala*	Psittacidae
2	Rose ringed Parakeet	*Psittacula krameri*	Psittacidae

* Birds of Indian Subcontinent. Richard Grimmit, Carol Inskipp, Tom Inskipp, Oxfprd University Press, 2001., **- Data not available , ***- Near Threatened , # International Union for Conservation of Nature-Red Data List - http://www.iucnredlist.org/

Review of literature shows that a thorough survey of bird diversity of Uttar Kannada has been done earlier by Sir Davidson (from 1890- 1895), Koelz from (1983) and Daniels (1983-1988). Biogeographically Uttar Kannada belongs to the southern Malabar of Malabar province of Oriental region. A total of 419 bird species have been recorded by Daniels et al (1990) including the contribution of Campbell, Davidson, Koelz, skin collection at BNHS and amateur bird watchers. The avifauna of Uttar Kannada represents 70 families under 18 orders. 25% of the bird taxa of the district are water birds, of which a little more are winter visitors. The major sources of water that these birds utilize are the sea, estuaries, backwaters, and the associated salt water marshes, salt pans, larger irrigation reservoirs and seasonal, vegetation covered ponds and tanks. The district also records the presence of the endangered and endemic bird from **Malabar- Nilgiri wood piegeon** (*Columba elphinstonii*) **(Vulnerable C2a (ii) - IUCN)**. Daniels (1989) records the presence of Sandwich tern (*Sterna sandvicensis*) at Karwar which is an exceptional record from this part of country. He has also reported 133 water birds from Uttar Kannada (including the records of Davidson) belonging to 20 different families which inhabit estuaries, marsh land, rivers or lakes/ponds (Table 14). The lower basin of Kali River covers all these habitats suitable for these bird species.

Table 14: Water birds in the study area (Daniels, 1989)

Sr.no.	Common Name	Scientific Name
Family	**Ardeidae**	
1	Grey Heron	*Ardea cinerea*
2	Purple Heron	*Ardea purpurea*
3	Little Green Heron	*Butorides striatus*
	Pond Heron	*Ardeola grayii*
4	Cattle Egret	*Bulbulcus ibis*
5	Large Egret	*Ardea alba*
6	Small Egret	*Egretta intermediata*
7	Little Egret	*Egretta garzetta*
8	Indian Reef Heron	*Egretta gularis*
9	Night Heron	*Nycticorax nycticorax*
10	Tiger Bittern	*Gorsachius melanolophus*
11	Chestnut Bittern	*Ixobrychus cinnamomeus*
12	Black Bittern	*Ixobrychus flavicollis*
13	Bittern	*Botaurus stellaris*
Family	**Ciconidae**	
14	Painted Stork	*Mycteria leucocephalus*
15	Openbill Stork	*Anastomus oscitans*
16	Whitenecked Stork	*Ciconia episcopus*
17	Black Stork	*Ciconia nigra*
18	Lesser adjuvant stork	*Leptoptilos javanicus*
Family	**Threskiornithidae**	
19	White Ibis	*Threskiornis melanocephala*
20	Black Ibis	*Pseudibis papilosa*
21	Glossy Ibis	*Plegadis falcinnellus*
22	Spoon Bill	*Platalea leucorodia*
Family	**Anatidae**	
23	Lesser whistling teal	*Dendrocygna javanica*
24	Brahminy teal	*Tadorna ferruginea*
25	Pintail	*Anus acuta*
26	Common teal	*Anas creca*

27	Spotbilled duck	*Anas poecilorhynca*
28	Gadwall	*Anas Strepera*
29	Wigeon	*Anas penelope*
30	Bluewinged teal	*Anas querquedula*
31	Shoveller	*Ans clypeata*
32	White eyed pochard	*Aythya nyroca*
33	Cotton teal	*Nattapus coromandelicus*
34	Nakta / Comb duck	*Sarkidiornis melanotos*
Family	**Phoenicopteridae**	
35	Flamingo	*Phoenicopterus roseus*
Family	**Gruidae**	
36	Demoiselle crane	*Anthropoides virgo*
Family	**Rallidae**	
37	Blue breasted banded rail	*Rallus striatus*
38	Indian banded crake	*Rallina eurizonoides*
39	Little crake	*Porzona parva*
40	Baillon's crake	*Porzona pusilla*
41	Ruddy crake	*Amaurornis fusca*
42	Whitebreasted waterhen	*Amaurornis phoenicurus*
43	Water cock	*Gallicrex cinerea*
44	Indian moorhen	*Gallinula chloropus*
45	Purple moorhen	*Porphyrio porphyrio*
46	Coot	*Fulica atra*
Family	**Otididae**	
47	Lesser florican	*sypheotides indicus*
Family	Jacanidae	
48	Pheasant-tailed jacana	*Hydrophasianus chirurgus*
49	Bronzedwinged jacana	*Metopidius indicus*
Family	**Haematopodidae**	
50	Oystercatcher	*Haematopus ostralegus*
Family	**Charadriidae**	
51	Greyheaded lapwing	*Vanellus cinereus*
52	Redwattled lapwing	*Venellus indicus*
53	Yellow Wattled lapwing	*Vanellus malabaricus*
54	Grey plover	*Pluvialis squatarola*
55	Golden plover	*Pluvialis dominica*
56	Large Sandplover	*Charadrius leschenaultii*
57	Europen little ringed plover	*Charadrius dubius*
58	Litlle ringed plover	*Charadrius d. jerdoni*
59	Kentish plover	*Charadrius alexandrinus*
60	Pamirs lesser sandplover	*Charadrius mongolus*
Family	**Scolopacidae**	
61	Whimbrel	*Numenius phaeopus*
62	Eastern curlew	*Numenius arquata*
63	Blacktailed godwit	*Limosa Limosa*
64	Spotted redshank	*Tringa erythropus*
65	Common redshank	*Tringa totanus*
66	Marsh sandpiper	*Tringa stagnatilis*

67	Greenshank	*Tringa nebularia*
68	Green Sandpiper	*Tringa ochropus*
69	Spotted sandpiper	*Tringa glareola*
70	Terek Sandpiper	*Tringa terek*
71	Common Sandpiper	*Tringa hypoleucos*
72	Turnstone	*Arenaria interpres*
73	Pintal snipe	*Gallinago stenura*
74	Fantail /common snipe	*Gallinago gallinago*
75	Jack Spine	*Gallinago minima*
76	Little stint	*Calidris minuta*
77	Temminck's stint	*Calidris temnickii*
78	Dunlin	*Calidris alpina*
79	Curlew sandpiper	*Calidris testacea*
80	Broadbilled sandpiper	*Limicola falcinellus*
81	Ruff	*Philomachus pugnax*
Family	**Rostratulidae**	
82	Greater Painted Snipe	*Rostratula benghalensis*
Family	**Recurvirostridae**	
83	Indian blackwinged stilt	*Himantopus himantopus*
84	Avocet	*Recurvirostra avosetta*
Family	**Burnhinidae**	
85	Indian Stone curlew	*Burhinus oedicnemus*
86	Great stone plover	*Esacus magniristris*
Family	**Glareolidae**	
87	Indian curser	*Cursorius coromandelicus*
88	Small indian pratincole	*Glareola lactea*
Family	**Laridae**	
89	Great blackheaded gull	*Larus icthyaetus*
90	Brownheaded gull	*Larus brunnicephalus*
91	blackheaded gull	*Larus ridibundus*
92	Slenderbilled gull	*Larus genei*
93	Indian Whiskered tern	*Chliodinas hybridus*
94	Gull billed tern	*Gelochelidon nilotica*
95	Caspian tern	*Hydroprogne caspia*
96	River tern	*Sterna aurantia*
97	Blackbellied tern	*Sterna acuricauda*
98	Brownwinged tern	*Sterna anaethetus*
99	Sooty tern	*Sterna fuscuta*
100	Large crested tern	*Sterna bergii*
101	Indian lesser crested tern	*Sterna bengalensis*
102	Sandwich tern	*Sterna Sandvicensis*
103	Indian Skimmer	*Rhynchops albicollis*
Family	**Alcedinidae**	
104	Indian Pied Kingfisher	*Ceryle rudis*
105	Small blue Kingfisher	*Alcedo athis*
106	blue eared kingfisher	*Alcedo meninting*
107	Three toed forest kingfisher	*Ceyx erithacus*
108	Brownheaded storkbilled kigfisher	*pelargopsis capensis*

109	Black capped kigfisher	*Halcyon pileata*
110	Malabar whitecollared kingfisher	*Halycon Chloris*
Famliy	**Phalacrocoracidae**	
111	Indian Shag	*Phalacrocorax fuscicollis*
112	Little cormorant	*Phalacrocorax niger*
113	Darter	*Anhinga rufa*

5.6 **Landscape based conservation**:

Daniels (1991,1994) have emphasized on the landscape based conservation of bird diversity in the Uttar Kannada district. The study done by Devdar et al. (2001) also highlights the need of conserving key stone habitats which maintain regional biodiversity on a priority basis for the conservation of species and management of the tropical biodiversity. As the demand for land is ever increasing conservation of large areas becomes difficult. However small patches for land representing different kinds of habitat (given the name as nodes) can be preserved to facilitate conservation of maximum bird taxa. The condition being that each node must differ significantly from other with respect to habitat type and must represent large number of bird taxa. Based on his study Daniels (1994) suggested 14 localities which can be maintained as nodes for conserving almost 80 % of the bird taxa. They are as follows-

> Doddukere (L), Gundoli (L), Supa (L), Patololi (C) Kolikeri (X), Salgaum-Chigalli (L), Suremane (C) , Bharatnalli (L), Karwar (P), Saniketa-Madanagiri (R), Saniketta (R), Kumta (Z), Bidralli (C) and Madurahalli-Coodnapur (L).
>
> [Note: the letter in parenthesis denote the habitat type of the region: C- Ever-green, L-Freshwater marsh, P- beach, R- Estuary, X- Moist deciduous forest, Z- Urban}.

The minimum area of each node is suggested to be 25 sq km for effective conservation of the habitat. Karwar showing the maximum number of water birds is the place suggested as the node for their effective conservation. Figure 14 shows the 14 nodal points identified for bird conservation .in the district (Daniels, 1994)

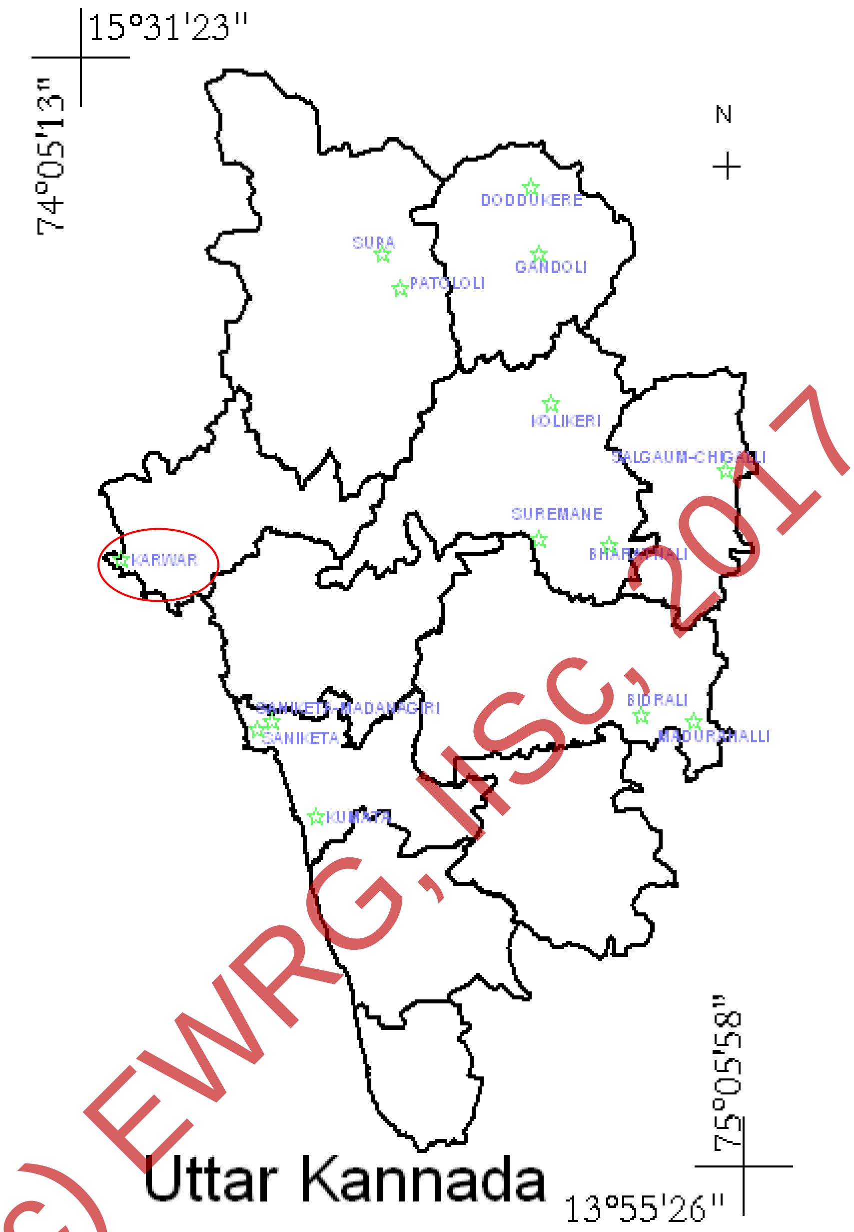


Figure 14 : Uttar Kannada District showing the 14 nodal points for conserving maximum bird diversity of the district. The circle highlights the area with maximum bird diversity.

The six major dams across the river, a nuclear power plant and the paper and sugar industries on its bank have already caused tremendous loss to the biodiversity of the region. Any further development be it a hydro electricity project, any thermal power plant in this river basin is likely to cause a lot of damage to the left over biodiversity as well as it will harm the fish production capacity of the region.

The Uttar Kannada district with 144 km of Coast line has around 5 fishing harbors and 16- fishing centre which are famous for catching Mackerels, Sardines, Prawns and other fishes having high demand in the international market thus creating revenue for the state. The average fish catching in the district is 47800 km with inland fishing contributing an additional of 79%. Shrimp culture is also very famous activity in the coastal area. River Kali basin contributes in a major way to this fish harvest. Deterioration of in physical, chemical or biological way will certainly hamper the fish production of the place and will thus affect the lively hood of the people dependent on it.

Major projects like thermal power projects should not be implemented in the region as it would affect the forests, which in turn affect the water yield in river catchment and biodiversity of terrestrial, rivers and coastal ecosystems

The power plants, particularly those fueled by fossil or nuclear fuels, can have the most profound and wide ranging negative impacts on water quality. According to a study by Pace University, New York (2000), the following procedures occur during routine operations and maintenance of power plants and each can significantly impact water quality:

- **Boiler blowdown**: This waste stream results from periodic purging of the impurities that become concentrated in steam boiler systems. These pollutants include metals such as copper, iron and nickel, as well as chemicals added to prevent scaling and corrosion of steam generator components.
- **Coal pile run-off**: This waste stream is created when water comes in contact with coal storage piles maintained on the power plant site. While most piles are kept covered, active piles used to meet the power plants immediate needs are often

open to the elements. Metals and other naturally occurring contaminants contained in coal leach out with the rainfall and are deposited in nearby water bodies.

- **Cooling process wastes:** Water used for power plant cooling is chemically altered for purposes of extending the useful life of equipment and to ensure efficient operation. Cooling tower blowdown contains chemicals added to prevent biological growth in the towers and to prevent corrosion in condensers.
- **Boiler cleaning wastes:** These wastes derive from the chemical additives intended to remove scale and other byproducts of combustion.
- **Thermal pollution:** The water used for cooling the thermal plants typically comes from adjacent water bodies or groundwater sources and is discharged back into the water body at significantly higher temperatures. The discharged heat can affect the aquatic organisms in either direct way by affecting their metabolism (as most of them are cold blooded animals) or indirectly by decreasing the solubility of oxygen in the water therby depleting the amount of dissolved oxygen in water.

Impact of acid rain on vegetation: The forest soils are mostly acidic in reaction, as is characteristic of heavy rainfall tropics. The impact of release of particularly SO2 and NOX, during the rainy season, could be defoliation and forest death apart from the impact of increased acidity on soil biota, and also on crop plants.

Increased air temperature: Release of waste heat into the atmosphere is common feature of all thermal power plants. This matter is much relevant in Uttara Kannada where there are just four months of heavy rainfall and two months of light rains. The evergreen-semi-evergreen forests use the water stored in the soil for the rest of the year, and almost behave like a rain forest. In fact these forests are very sensitive to any temperature increase, as desiccation could set in and chances increase of devastating forest fires.

Flyash pollution: Flyash is the major particulate matter released into the air from coal based power plants. The surge in energy demand in south Asia, characterized by the region's dependence on coal (particularly in India), has manifest itself in major increases in airborne pollution. Urban air quality has deteriorated largely on account of growth in industrial activity, transportation needs, and energy production. Fly ash, combined with emissions from the increased use of coal, has emerged as a major environmental concern. It is also estimated that about 30-40 million tons of fly ash, (100 million according to some other studies) is generated by thermal power plants each year in India, of which a mere 2%-3% is recycled. In 1990, areas with acid loads in excess of the critical levels were in parts of northern India and Bangladesh. Recent evidence from atmospheric studies of the Indian Ocean shows high concentrations of small particles, known as aerosols, consisting primarily of soot, sulfates, nitrates, organic particles, fly ash, and mineral dust suspended over a very large area of the northern Indian Ocean, including the Arabian Sea and much of the Bay of Bengal. The studies indicate that the long-term impact of air pollution on climate through radical changes in the hydrological cycle will be widely felt throughout the region (Chatterjee *et al*., 2000).

Flyash impact on leaf chemistry: A study conducted on the impact of flyash generated from Shaktinagar (UP) Thermal Power Plant on leaf chemistry of Ipomea cornes, Cassia tora and Acacia nilotica, naturally growing on flyash dyke, shows that flyash severely affects the plants by changing the chemical and biochemical compositions. Protein, carbohydrates, chlorophyll and ascorbic acid decrease significantly with a significant increase of phenols (Banerjee *et al*., 2003). Coarse particles of fly ash affects the composition of mangrove soils and mudflats, which are indeed centres of biological productivity.

Disturbances on the mangroves: Mangroves are rated among the top ecosystems of the world in terms of productivity, ranking at par with coral reefs. Humans do not make any inputs into the mangrove ecosystem, but make heavy harvests of fish, shellfish, prawns, oysters, crabs etc from it. The minerals of the sea and the silt-laden alluvial soils brought by the rivers mingle in the mangrove swamp and make it very fertile. Constant churning of the shallow water by the tidal currents oxygenate the water, making it ideal for aquatic animals. Mangrove detritus itself forms the food for various benthic animals, which play important role in the food-web of the estuary and the coastal sea.

The key to the success of the mangroves seem to be the fine, soft and silty mud in which they grow. Mangroves grow on predominantly silty soils. A study in Taiwan shows that silt constitutes 54 to 72% of mangrove soils, and sand constitutes only less than 20% (Hseu & Chen, 1999). A greater mixture of sand or other coarse particles can alter mangrove soils and most mangroves disappear from sandy soils or from soils having rough elements in it. Mangroves grow in shallow and peaceful part of the estuaries. The mangrove soils are exposed during low tides. Therefore the key to the success of the mangroves and therefore the richness of the ecosystem lies in the nature of the soil.

Estuary mangroves in Uttara Kannada suffered in the recent times when permanent bunds were built to protect the gazni rice fields. These permanent bunds replaced the earlier earthen embankments, fortified alongside by planting of mangroves. The mangroves suffered heavily when they were totally eliminated from the very vicinity of shrimp farms. Intensive shrimp culturing began in the estuary in the late 1980's.

6.0 **Conclusion**

This study re-affirms 'hottest hotspot' status of the Western Ghats, a repository of biological wealth of rare kind, both in its aquatic and terrestrial ecosystems and indicates strongly the need for adoption of holistic eco-system management for conservation of particularly the rare and endemic fauna of the Western Ghats. The premium should be on conservation of the remaining evergreen and semi-evergreen forests, which are vital for the perenniality of streams and sustenance of biodiversity. Through appropriate management there still exists a chance to restore the lost natural evergreen to semi-evergreen forests.

Considering the ecological significance and rich biodiversity, entire district be declared as an Eco-sensitive region as per sub-section (1) with clause (v) of sub-section (2) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) and clause (d) of sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986 in concurrence with the provisions of the Indian Forests Act, 1927 (16 of 1927) and Forest (Conservation) Act, 1980 (69 of 1980) the Wildlife (Protection) Act, 1972 (53 of 1972) and also Biological diversity act 2002.

7.0 **Acknowledgements**

We are grateful to the Ministry of Environment and Forests, Government of India for the financial assistance to the ecological research in Western Ghats. We thank Mr.Shrikant for the assistance during the field work. People of flood plains of Kali river helped us in providing local logistics.

8.0 **References**

[1] Ali Sameer, G.R Rao., K. Mesta Divakar, Sreekantha, Mukri Vishnu D., M.D Subhash Chandran., Gururaja K.V., Joshi N.V. and Ramchandra T.V.(2007). Ecological Status of Sharavathi Wild Life Sanctuary. Prism Books Pvt. Ltd. Pp.1-5.

[2] Babu, K.K.S. and Nayar, C.K.G. A new species of the blind fish *Horaglanis Menon* (Siluroifea: Claridae) from Parappukara (Trichur District) and a new report of *Horaglanis krishnai Menon* from Ettumanur (Kottayam district), Kerala. Journal of Bombay Natural History Society, 2004, **101**, 296-299.

[3] Banerjee, S., Singh A.K. and Banerjee, S.K, 2003. Impact of flyash on foliar chemical and biochemical composition of naturally occurring ground flora and its possible utilization for growing tree crops. Indian Forester, 129(8), 964-977.

[4] Bhat A.(2001). New report of the species, Horabagrus brachysoma in Uttar Kannada district in Karnataka. Journal of Bombay Natural History Society. 98(2),pp. 294-296.

[5] Bhat, K.G. 2003: Flora of Udupi, Indian Naturalist, Udupi.

[6] Bombay Gazetteer: 1883 The Bombay Presidency, Vol. XV.-Part I and Part II, Kanara; Government Central Press, Bombay, 1883.

[7] Chatterjee, R., Mehra, M. and Banerjee, S. 2000. Environmental security in South Asia. *Indian Energy Sector.*

[8] Cooke, T. 1903: The Flora of the Presidency of Bombay Vol. 1; Tailor and Francis, London. (Bishen Singh Mahendra Pal Singh, Dehradun

[9] Dahanukar, N., Raut, R. and Bhat, A. Distribution, endemism and threat status of freshwater fishes in the Western Ghats of India. *Journal of Biogeography*, 2004, 31, 123-136.

[10] Daniels R. J. R. 1989. A Conservation strategy for the birds of Uttara Kannada District. PhD Thesis, Indian Institute of Science.

[11] Daniels, R. J. R. and Joshi, NV and Gadgil, Madhav (1990). Changes in the Bird Fauna of Uttar Kannada, India, in Relation to Changes in Land Use over the past century. Biological Conservation. 52(1).37-48.

[12] Daniels R.J. R, Hegade Malati, Joshi N.V., Gadgil Madhav (1991) Assigning conservation values: A case study from India. Conservation Biology, Vol. 5, No. 4, pp. 464-475

[13] Daniels R. J. R. 1994. A landscape approach to conservation of birds. Journal of biosciences, 19(4), 503-509.

[14] Daniels, R.J.R. Biodiversity of the Western Ghats: An overview. *In: Wildlife and Protected Areas, Conservation of Rainforests in India*, A.K. Gupta, Ajith Kumar and V. Ramakantha (eds.), *ENVIS Bulletin*, 2003, 4, 25-40.

[15] Devdar Priya, Yoganand K. and Ganesh T. (2001).Distribution of forest birds in the Andaman Islands: importance of key habitats. Journal of Biogeography. 28, 663-671.

[16] Gururaja, K.V. Sahyadi Mandooka: Western Ghats Amphibians, *Sahyadri e-news*, 2004, http://wgbis.ces.iisc.ernet.in/biodiversity/newsletter/issue6/index.htm.

[17] Hooker, C. B. 1885. Flora of British India. (7 volumes) International book distributors, Dehradun, India.

[18] Hseu, Z.Y and Chen, Z.S. 2000. Monitoring the Changes of Redox Potential, pH and Electrical Conductivity of the Mangrove Soils in Northern Taiwan. *Proc. Natl. Sci. Counc. ROC(B)* Vol. 24, No. 3, 2000.

[19] Islam M.Zafar-Ul, Rahamani Asad R (2008) Potential and Existing Ramsar Sites in India. Indian Bird Conservation Network: Bombay Natural History Society, Bird Life International and Royal Society for the Protection of Birds. Oxford University Press. Pp. 1-18.

[20] Myers, N., Mittermeier, R.A., Mittermeier, C.G., Da Fonseca, G. A. and Kent, J. Biodiversity hotspots for conservation priorities. *Nature*, 2000, 403, 853-858.

[21] Primack B. Richard., 1998. Essentials of Conservation Biology. Second edition, Sinauer associates, Inc., USA.

[22] Ramachandra, T.V., Subash Chandran, M.D., Gururaja, K.V. and Sreekantha, 2006. Cumulative Environmental Impact Assessment, Nova Science Publishers, Inc., New York.

[23] Saldanha, C. J. 1984: Flora of Karnataka Vol. 1. Oxford & IBH Publishing Co. New Delhi.

[24] Sreekantha, Subhash Chandran M.D., Mesta D K, Rao G. R., Gururaja K.V. and Ramchandra T.V. (2008). Fish Diversity in relation to landscape and vegetation in Central Western Ghats, India. Current Science, Vol. 92, No.11, Pp 1592.

[25] Sreekantha, Gururaja K.V., Ramadevi K, Indra T. J. and Ramchandra T.V. (2007) Two new fish species of the genus *Schistura Mcclelland* (Cypriniformes: Baltitoridae) from Western Ghats, India. Zoos' print journal, 21(4): 2211-2216

[26] Talbot, W. A. 1909; Forest Flora of the Bombay Presidency and Sind. Photozincographic, Department, Poona

[27] Uttar Kannada Gazetteer, 1985., Government of Karnataka

Web links

1. http://www.ramsar.org/
2. http://www.birdlife.org/
3. http://www.censusindia.gov.in/
4. http://www.karnatakaforest.gov.in/English/index.html/
5. http://www.nbaindia.org/bmc.htm
6. http://www.ekarwar.com/aboutuk.html/
7. http://wgbis.ces.iisc.ernet.in/biodiversity/sahyadri_enews/newsletter/issue15/index.htm

Grasslands of Anshi-Dandeli Tiger Reserve

Subash Chandran M.D	Rao G R	Vishnu Mukri
Prakash Mesta	&	Ramachandra T.V.

Western Ghats Task Force, Government of Karnataka
Karnataka Biodiversity Board, Government of Karnataka
The Ministry of Science and Technology, Government of India
The Ministry of Environment and Forests, Government of India
Anshi-Dandeli Tiger Reserve, Karnataka Forest Department

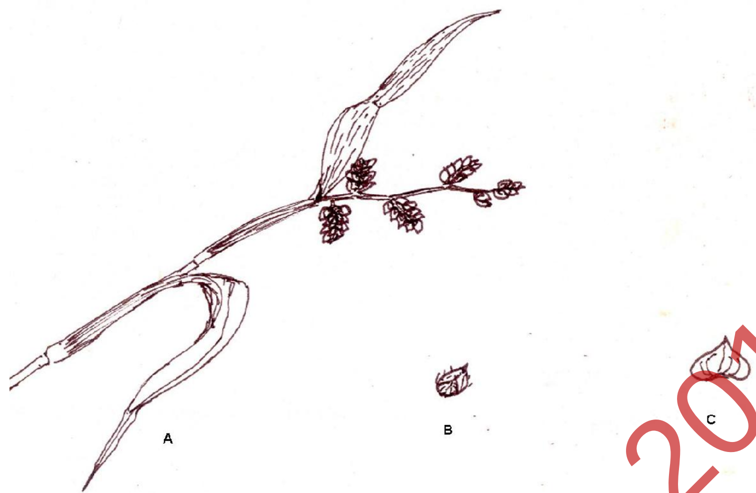
ENVIS Technical Report: 36

February 2012

Environmental Information System [ENVIS]
Centre for Ecological Sciences,
Indian Institute of Science,
Bangalore - 560012, INDIA

Web: http://ces.iisc.ernet.in/energy/
http://ces.iisc.ernet.in/biodiversity
Email: cestvr@ces.iisc.ernet.in,
energy@ces.iisc.ernet.in

Grasslands of Anshi-Dandeli Tiger Reserve



M. D. Subash Chandran, G. R. Rao, Vishnu Mukri, Prakash Mesta
&
T. V. Ramachandra
E mail: cestvr@ces.iisc.ernet.in, mds@ces.iisc.ernet.in, grrao@ces.iisc.ernet.in

Sahyadri Conservation Series 12

ENVIS Technical Report**: 36**

February 2012

Environmental Information System [ENVIS]
Centre for Ecological Sciences,
Indian Institute of Science,
Bangalore - 560012, INDIA

Web: http://ces.iisc.ernet.in/energy/
http://ces.iisc.ernet.in/biodiversity
Email: cestvr@ces.iisc.ernet.in,
energy@ces.iisc.ernet.in

Grasslands of Anshi-Dandeli Tiger Reserve

Chapter 1: INTRODUCTION

During the last century, there were over 40,000 tigers in India. This number has dwindled to 1827 by 1972 due to poaching, illegal hunting, fragmentation and destruction of habitat, making them an endangered species. The Government of India started "Project Tiger" on April 1st, 1973 to protect the tigers from extinction. Uttara Kannada district was exceptionally rich in tigers almost until late 19th century. British chronicles show hundreds were hunted down in the district during late 19th century, and such hunting was even sponsored by the government. Presence of numerous tigers in the district until the close of 19th century highlights the richness of forests interspersed with grasslands, abundance of water resources and richness of wildlife in general, especially the grazing mammals, constituting the prey stock of the wild carnivores.

Dandeli Wildlife Sanctuary with the extent of 206.75 sq kms was first notified as Game Sanctuary in the year 1956 (vide Bombay Govt. Resolution WLP.1957 dated 10-05-1956). This was extended to 5729.07 sq kms (vide Government of Karnataka Notification No. AFD 52 FWL 74 dated 08-01-1975) and subsequently reduced to 834.157 sq kms (vide FFD 150 FWL 81 dated 01-09-1987) and 475.018 sq kms. (vide draft Notification no. FEE 172 FWL 93, on 29-04-1994), which was finally notified as Dandeli Wildlife Sanctuary (vide FEE 58 FWL 96/09-03-1998). The draft notification of Anshi National Park was done covering an area of 250 sq kms (vide AHFF 77 FWL 87 / 02-09-1987) and the final area notified is 339.866 sq kms (vide Notification No. FEE 221 FWL 99 dated 18.08.2003). Both the Protected Areas with the spatial extent of 814.884 sq km was declared as Tiger Reserve on 4th January 2007 (GO No. FEE 254 FWL 2006). This along with the Mahaveer Wildlife Sanctuary of Goa covers an area of over 2,000 sq.km.

Anshi-Dandeli Tiger Reserve-Study area

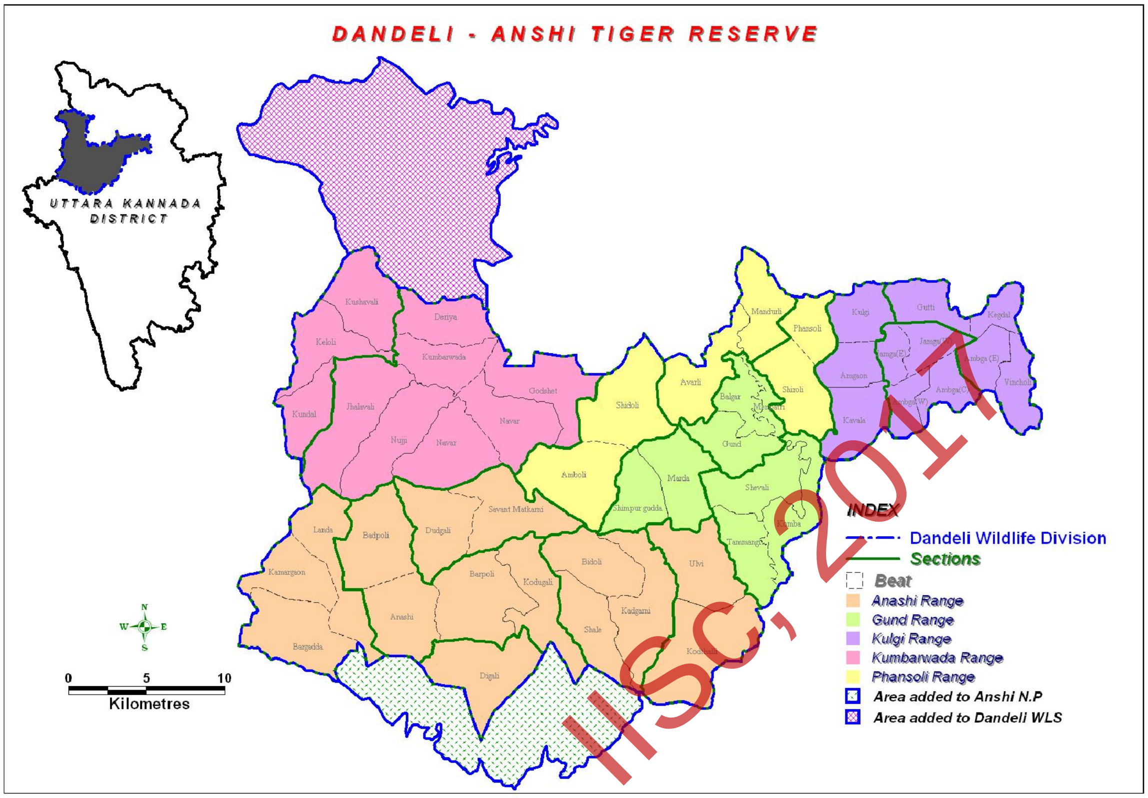


Figure 1.1: Dandeli-Anshi Tiger Reserve

The Anshi-Dandeli Tiger Reserve (ADTR) covers the hill ranges of northern Uttara Kannada district in the taluks of Joida and Haliyal (Figure 1.1). The western side of the Tiger Reserve, receive seasonal heavy rainfall from the South-West Monsoon to the tune of 3000-6000 mm. Tropical evergreen forest is the climax vegetation here. However, human factors through millennia have transformed bulk of these forests into semi-evergreen types, interspersed with savannas and agricultural areas. Progressive decline in rainfall towards the east, which gradually merges with the Deccan Plateau in the rain-shadow region, is responsible for moist and dry deciduous forests. Long history of forest burning in the past and wholesale transformations of the forests into teak plantations, beginning with the British period have acted as powerful factors that modified natural vegetation. Places such as Kumbarwada, Diggi, Terali, and Kundal have large expanse of grasslands, due to the slash and burn cultivation practices earlier by shifting cultivators consisting communities such as Kunbis and Kumri Marathis. *Gavli* pastoral tribes and *Siddi* forest dwellers live in this area. Many village settlements are present in the reserve and the surrounding areas where the wild animals move.

Faunal diversity of Anshi and Dandeli Tiger reserve

This Tiger- Reserve is habitat for large mammals, which include bonnet macaque, spotted deer, barking deer, mouse deer, gaur, civet, Malabar giant squirrel, pangolin and sloth bear. Besides, the black panther, elephants and tigers are rare species found in the park. Reptiles spotted in the park include the king cobra, krait, python, rat snake and viper. Around 200 species of birds are reported from the park. These include the adjutant stork, ashy woodswallow, black-crested bulbul, blue-headed pitta, brahminy kite, broad-billed roller, crested serpent eagle, and yellow-footed green pigeon (Source: Karnataka Forest Department, Dandeli).

IMPORTANCE OF GRASSLANDS FOR TIGER CONSERVATION

The tiger is internationally recognized as an endangered animal destined to be extinct in the wild if the forces causing its decline continue. Many small tiger populations are completely isolated and critically endangered. Entire subspecies from Bali, Java and areas adjacent to the Caspian Sea have not survived. The South China tiger is down to a few individuals and is slipping away. There has been much anxiety for the tiger and its future. Some predict the tiger's demise, with some isolated populations expected to blink out in the near future (Seidensticker et al., 1999). The resonating theme of the excellent work *Riding the Tiger*, has been the importance of the tiger's prey, mainly the large mammal. "…this great cat evolved as the predator of the largest deer, wild cattle and wild pig, and where this essential prey has been extirpated, the tiger does not survive. However, where large prey are abundant, the tiger survives and has a robust reproductive output" (Seidensticker et al., 1999).

If we examine the important prey animals throughout Asia, where the tiger survives in many pockets, there are many kinds of deer among them such as the chital, sambar, chousingha, muntjac etc. and other ungulates like gaur, wild pig, nilgai and domestic cattle; they sometimes even feed on langurs and porcupines. By and large the tiger's prey are herbivores that depend substantially on grasslands. Yet we cannot underestimate other landscape elements such as forests, scrub, riverine habitats and even mangroves as harbouring tigers and their prey. Diverse kinds of landscape elements are preferred by tigers. Even their prey, deer for example, not only feed on grasses but also browse on the leaves of trees and fallen fruits of many trees. Water bodies are visited by almost all animals. Therefore the Tiger Reserve should be a healthy combination of different landscape elements, including the grasslands that provide bulk of the fodder needs of the ungulates.

UNDERSTANDING GRASSLANDS

Grasslands are the grass-dominated areas with few trees. Global grasslands even though widespread are shrinking alarmingly and merit consideration as one of the most endangered ecosystems, even more so than tropical rainforests. Though the grasses form an easily identifiable natural group of plants they have remarkable diversity. Grass belongs to family Poaceae, the fourth largest family of flowering plants, has over 700 genera and probably 10,000 species (Sreekumar and Nair, 1991). Civilizations flourished in and around grasslands as grasses meet most of the basic human needs - bulk of the food, fodder, thatching materials, medicines etc. Livestock constitutes the backbone of agricultural economy and its sustenance depends on the grasslands. In grasslands worldwide are found maximum numbers of large herbivore animals. They also hold the key to the richness of wildlife as most wild herbivores survive on grasslands. In the grassland ecosystems we find high levels of productivity and energy utilization. A forest cannot support such large populations of grazing animals since the herb layer is less luxuriant and deficient in grasses, and the forest shrubs and trees cannot withstand heavy browsing, nor are most of them palatable. In such situations, even the forest living animals come out into open grasslands and clearances for grazing. The rapid decline of natural grasslands is due to several reasons. Grasslands being relatively open areas with low-stature vegetation receiving higher light intensity, they are easily vulnerable to invasive species, more so following disturbance (Wagner, 1989). They are sensitive to various human impacts such as conversions to agriculture and rangelands, spread of invasive species introduced by humans, road making, alterations in natural fire cycles and pollution that alters soil fertility and rates of plant growth. Their structure and function make them one of the most vulnerable land ecosystems to global climate change (Schlesinger, 1997; Mooney and Hobbs, 2000; Lejeune and Seastedt, 2001). Grassland studies are of paramount importance and pre-requisite for conservation and management of wildlife (Panwar, 1986; Rodgers and Sawarkar, 1988 Rahmani, 1992). Many studies are found on grasslands of India, including of the Western Ghats (Lele et al., 1997; Bhat et al. 2005; Misra and Misra 1981; Kotwal and Pandey, 1981; Rawat et al. 1997; Lehmkuhl, 1989; Rodgers, 1990).

Evolution and spread of grasslands: Grasses appear in the fossil records of the Earth from the late Cretaceous Era about 100 million years ago. The early grasses probably evolved at high altitudes, above the tree line in the mountains, because all grasses have one common attribute; they cannot tolerate shady conditions. As dense forests covered most of the land surface the deep shade of the trees did not favour grasses underneath. Pollen of grass species is notable for its absence beneath all types of forests but as soon as tree pollen begins to decline, grass pollen makes a sudden appearance in the pollen profile. There is also the unexplainable fact that pollen from grasses has been observed at the same time in many different parts of the globe. This probably is correlated to increased aridity in climate unfavourable for forests (http://www.bcgrasslands.org/library/world.htm.).

Grasses and Adaptability: Although grasses do not thrive underneath the canopy of forests they belong to a vegetation type that actually thrives on being eaten, burnt, and trampled upon. They can grow at sites ranging from sea level up to the edges of high altitude glaciers and tolerate salinity, acidity and alkalinity. Many grow submerged partly or fully in water, yet others colonize deserts. They are successful invaders capable of colonizing diverse habitats due to their various adaptations. Their remarkable genetic adaptability equips them to adapt to such varied environmental conditions. By means of sexual reproduction they can quickly evolve new varieties to suite new growing environments. Perennial grasses spread fast by vegetative methods as well. Close to their nodes are tender spots packed with actively dividing cells constituting meristematic tissue. Stems elongate and new shoots sprout from these meristems (Misra, 1980; http://www.bcgrasslands.org/library/world.htm.).

Grasses of wetter conditions (Figure 1.2) are softer and delicate than land grasses. They have less of fibrous tissues in them. Their leaves are bright green, thinner and broader than land grasses. *Hubbardia heptaneuron*, a grass feared to have gone extinct from the spray zone of Jog water falls in Uttara Kannada is very delicate with almost translucent thin leaves and soft tissues. The grass has been rediscovered in some waterfall areas of Maharashtra Ghats. The plant parts of aquatic grasses are spongy due to air spaces that enable to them to keep their floating. However, because of silica crystal deposit even aquatic grasses like the rice plants can have rough and sharp leaves. Grasses of the other extreme, in water scarcity areas, have xerophytic adaptations. They look duller and many are with hairy surfaces. Some have water storage tissues in their leaves, which enable them to survive drought. These grasses are stronger with lot of fiber tissues. Most desert grasses have stomata on the upper epidermis which also has special cells that help in rolling of leaves into a hollow tube. Therefore the stomata are protected from the desiccating conditions during the hot hours of the day. Not only in deserts in most other drier habitats like sandy sea shores, rocky places, and other open dry areas, grasses tend to have similar adaptations.

Figure 1.2: Grasses and sedges (grass like plants) along with water-lilies

The trailing habit of many grasses (e.g., *Cynodon dactylon, Oplismenus burmanii etc.*) helps them to withstand grazing pressure, trampling and even fires. Taller grasses tend to dominate areas where they have to compete with dicot herbs. Bamboos though woody and tree like are also grasses. For them the height is of advantage in competing with trees of the forest. Grasses are prolific seed producers. Their smaller seeds have enabled them to spread widely. Most grasses also reproduce vegetatively, so that even if their shoots are browsed by animals or destroyed in fire, they produce fresh shoots from underground rhizomes or from nodes at ground level. Some grass species can survive in diverse ecological conditions; for instance the Bermuda grass (*Cynodon dactylon*), commonly found in Anshi- Dandeli Tiger Reserve can grow in submerged habitats as well as on drier soils. Tiny, wind dispersed seeds of many grasses and their light loving nature enable them to be the pioneer colonizers of freshly created open habitats. Elasticity of grass internodes confer on them survival value in windy conditions and resist trampling. Another reason for the success of grasses is wind pollination and their non dependence on animals as pollinators. All such characters of grasses provide them with greater plasticity to grow in situations not favorable for many other flowering plants.

Grasslands constitute a critical resource, as the grasses constitute bulk of the diet of herbivorous mammals, especially ungulates, which constitute bulk of the prey for the big cats, the tiger and the panther. Ecological history of the Western Ghats, especially of Uttara Kannada district, and the recent studies highlight that the number of tigers in any reserve is correlated to the number of prey animals and prey animals depends on grasslands. Therefore grasslands deserve prime attention in the management plans of ADTR. The work on grasses of ADTR is scanty and this work constitutes preliminary work which help in understanding grassland ecology. Tigers are part of a landscape of varied elements and grasslands cannot be treated in isolation, but in combination with forests, savanna, scrub, streams and rivers, gorges, ravines and cliff, which in a mosaic constitute homes for the deer, sambar, gaur and pig which are among the important preys of the tiger.

This report is based on a short term study conducted on the grasslands of ADTR keeping above objectives in view. Here we try to understand and place the grasslands of ADTR in the backdrop of the world of grasses. Not only large grasslands, but various microhabitats of grasses have bee identified and their characteristic flora catalogued. The results are discussed at length and many useful recommendations are arrived at with the tiger in the focus. Though apparently digressions from grasslands are many in this report, efforts are made to harmonise them into the holistic concern for conservation. We have also provided here locations of grasslands and other openings in the forest canopy based on Google Earth, and made efforts at estimating the forest Range-wise area under grasslands. This report carries a useful guide of pictures and descriptions of a good number of grasses of the Reserve. The use of technical terminology cannot be easily dispensed with while describing grasses, since they are plants with very subtle features. We have provided a glossary of technical terms used in taxonomic descriptions. This report is more of a preliminary study and constant efforts have to be carried out in the coming years to understand the dynamics of the grassy habitats, evaluating them in sustaining a good prey population critical for increasing the number of tigers to the potential carrying capacity of the Reserve.

CHAPTER 2: GRASSLANDS OF THE WORLD

Grasslands are of many types, and are associated with all the continents of the world, barring the Antarctica. Latitude, soil and local climates for the most part determine what kinds of plants grow in particular grassland. Natural grassland is a formation in low rainfall areas where the average annual precipitation is normally just enough to support grasses, and in some areas a few trees. The precipitation is so erratic that drought and fire prevent large forests from growing. Grasses can survive fires because they grow from the bottom instead of the top. Their stems can grow again after being burnt off. The soils of most natural grasslands are also too thin and dry for trees to survive.

The Grasslands in the southern hemisphere receive more precipitation and support taller grasses than those in the northern hemisphere. In Argentina of South America, with a humid climate, the grasslands are known as **Pampas.** A large area of grassland that stretches from the Ukraine of Russia all the way to Siberia is known as the Russian and Asian **Steppes**. The climate in this region is very cold and dry because there is no nearby ocean to get moisture from; winds from the Arctic aren't blocked by any mountains either (www.blueplanetbiomes.org/grasslands). In the Miocene and Pliocene Epochs, which spanned a period of about 25 million years, mountains rose in western North America creating a continental climate favoring the spread of grasslands and decline of ancient forests in the interior plains. Following the Pleistocene Ice Ages, grasslands expanded in range as hotter and drier climates prevailed worldwide. But natural grasslands today have highly decreased; for instance the tall grass prairie of Ontario is only three percent of the original extent (www.ucmp.berkely.edu/exhibits/biomes/grasslands). Grasslands can be broadly divided into Temperate grasslands and Tropical grasslands or savannas (Figure 2.1).

Temperate grasslands: Temperate grasslands are characterized by the general absence of trees and large shrubs. The '**Veldts**' of South Africa, the '**Puszta**' of Hungary, the '**Pampas'** (Figure 2.2) of Argentina and Uruguay, the and the '**Prairies**' (Figure 2.3) of Central North America '**Steppes**' (Figure 2.4) of the former Soviet Union, belong to this category. Summers here are hot, winters cold and rainfall moderate, lower indeed than in tropical savanna grasslands. Summers here are hot, winters cold and rainfall moderate, lower indeed than in tropical savanna grasslands (http://www.hamiltonnature.org/habitats/grasslands). The grasses attain greater heights in wetter than in drier regions. Seasonal drought and occasional fires have decisive influence on biodiversity.

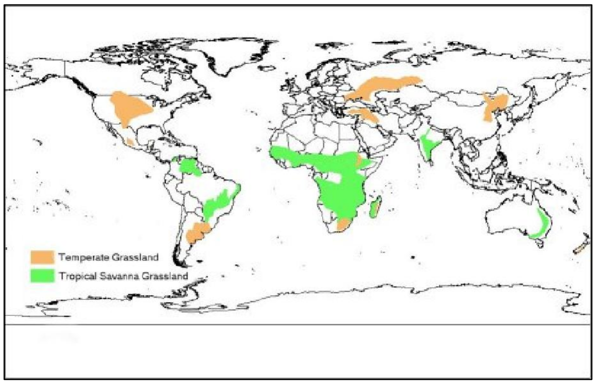


Figure 2.1: Grasslands of the world (Source: **www.bcgrasslands.org/library/world.htm)**

Figure 2.2: Pampa grasslands of Argentina

Figure 2.3: Bisons grazing in Prairies of North America

Figure 2.4: Short grasses of Steppe grassland

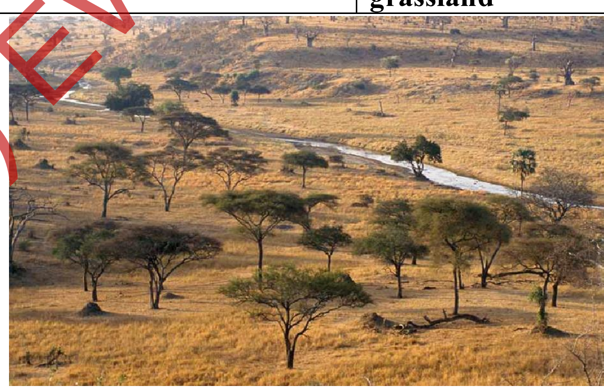


Figure 2.5: Savanna grassland

Tropical Grasslands (Savannas): The word 'Savanna' is derived from the Caribbean Indian language in which Sabana means forest clearings. (Savannas are grass dominated lands with scattered individual trees). Savannas of one sort or other cover almost half the surface of Africa (about eight million square kilometers, generally in Central Africa), large areas of Australia, South America, and India. Climate is the most important factor in creating a savanna, always found in warm or hot climates where the annual rainfall ranges from 51-127 cm (www.ucmp.berkely.edu/exhibits/biomes/grasslands). The rainfall here is confined to four to eight months a year, followed by a spell of drought punctuated with fires. If the rains were to be well distributed throughout the year, many such savannas would turn into tropical forest.

Savannas can be in general divided into:

- ***Climatic savannas***: These savannas are derived from climatic conditions. Their change into other forms depends on climatic variations.
- ***Edaphic savannas***: Savannas resulting mainly from soil conditions such as hill soil, clayey water logged soil etc.
- ***Derived savannas***: Most of the Indian grasslands of plains and low altitude hills belong to this category. They are considered to be derived from slashing and burning of forests and other human impacts. Variations in rainfall and soil conditions between different savannas maintain different grass species of which some become dominant.

Indian Grasslands: The climax vegetation of India is either forests or desert vegetation (Misra, 1980). These grasslands exist solely due to the anthropogenic activities such as lopping, burning, shifting cultivation and grazing for the last several thousand years. The tropical grasslands of India are often referred as savanna. Maximum growth rates are found at about 35°C, about 10°C warmer than the optimum for temperate grasses, and at light intensity twice the optimum. The reason for this is that most tropical grasses have a different photosynthetic mechanism compared to temperate grasses. These biochemical reactions have given rise to C4 and C3 plants (Misra, 1980). During the last few thousand years, the Indian grasslands have undergone many changes. The West Indian desert (Thar) of Rajasthan today is characterized by a hot and dry summer followed by a cold winter. Historical evidence indicates that the area was under forests some 2000 years ago but was gradually destroyed by man for agricultural practices and became desert due to excessive dryness. In the North-Eastern region, under a hot and humid climate, where rainfall exceeds 1,000 cm (world's highest), there has been development of dense evergreen forests of rich biodiversity. Over a long period of time, tribes and local peoples in this region have cleared forests and practiced Jhum (shifting) cultivation leading to the conversion of primary forests to secondary forests to grasslands (www.pages-igbp.org.; Ramakrishnan, 1992). Indian savannas during the past four centuries are stated to have changed from moderately moist (mesic) to arid (xeric) conditions favoring common woody elements like *Acacia nilotica, A. senegal, A. catechu, Calotropis gigantea, Mimosa sp., Phoenix sylvestris and Ziziphus nummularia*. Indian grasslands are tentatively divided into eight major types (Whyte R.O., 1954, 1957):

Many of the hilly forested areas of Western Ghats were under shifting cultivation by forest dwelling people, such as the Kunbis, Kumri Marattis etc. of Uttara Kannada. Patches of forests were cleared by cutting and burning, and cultivated the cleared lands for two or three years. As prolonged cultivation would cause soil erosion, decrease soil fertility and increase pest pressures the shifting cultivators would repeat this process in another patch of forest. After many years when forest had regrown on abandoned lands the cycle would be repeated (Chandran, 1998). In India, this system of cultivation is widespread to this day in the Northeastern states. It was banned in most of the South Indian Western Ghats by the British, during late 19th Century. Considerable part of the Anshi Dandeli Tiger Reserve (ADTR) was affected by this system. Whereas forests have re-grown in old shifting cultivation areas, there are very good stretches of savanna grasslands still within the Reserve. These are good examples of derived savannas. The periodic firing of these savanna grasslands keep them in their present state. If fire factor is stopped these savannas have chance to revert to forest if the ground is not rocky or severely eroded. Grasslands associated with wind exposed medium altitude of 1000-1600 m (eg. Kudremukh, Bababudan) and higher altitudes of >1600 m (eg: Anamalais and Nilgiris) are known as 'shola' grasslands. These grasslands alternate with stunted evergreen forests in the wind sheltered folds of hills (Figures 2.6 & 2.7) The species found here are *Andropogon pertusus, Ischaemum pilosum, Themeda imberbis, Cymbopogon polynuros, Eragrostis nigra* etc. Extensive areas of temperate, subalpine and alpine grasslands occur in the higher altitudes of the Himalayas (Figures 2.8 and 2.9)

Indian grasslands are broadly grouped into eight major types (Whyte, 1954, 1957) as in Table 2.1:

Table 2.1 Major types of Indian grasslands and their distribution

Sl	type	Dominant grasses	Associated grass sp.	States occurring
1	*Sehima-Dichanthium*	*Sehima sulcatum, S. nervosum, Dichanthium annulatum, Chrysopogon montanus* and *Themeda quadrivalvis.*	*Ischaemum rugosum, Eulalia trispicata, Isilema laxum* and *Heteropogon contortus. Themeda* and *Heteropogon* are more extensive on hilly tracks.	Black soils of Maharastra, Madhya Pradesh, south-western Uttar Pradesh and parts of Tamilnadu and Karnataka.
2	*Dichanthium-Cenchrus*	*Dichanthium annulatum* and *Cenchrus ciliaris* are very important fodder grasses	Perennials like *Bothriochloa pertusa, Heteropogon contortus, Cynodon dactylon* and the annuals, *Eragrostis tennela, E. tremula, E.viscosa, E.ciliaris, Aristidia adscensionis* and *Dactyloctenium aegyptium.* Well drained wet soils are characterized by *Desmostachya bipinnata* and *Dichanthium annulatum.*	Sandy loam soils of the plains of Punjab, Haryana, Delhi, Rajasthan, Saurashtra, eastern Uttar Pradesh, Bihar, Bengal, eastern Madhya Pradesh., coastal Maharastra and Tamilnadu. In dry areas of Rajasthan, Saurastra and Western Madhya Pradesh, after severe grazing these are replaced by sparse population of annuals.
3	*Phragmitis-Saccharum*	*Phragmitis karka, Saccharum spontaneum, Imperata cylindrica and Bothriochloa*		Terai areas of northern Uttar Pradesh, Bihar, Bengal, and Assam. Swamps of Sundarbans and Cauvery delta of Tamilnadu.
4	*Bothriochloa*	*Bothriochloa odorata*		high rainfall paddy areas of Lonavala track of Maharastra is only with dense growth of *Bothriochloa odorata*
5	*Cymbopogon*	*Cymbopogon spp.*	*Themeda, Heteropogon* and *Aristida.*	Low hills of the Western Ghats, Vindhyas, Satpuras, Aravali and Chota Nagpur
6	*Arundinella*	*Arundinella nepalensis, A.setosa* with *Themeda anathera* form extensive stands with sporadic growth of *Chrysopogon* spp.		High hills of the Western Ghats, Nilgiris, and throughout on lower Himalayas from east in Assam to west in Kashmir. On the Himalayas, between 1500 m to 2000 m

7	*Deyeuxia-Arundinella*	*Deyeuxia, Arundinella, Brachypodium, Bromus and Festuca sp.*		Temperate regions of the upper Himalayas between 2000 m. to 3000 m. from Assam, Bengal through Uttar Pradesh to Punjab and Himachal Pradesh
8	*Deschampsia-Deyeuxia*	*Deyeuxia, Deschampsia, Poa, Stipa, Glyceria* and *Festuca. Deschampsia* and *Trisetum spicatum* extend even beyond 5000 m.		Restricted to the Himalayas above 2500 m in the alpine to subartic region.

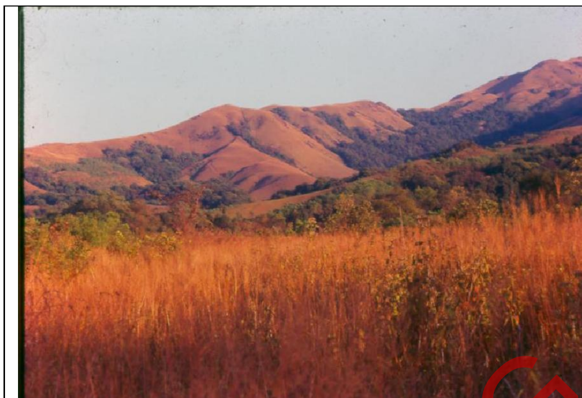


Figure 2.6: Medium altitude shola grasslands of Kudremukh

Fig: 2.7. High altitude shola grassland of Anamalais

Figure 2.8: High altitude subalpine grasslands in Western Himalayas

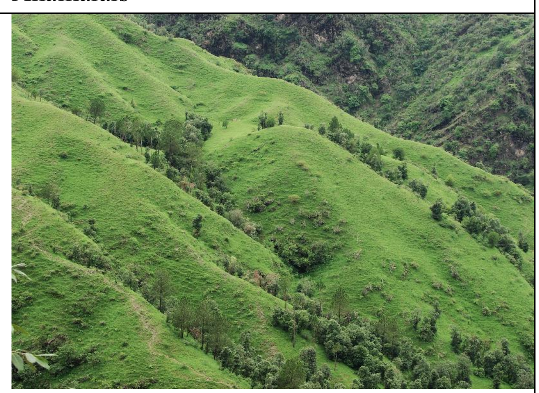


Figure 2.9: High altitude temperate grasslands in Western Himalayas

CHAPTER 3: GRASSLANDS OF UTTARA KANNADA

Uttara Kannada district (74^0 9'-75^0 10' E and 13^0 55'-15^0 31' N), having 10,327 sq km area is bordered by the Arabian Sea to the west. Most of the district is covered by the low altitude (<800 m) hills of Central Western Ghats. The South-west Monsoon brings to the western parts of the district, up to the crestline, copious rainfall ranging from 3000-5000 mm per annum. As the Ghats cause most of the clouds to precipitate towards the west, there is dramatic decline in rainfall towards the rain-shadow eastern portions; just 40 km east of the crestline the rainfall would be less than 1500 mm. The rainfall over the district is highly seasonal, with more than 90% occurring in June-November. Mean monthly temperature range from 20-27^0 C. The net result is an effective dry season of almost six to seven months. The western portions of the district with higher rainfall tend to have evergreen to semi-evergreen forests as the natural climax vegetation, in the absence of human interference. The eastern undulating landscape merging with the Deccan Plateau, in the taluks of Mundgod and Haliyal tend to have moist deciduous to dry deciduous forests as the climax forests. The grasslands in the district are mainly due to the forest clearance by humans carried out through centuries of shifting cultivation and cattle grazing. Specially maintained 'bena' grasslands (Figure 3.1) of farmers as well as many grassy blanks within forests and closer to villages are the result of arresting the natural succession of forest vegetation because of periodic burning of woody growth by the people. Savanna vegetation (Figure 3.2) is very common element of landscape in every taluk of the district. It is a mixture of isolated trees or clumps of dwarf trees amidst a general matrix of grasses. In the absence of fire these savannas often tend to progress towards forest, through recruitment of more trees, which shade the grasses, giving not much scope for their multiplication.

Man-made savanna grasslands: Pollen grain deposits in swamps and marshes and in the seabed along the coastline are often indicators of the past vegetation and the changes that happened in the course of time. We do not have much of pollen deposit studies from Uttara Kannada. However, one outstanding study by Caratini et al. (1991) based on a soil core sample from the sea bottom off the Karwar coast shows that the land was covered until 3,500 years ago by forests dominated by evergreen trees. Thereafter the pollen deposit from savanna plants such as grasses and herbs increased. Such change would indicate the human impact on the forests of Uttara Kannada by slash and burn method or shifting cultivation or *kumri* cultivation (Chandran, 1998). Climatic conditions would still favour return of the forests on fallow or abandoned agricultural lands. Cattle rearing also contributed to savanna formation; as humid weather promoted the growth of forests in savannas and grasslands, the farmers were forced to keep forests away by periodical burning of woody outgrowth.

Figure 3.1: A 'bena' grassland in coastal Uttara Kannada

Figure 3.2: A hill top savanna element in the forest landscape

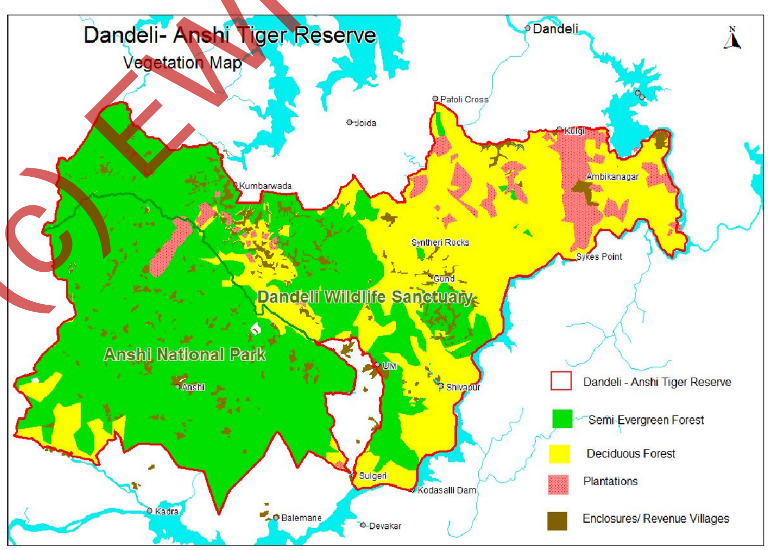


Figure 7: Vegetation map of ADTR

Grassland types in Uttara Kannada: The savanna grasslands can be mainly categorized into two types:

- **Dry to mesophilous grasslands** occur along the rocky plateau, open hill tops and slopes, scrub jungles, forest undergrowth and openings, uncultivated lands, fallow fields etc. The mesophyllous grasslands occur in more moist conditions than the dry land grasses. Those in gardens, rice field bunds, wet meadows etc. are of this type.
- **Hygrophilous grasslands** are more water-loving and seen along the margins of water courses like pools, puddles, back waters, along marshy places, low lying areas etc.

In both these grassland categories, depending upon human pressures, topography, soil nature and grazing pressure short or long type grass species would occur. Human factor is decisive factor governing the permanency of grasslands, but for which vegetation would change in most cases according to the principles of ecological succession. Based on Sarmiento, 1984on these factors Savannas can be differentiated as:

1. Savannas without woody species taller than the herbaceous stratum: *Grass savannas or grasslands.*(e.g., Benas; Figure 3.1)
2. Savannas with low (less than 8 m) woody species forming a more or less open layer.
   (a) Shrubs and/or trees isolated or in groups; total cover of woody species less than 2%: *Tree and shrub savanna* (e.g., Coastal scrub savannas)
   (b) Total tree/shrub cover between 2% and 15%: *Savanna woodland, wooded grassland, or bush savanna*
   (c) Tree cover greater than 15 %: *Woodland* (e.g., Interior Coastal scrub savannas, and hill top grasslands)
3. Savannas with trees over 8 m
   (a) Isolated trees with less than 2% cover: *Tall- tree savanna* (Lands near agricultural fields)
   (b) Tree cover 2-15%: *Tall savanna woodland* (Eg.,Scrub lands)
   (c) Tree cover 15-30%: *Tall wooded grassland* (Highly degraded deciduous forests, Soppina Bettas)
4. Savannas with tall trees in small groups: *Park savanna*
5. *Mosaic of savanna units and forests: Park* (Forest hill slope grassland, forest openings, etc.).

Figure 9: A coastal wetland grassy area mixed with the sedge *Cyperus pedunculatus*

CHAPTER 4: GRASSLANDS OF ANSHI-DANDELI TIGER RESERVE - Study method

The grasslands of the ADTR were mapping through the IRS P6 - remote sensing data (Google Earth etc.) and field survey. Representative patches for all types of grasslands or rather grass growing areas, including marshes, puddles, forest underneath etc. were studied using ecological sampling technique 'transect cum quadrat method'. In each selected grassland 5 plots (quadrats), each 1 m x 1m (Figure 4.1), were laid along a straight line (transect line) leaving a distance of 10 m between any two plots (Figure 13). We have characterized grasslands as short (<15 cm height), medium (16-30 cm) and tall (>30 cm). In each plot, grasses and other herbs were noted and their numbers counted. Data on their habit (clumps, trailing, erect etc.) and notable field characters were also recorded. Searches were made outside the sample plots to document other species. Rare and unidentified specimens were pressed for herbaria. Geographical co-ordinates of study localities were recorded using global positioning system (GPS). Fresh specimens were identified with the help of floras and our own herbarium specimens. Experts were consulted for unidentified collections; some of the specimens were also taken to the BSI herbarium at Pune. Bamboos and reeds, though also grasses, have not been included in this study as they do not form part of grasslands. The locations of sampling are given in Figure 4.2. The grasslands studied in different localities have been characterized and the details are given in Table 4.1. A typical grassy blank in the forest is shown in Figure 4.3.

Sl.	Transect locality	Grassland type	Dry/Wet
1	Goyar-Savadi	Forest underneath*	Dry
2	Kailwada-Dongrewada	Grassland adjacent to fields	Dry
3	Kailwada – Kailwada	Fallow fields	Dry
4	Kailwada-Madgaon	Grassland adjacent to fields	Dry
5	Thayamaddi-Barpoli Cross (Anshi)	Hill slope grassland	Dry
6	Burpalli (Anshi)	Open grassland	Dry
7	Shiroli-near Bamnia (Kumbarwada)	Wet grassland	Wet
8	Terali	Forest opening grassland	Dry
9	Kundal	Forest opening grassland	Dry
10	Kaneri dam site	Forest opening grassland	Dry
11	Virnoli safari route	Forest underneath*	Dry
12	Shiroli mining area (Kulagi)	Wet grassland	Wet
13	Mandurlli (Kulagi)	Wet grassland	Wet
14	Bommanahalli Reservoir	Reservoir side grassland	Dry
15	Lande	Forest opening grassland	Dry
16	Anshi	Forest opening grassland	Wet

*Forest underneath: Sparse growth of certain grasses occurs beneath forest canopies.

Table 4.1: Transect locations in Anshi and Dandeli Tiger Reserve and grassland type

Figure 4.1: Laying quadrat in *Dimeria* and *Arundinella* dominated grassland in Kundal

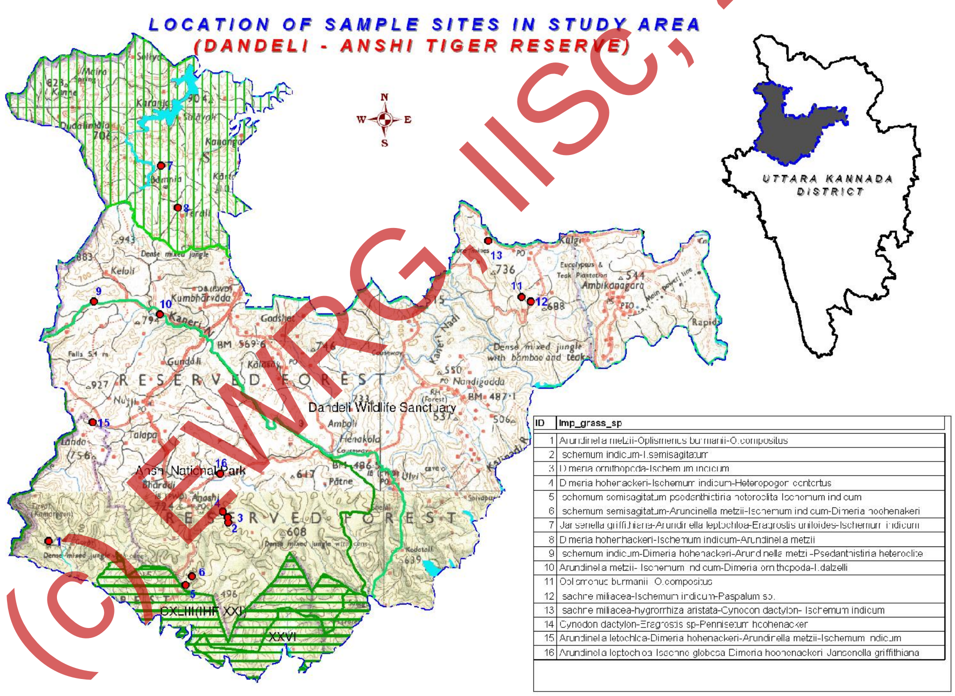


Figure 4.2: Grasslands study locations in ADTR

Opportunistic surveys: Grasses occurring in many minor habitats other than grasslands such as old walls, alongside water courses, wastelands, cultivations, crevices in rocks etc., were also listed.

- ***Wall grasses*:** The monsoon rains promote a flourish of seasonal grasses on mud walls, stone fences, old compound walls, abandoned houses etc. The commonest among these wall grasses are *Arthraxon lancifolius, Dimeria ornithopoda, Arundinella pumilla* etc.

- ***Grasses along water courses***: *Paspalum conjugatum, Hygrorrhiza aristata, Leersia hexandra, Sacciolepis interrupta, Isachne miliaceae*, etc. occur along water courses.
- ***Fallow land grasses:*** The fallow lands of the village areas are dominated by grasses like *Panicum repens, Dactyloctenium aegyptium, Eragrostis uniloides, Paspalum scrobiculatum* etc.
- ***Grasses as weeds***: Several grasses occur as weeds in fields and gardens. Notable of them are *Echinochloa colona, E. crusgalli, Oryza rufipogon, Sacciolepis interrupta* etc., associated with rice fields. Weeds in gardens and other croplands include *Panicum repens, Dactyloctenium aegyptium, Centotheca lappacea* and *Ischemum indicum.*

Results (using sample plots)

Based on 16 transects and 80 plots (each of one sq.m) we recorded 116 flowering plant species, belonging to 109 genera and 36 families There were 100 herb species belonging to Poaceae (grasses) and its close relative Cyperaceae (sedges). Eight shrub species, seedlings of six tree species and two climber species were also recorded. Poaceae with 32 species was the largest and dominating family followed by Cyperaceae (13 sp.), Scrophulariaceae (8), Asteraceae (6), and Acanthaceae (5) and others in smaller numbers. The notable grasses of different grasslands sampled are given in Table- 4.2

Population: Terali grassland (Figure 4.4) had the highest number of individuals (3800/transect) followed by Kailwada-Kailwada (3022) (Figure 4.5) and others. Terali has many grasslands, rich in fodder grasses dominated by *Dimeria hoohenackeri, Ischemum indicum*, and *Arundinella metzii*, all these endemic to Peninsular India. The fallow fields of Kailwada-Kailwada under heavy grazing pressure from cattle, are dominated by weedy species of sunflower family, Asteraceae. If fallow period continues and grazing pressure reduced this area could be transformed into good grasslands. Most fallow fields of the ADTR are of similar kind. The fenced *bena* lands near paddy fields are naturally having tall grasses cherished as good fodder by villagers.

Table 4.2: Grassland study locations and notable grass species.

Sl.	LOCATION	Important grass species
1	Anshi	*Arundinella leptochloa-Isachne globosa-Dimeria hoohenackeri-Jansenella griffithiana*
2	Bommanahalli reservoir	*Cynodon dactylon-Eragrostis sp-Pennisetum hoohenackeri*
3	Burpalli-Anshi	*Ischemum semisagitatum-Arundinella metzii-Ischemum indicum-Dimeria hoohenakeri*
4	Goyar-Savadi	*Arundinella metzii-Oplismenus burmanii-O.compositus*
5	Kailwada – Kailwada	*Dimeria ornithopoda-Ischemum indicum*
6	Kailwada-Dongrewada	*Ischemum indicum-I.semisagitatum*
7	Kailwada-Madgaon	*Dimeria hohenackeri-Ischemum indicum-Heteropogon contortus*
8	Kaneri damsite	*Arundinella metzii- Ischemum indicum-Dimeria ornithopoda-I.dalzelli*
9	Kundal	*Ischemum indicum-Dimeria hohenackeri-Arundinella metzii-Psedanthistiria heteroclite*
10	Lande	*Arundinella letochloa-Dimeria hohenackeri-Arundinella metzii-Ischemum indicum*
11	Mandurlli (Kulagi)	*Isachne miliacea-hygrorrhiza aristata-Cynodon dactylon- Ischemum indicum*
12	Shiroli mining area	*Isachne miliacea-Ischemum indicum-Paspalum sp.*
13	Shiroli-near Bamnia	*Jansenella griffithiana-Arundinella leptochloa-Eragrostis uniloides-Ischemum indicum*
14	Terali	*Dimeria hohenhackeri-Ischemum indicum-Arundinella Metzii*
15	Thayamaddi-Barpoli Cross	*Ischemum semisagitatum-psedanthistiria heteroclita-Ischemum indicum*
16	Virnoli safari route	*Oplismenus burmanii- O.compositus*

Figure 4.3: A typical hill slope grassland

Figure 4.4: *Dimeria hohenakeri* dominated grassland in Terali

Species richness: Figure 4.6 shows species richness of different transects. Shiroli-Bamnia had the highest number of species (43). Marshy spots with characteristic herbs contribute to its species richness. Drier highlands of Shiroli-Bamnia had perennial grasses like *Arundinella leptochloa* and seasonal *Dimeria hoohenackeri, Ischaemum indicum* etc. all of fodder value. Diggie area, newly added to ADTR, has some good and large grasslands, followed by Anshi transect (39 species), also with marshy plots. Anshi region is mostly clad in evergreen to semievergreen forests. There are fairly large agricultural areas cum grassy blanks, within these forests.

Figure 4.5: Kailwada–Kailwada grassland & fields (from Google Earth)

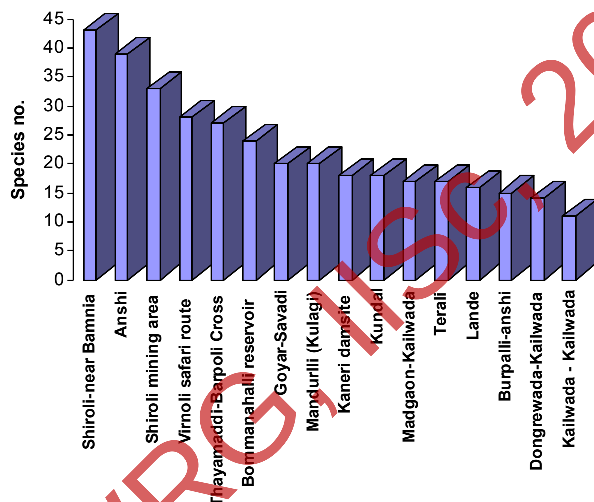


Figure 4.6: Transect-wise species richness in ADTR.

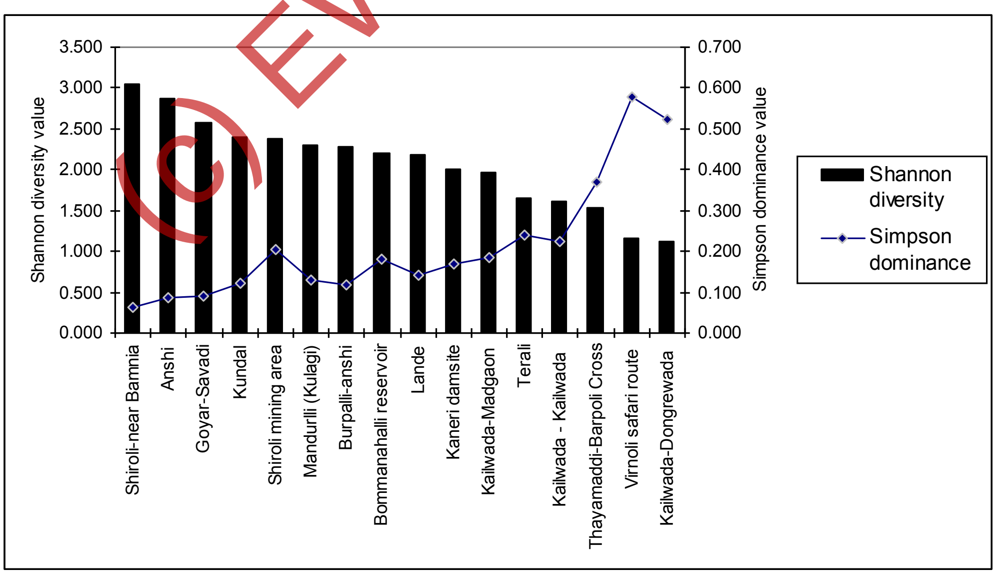


Figure 4.7: Transect-wise Shannon diversity and Simpson dominance in ADTR

Details regarding Shannon diversity and Simpson dominance of the grasslands are given in Figure 4.7. Terali open grassland though low in Shannon diversity index (1.65) was dominated by fodder grasses. Shannon diversity was higher in forest underneath grassland of Goyar (2.5), open grassland (Figure 4.6) of Kundal (2.4), wet grasslands of Shiroli- old mines area (2.4) and Mandurli near Kulgi (2.3).

Figure 4.8: Kundal forest opening and nearby large fields

Figure 4.9. Kailwada-Dongrewada – highly fragmented landscape

In Goyar though species number was high (20) grasses constitute only 40%, and that too of not much fodder significance such as *Oplismenus burmanii* and *O. compositus,* which by habit creep on the forest floor amidst other non grass herbs. The same was the case with Shiroli old mines area. Forest transect along Virnolli (safari route), and fallow fields of Kailwada-Dongrewada study area (Figure 4.9) had the lowest Shannon diversity indices at 1.166 and 1.129 respectively. Bommanahalli reservoir grassland had a moderate Shannon diversity of 2.21. The number of grass species here was poor and their fodder significance less, understandably due to constant fluctuation of water level in the dam. Diversity was very poor and dominance very high in Virnolli (safari route) with 75% of population constituted by single short grass species of *Oplismenus burmanii*. Kailwada-Dongrewada also had very high dominance with *Ischaemum indicum* but this grass has good fodder value. Percentage of grass species versus non-grass species for different study sites are given in Figure 4.10. It was observed that habitat heterogeneity at the micro-level within the grassland causes increase in the number of species, but need not be reflecting the pasturage value of the grassland.

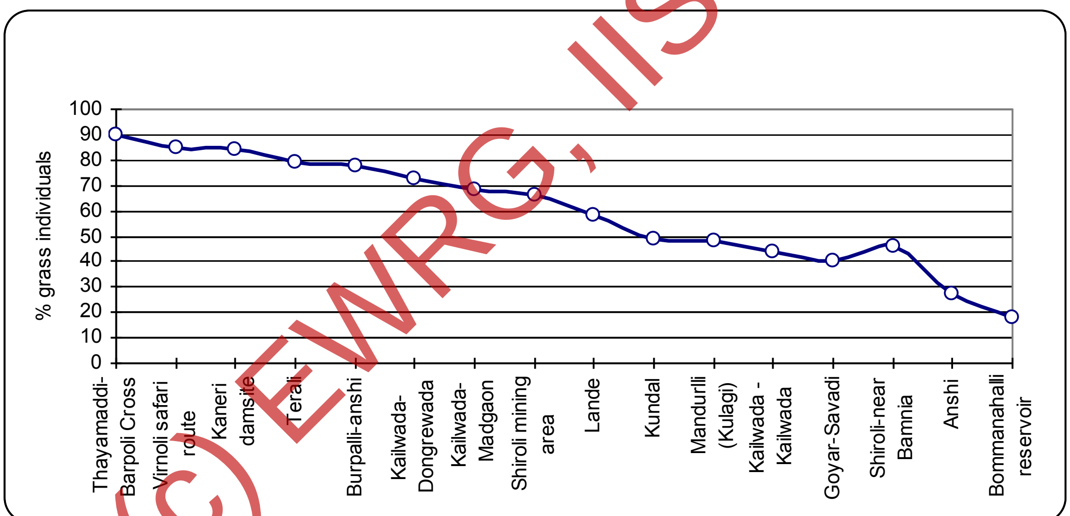


Figure 4.10. Grass individuals (%) compared to non-grass individuals (%) in the samples.

CHAPTER 5: GRASSLANDS AND TIGERS

The primeval grasslands played major role in sustaining large mammals than other ecosystems almost anywhere in the world where they occur. The Great Plains of North America was once teeming with vast herds of bison, deer, elk and pronghorns. The gray wolf, cougar, bears, gray fox and badger were common predators. Today the large mammals have become extremely rare or extinct in most of their former ranges because of hunting and habitat destruction. The savanna grasslands of Serengeti Plains of Kenya and Tanzania are home to the highest density of hoofed grazing animals in the world. Over 1.5 million wild beasts, which include antelopes, gazelles, black rhinoceros, zebras, impalas and giraffes graze on the savanna. The herbivores in turn support lions and a variety of predators and scavengers, such as leopards, hyenas, cheetahs and wild dogs. Rapidly growing human populations, herds of domestic cattle competing with wild animals for grazing and agriculturists clamoring for farmlands are major threats to wildlife here. Threat from hunters is a major problem for African wildlife (Cunningham and Saigo,1990).

There are several accounts of the rich and varied wildlife that Uttara Kannada had in the past, as described by many visitors and officers to Uttara Kannada, even before one thought of sanctuaries and national parks. Francis Buchanan, as early as 1801, mentioned about the tiger infested forests of Kanara. The *Kanara Gazetteer* (Campbell, 1883) has a rich account of Uttara Kannada's wildlife. As early as 1676 an English traveler Fryer and in 1690 Ovington commented upon the abundance of wild animals in the forests close to Karwar. The British residents of Karwar went to the woods regularly for hunting and could bring home for meat spotted deer, sambar, wild hogs and gaurs "without any further expense than that of powder and shot".

The hunting spree continued more intensified, both by native shikaris and the British sportsmen, during the 19th century. That was the period when the British consolidated their hold on Uttara Kannada. Wildlife was plentiful in the district until the mid-19th century. Tigers, panthers and bears had proliferated. Incidents of human and cattle kills had increased so much so that was taken as the reason for launching a massive programme for eliminating most of these animals of prey and other dangerous animals by the British. Rewards were paid to the shikaris for every animal killed.

Colonel Peyton, Conservator of Forests had made graphic account on the hunting of tigers, panthers and bears in Uttara Kannada. For a period of 22 years from 1855, 510 tigers were officially reported to be killed in the district. Between 1878 and 1882, yet another 130 tigers were hunted down. During the same five year period 214 panthers were hunted. Between 1844 and 1861, 51 bears were hunted down. Hunting for sport became a very common feature under the British rule until the animals became scarce. Among the prolifically hunted animals for meat purpose were sambar, gaur, antelopes, spotted deer, barking deer, mouse deer etc. So much so there was a precipitous decline in the population of many wild mammals by the close of the 19th century. Colonel Peyton wrote on the hunting of spotted deer (chital): "Chittal was at one time numerous over the whole of Kanara…. Ten of fifteen years ago the spotted deer was abundant throughout the valleys of the Kalinadi, Bedtihalla, Gangavali, and Tadri, as well along the east of the district….. At Dandeli in 1867 from a herd of not less than 150 to 200, three splendid stags were picked out and shot in a few moments. Now, about same place, the sportsman has had a lucky morning if he sees a small herd or two."

Regarding gaur Col. Peyton stated: "The Bison…. is found over the greater part of Kanara, but being so much shot at and from being subject to the disease which prevail among domestic cattle …. it is disappearing from many parts where it abounded fifteen or sixteen years ago …. They were especially common about sixteen years ago in the Gund forests, and between Gund and Anshi, as well as along the Kaneri river." The Sambar and barking deer were also quite widespread in the district (Campbell, 1883). What made Uttara Kannada such a special place for the abundance of tigers and panthers as well as so many kinds of herbivores, at a time when there were no sanctuaries or National Parks? That was also a time when the Forest Department, under the British, was acquiring and settling forests. The animals like tigers were in such excess that every year dozens were eliminated. Hunting was wantonly carried out for sport than for subsistence. To find answer to these questions, we need to look into the forest history and learn some lessons crucial for wildlife management. At the time of British take over of Uttara Kannada in 1799 the land was a mosaic of primeval evergreen forests, secondary forests in different stages of succession and extensive grassy blanks, the results of forest clearance for shifting cultivation. Many times the shifting cultivators did not return to the same spot for repeating the slashing and burning resulting in late successional stages of secondary forests. Where the grasslands were fired systematically during summers for fresh growth during rains, by the local farmers, the climax vegetation remained as grasslands or savanna grassland complex, as is found in many parts of the Anshi-Dandeli Tiger Reserve to this day. The period of shifting cultivation was one of landscape heterogeneity ideal for wildlife. The forests on both sides of the district's rivers were already of a secondary kind, dominated by deciduous trees, during the early British period itself (early 19th century). This could have been the result of shifting cultivation, as well as due to timber logging for commercial purposes (Chandran, 1998). Anshi-Dandeli Tiger Reserve area has perhaps the largest concentration of the descendents of shifting cultivators of the past.

HABITAT SUITABILITY FOR LARGE UNGULATES

Prey-Predator: their relation with habitat -

Unlike lions or cheetah which need vast grasslands for their prey capture, tigers rely on surprising a prey and capturing it. Hence tigers prefer to inhabit mosaic kind of landscape elements such as dense forest, grasslands, scrub, ravines, wetlands etc. According to Karanth (2003) tigers have the ability to live in very diverse natural habitats and they can tolerate wide range of temperatures and rainfall regimes. They produce relatively large litters with relatively short inter-birth intervals. They can take prey differing considerably in size and their hunting tactics will vary based on prey size, prey species and habitat. ADTR hosting large number of these landscape elements would have been ideal as tiger habitats, as is obvious from the historical records. The tiger population largely vanished from Uttara Kannada itself mainly due to hunting (both tigers as well as its prey animals), and large scale conversion of forests into monoculture of mainly teak (about 1000 sq km of forests have been converted into teak plantations in the district) and other forms of intensified habitat degradation due to commercial working of forests for timber and industrial raw materials. Weeds like *Lantana* and *Eupatorium* proliferated in the canopy openings and inside the teak plantations adversely affecting native species, and therefore understandably, with adverse consequences on the rich wildlife that the region had once. Increase in human and cattle population, the growth of Dandeli as an industrial city, from an obscure village prior to independence and the execution of a chain of hydel projects in the river Kali and associated disturbances such as the setting up of new colonies for project employees at Ambikanagar and Ganeshgudi etc. would have obviously reduced wildlife areas and affected habitat quality. Evacuees from the submersion areas of Supa dam were resettled in the newly created Ramnagar township. Moreover several mining leases were given inside the forest areas damaging forests and grasslands as well as converting the region into a transportation hub. The stoppage of shifting cultivation in the late 19th century witnessed the erstwhile shifting cultivators like Kunbis, Kumri Marattis etc. taking to permanent cultivation. With settled cultivation these historically nomadic cultivators, who were earlier not associated with pastoralism, took to cattle rearing for manure and milk. Therefore, naturally, the pressure on the grazing resources from the domestic cattle would have increased substantially, with telling consequences on the ungulate preys of the tiger and panther. Shifting cultivation today is a thing of the past. Working of reserved forests for timber and firewood and industrial raw materials is no more in the reserved forests, from mid 1980's, and more so in the Protected Areas. There are strict rules regarding forest and wildlife conservation. As such we could expect an increase in the prey population favouring the multiplication of tigers.

In contrast to the earlier approach in tiger conservation, relying on large unbroken habitats new approaches are emerging. Tigers are visualised to living in large, dynamic landscapes. Tiger conservationists know that it is impossible to isolate and protect tigers from human influences (Seidensticker et al., 1999). Karanth and Smith (1999), looking at the ecological history tiger, propose that prey depletion is a major factor driving the current decline of wild tigers. If depressed prey is a significant negative factor, reducing poaching pressure on tigers alone is not an adequate conservation response. A model proposed based on several studies on prey depletion in recent years postulates strongly that prey depletion has a strong effect on tiger population dynamics. Prey scarcity will affect nutrition of adults forcing them to move into unstable habitats. Juvenile tigers, nutritionally dependent on their mothers are also affected. Cub survival is reduced and the tiger population size declines rapidly (–ibid-).

CURRENT WILDLIFE SCENARIO IN ADTR

Wildlife census was carried out in 1997 and 2002. The census covers only selected mammals. In due course more detailed and accurate census details may be expected. Latest census details are yet to be obtained. The data reveals that the tiger population had remained static at 13 during this period. Of these 13 tigers, 11 were reported from Dandeli Wildlife Sanctuary and only two from Anshi National Park. As the latest census report is awaited there is cause for concern. Moreover the prey population leaving the (monkeys s.n. 9 & 10) in the Table has not improved. Most alarming is the decline of gaur (*Bos frontalis*) from 1817 in 1997 to 1376 in 2002. This could be due to sampling error, habitat destruction or poaching or a combination of these. In Schaller's (1967) estimate of adult tiger's food the gaur's share was only 7% (0.5 animal/year). In the Nagarahole National Park, in the Western Ghats, which is closest to ADTR in vegetational comparison the number of gaurs killed by tigers, based on scat analysis, constituted 11.4% of the total prey animals (Karanth and Sunquist, 1995). It was 4.8% in Kanha National Park (Schaller, 1967).

The decline of the spotted deer or chital (*Axis axis*) is still more alarming. Its number in the Dandeli Wildlife Sanctuary declined from 1667 in 1997 to 1252 in 2002. In 2002 the total number was 1429 because of adding the population of Anshi National park. Considering the fact in the conservancies of the Indian subcontinent the spotted deer was one of the predominant prey killed by tigers, 27.8% in Chitwan National Park, Nepal, 50.3%, in Kanha and 22.8% in Nagarahole, (Schaller, 1967, Mcdougal, 1977 and Karanth and Sunquist, 1995), this decline of one of the commonest forest animals has to be considered seriously. The consolation, however, comes from the significant increase in sambar deer. However, for the sheer size of the ADTR the total estimated number of sambar deer at 722, is not satisfactory. Overall the census methods for the animals have to be streamlined to project reasonably good pictures. Although the pig (*Sus crofa*) is one of the notable preys of the tiger its enumeration has not been carried out, may be due to the understandable difficulties in counting this animal of varied habitats. The barking deer (*Muntiacus muntjac*), though an important prey, 6.4% of numbers killed in Chitwan, 34.8% in Huai Kha Khaeng Wildlife Sanctuary, Thailand and 8.4% in Nagarahole (Sunquist et al., 1999), the total estimated for ADTR is only 592.

Table 5.1: Details of wildlife census carried out in 1997 and 2002

(Source: Karnataka Forest Department, Wildlife Division, Dandeli)

Census Details for the year 1997 and 2002

Sl. No.	Name	1997 Census			2002 Census		
		Dandeli Wildlife Sanctuary	Anashi National Park **(#)**	Total Dandeli Wildlife Division	Dandeli Wildlife Sanctuary	Anashi National Park	Total Dandeli Wildlife Division
1	2	3	4	5	6	7	8
1	Tiger	11	2	13	Census work is to be done	Census work is to be done	
2	Leopard	9	-	9			
3	Elephant	45	-	45	45	-	45
4	Gaur	907	910	1817	1376	216	1592
5	Spotted Deer	1667	-	1667	1252	177	1429
6	Barking Deer	423	28	451	470	122	592
7	Sambar Deer	217	87	304	348	374	722
8	Sloth Bear	390	293	683	43	39 **(o)**	82 **(o)**
9	Common Langur	7690	6620	14310	27019 *	11118 *	38137
10	Bonnet Macaque	2726	146	2872	2914	1386	4300
11	Malabar Squirrel	2741	1870	4611	7448	2182	9630

Source: Deputy Conservator of Forests, Wildlife, Dandeli Division

(#) File not available in this office (DCF Wildlife)

*This is quite a high number

(0) Possibly an overestimate due to sampling error/insufficient sampling

Fodder needs: Sunquist et al. (1999) estimated the mean mass (kg) of prey killed by tiger in the Nagarahole National Park ar 65.5 kg. We may assume the case in ADTR to be similar. Sunquist (1981) recorded that a tigress needs 5-6 kg of meat a day for a maintenance diet. This amounts to 1825-2190 kg/year of meat; but as 30% of each carcass is inedible (due bones, hoof, hair etc.), a tigress needs to kill some 2373-2847 kg/year of meat. Using the above example we may attempt to arrive at the annual meat requirements of 13 adult tigers in the ADTR. At a modest maintenance diet of 2610 kg meat/tiger/year the total meat requirement for 13 tigers would be 33930 kg/year. For meeting this requirement the tigers need to kill 518 prey animals of mean weight 65.5 kg. The meat requirement of a tigress feeding two large cubs is estimated to be 50% more. This meat would also come from pigs, and monkeys and other miscellaneous prey to a smaller extent. At the generally accepted energy flow models of 10% of biomass energy reaching successive levels of consumers in the food chain, to produce harvestable 33930 kg/year of harvestable meat for tigers the food needs of the herbivorous prey animals would be 3393000 kg/year (3393 tons of fodder). Considering the fact that there were only 4335 important prey animals (all deer spp. and gaur together) in the ADTR in 2002 the future of the tiger depends on how best we can increase the prey resources. We should also bear in mind that there are panthers, hyena, and some minor carnivores which have a share in the major and minor prey population of ADTR. As most of the ungulate prey mainly depends on grasslands for their fodder the management of these grasslands is of paramount importance.

Competition with domestic cattle: Good number of grasslands and savanna woodlands with grassy ground cover are in the vicinity of villages, where the wild animals will have to compete with them for fodder. At a modest rate of 10 kg of grass/other plant resources as fodder, the 6000 plus cattle would need annually about 22,000 tonnes of fodder. As ADTR has forest as climax vegetation, and large areas already covered with monoculture plantations. Many village grasslands grasslands are in eroded and poor state where again the cattle become competitors for wild herbivores. Unless this situation changes tiger population is not likely to improve significantly. Most of the deer and gaur usually come to grasslands only after dusk hours to escape humans. As villages, at least in the core areas, will be resettled outside the pressure from domestic cattle on these grasslands is bound to decline in the coming few years. The range-wise details cattle number are given in the Table 5.2.

Table 5.2: Range-wise cattle population in the ADTR

Sl No.	Range	Number of Cattle
1	Kulgi	2202
2	Phansoli	260
3	Gund	952
4	Kumbarwada	1342
5	Anshi	1414
	Total	**6170**

Grazing and productivity: In the largely forested district of Uttara Kannada, it has been traditional practice of the agriculturists to leave the cattle for foraging freely. The cattle often enter into the adjoining forests. They browse upon any edible herb and sapling and enter the grassy blanks even in the interior of forests. Village cattle can be found roaming in many places even inside the ADTR. They come from the villages within as well as from peripheral villages. An experimental study carried out in the grasslands of Uttara Kannada by Lele and Hegde (1997) shows that heavy grazing in the open grasslands lead to 40% drop in production relative to the control which was ungrazed. The above ground herb layer biomass (AGHB) was 3-6 t/ha/yr in ungrazed areas, compared to heavily grazed ones with 1 t/ha/yr. However initial months of grazing in monsoon and avoiding in non rainfall growing months also lead to higher AGHB. This shows that late monsoon grazing is deleterious to AGHB. Bhat et al. (2005) observed that the herb biomass productivity (HBP) in a completely open area adjoining a forest in Uttara Kannada was 4.5 t/ha compared to 0.0524 t/ha within the forest. Here, however, the herb layer does not mean all grasses or other palatable plants. If we consider 4.5 tons/ha/yr as mean productivity of good grasslands, hypothetically, nearly 800 ha of such grasslands have to be conserved as such for exclusive use by ungulate prey animals of tigers only. It also implies that the production should be only of edible grasses. It is not practicable to delimit the grasslands to only 800 ha., as, understandably, there are no chance at all of all the potential prey animals ending up as tiger's food. If we consider that about 10% of the wild ungulates are captured every year by the tigers, and the rest are not, we would require about 8000 ha of good quality grasslands to feed exclusively the potential prey stock of the ADTR. The actual demand would be much more, as there are currently about 6000 domestic cattle and many other herbivorous wild animals in the ADTR and all the herbs/other plants growing in grasslands/savanna grasslands are not necessarily palatable.

Traditional fodder management in hilly areas and wildlife fodder crisis: Different types of historical grassland management practices create different plant diversity patterns (Gustavsson, 2007). The open grasslands with long history of maintenance either by humans (by mowing, grazing by domestic animals, fire etc) or from wild animals (by grazing) tend to be more species rich with more fodder species. The grasslands in high rainfall hilly regions are exposed to varying levels of grazing such as in *benas* and *soppinabettas*. Some are temporarily fenced off and harvested by hand at the end of growing season. These management practices have co-evolved with the local agrarian system, which is a combination of Areca-spice orchards and paddy fields. Productivity depends critically on the continuous input of organic matter and nutrients in the form of livestock dung (along with leafy mater), and on the availability of draught animal power for ploughing. Milk is an important additional benefit. Livestock, almost all cattle and buffalo, are thus an integral part of the agrarian system. This has lead to the serious competition with wild life animals for natural grasslands as cattle population has increased. The grasslands areas are dwindling because of the need for land for housing, agriculture, roads and various other developmental activities

Fodder rich and poor areas in ADTR: Larger grassland areas such as Thayamaddi-Barpoli cross, Kaneri dam site, Terali, Burpali-Anshi, Kumbarwada-Diggi areas etc., are old grasslands having not only highly palatable, high yielding grass species but also good number of other fodder dicot species.

Most of the highly exploited, overgrazed, lands will have species very different from those they had earlier. Virnoli safari route forest grassland though showing high percentage grass individuals have only two low yielding fodder grasses (*Oplismenus burmanii* and *O.compositus*) dominating (Table 3). Same is the case with Goyar forest grassland which had also very low fodder value grass species. It also had low density of dicot herbs.

Areas underneath the forest canopy having low density dicot forage herbs along with sparsely occurring grasses as in the Virnolli-safari route, Goyar etc., cannot sustain any significant number of herbivores. On the other hand open grasslands interspersed with wetlands are more important in sustaining herbivores. In the ranges with dense forests and/or monoculture plantations such as at Anshi, Phansoli, Gund and Kulgi, the wildlife mostly depend on openings within the forest, on wetlands and on the sparse growth of grasses underneath the forest canopy. Hardly any grasses grow in the teak plantations and inside dense evergreen-semievergreen forests (as in Anshi Range) therefore these ranges do not have as much potential to support wildlife unlike Kumbarwada and Diggie Ranges. The entire forest region especially along the deciduous zone is dotted with teak plantations which are not congenial for grasses. Phansolli, and Kulgi forests are also largely planted with teak.

Management recommendations

- Grassland enrichment is to be thought of for selected grasslands. Very degraded grasslands may be closed to grazing facilitating revival of the grasses.
- The practice of afforestation of grassy blanks has to be discontinued unless there is need for recreation of resource patches (fruit trees and keystone plant resources favouring life of herbivores). These resource patches have to be in block planting or in linear forms facilitating corridors for movements, for animal movements. A combination of both may be also carried out, after planning and deliberations. A list of species that can nurture by their products the fauna of the ADTR is given in Table 5.3.

- Afforestation of grassy blanks to be limited to very unproductive areas only. While selecting tree species for planting the animal community should be borne in mind. Patches have been observed where instead of raising natural vegetation the exotic industrial cum pulpwood species *Acacia auriculiformis* has been planted (Figure 5.2). For example Acacia was planted up in Thayamaddi-Barpoli Cross and few other places.
- Controlled fire to be used in grasslands in transition such as under dicot weeds and woody vegetation. Such grasslands to be divided into blocks and alternate blocks to be set on fire. Volunteers may be trained and their services used in meticulous use of fire so as to promote grasses
- Since legumes are nitrogen rich and good as fodder, leguminous fodder herbs may be planted in abandoned agricultural fields to promote wildlife. Herbaceous climbers of legumes, that provide forage for wildlife may be promoted experimentally in some of the poor grade mono-culture plantations.
- Natural succession inside monoculture plantations may be directed towards enhancing the food resources of the ADTR for wildlife.
- Herbaceous forage legumes may be considered experimentally for planting along the sides of some of the forest roads.
- Priority to be given for resettlement of villages with large number of cattle. Some of the good pastures of importance to wild herbivores need to be spared from grazing by domestic cattle. In the peripheral villages the concept of village fodder farms, to meet the fodder requirements of domestic cattle, needs to be promoted, so as to prevent those cattle from entering the ADTR.

Table 5.3: Wild woody plants that provide food for wildlife and recommended for selective planting in grasslands

Sl.	Species	Local/common Name	Parts eaten and wild animals feeding on them	Remarks
1	*Acacia concinna*	Seege	Pods-Deer*, Sambar, Gaur	
2	*Acacia ferruginea*	Banni	Pods-Deer*, Sambar,	
3	*Artocarpus integrifolia*	Halasu, Jack	Fruits-Monkeys, Bear Leaves- fodder	Fallen fruits of *A.integrifolia* and *A.hirsutus* are relished by many ungulates
4	*Bauhinia sp.*	Basavanapada	Pods- Gaur, Sambar, Deer*	
5	*Bombax ceiba*	Buraga, Silk cotton	Flowers-Monkeys, Sambar, Deer*, Wild pig. Nectar for many birds	

6	*Careya arborea*	Kumbia, Kaul	Bark-Sambar, Fruits-Elephant, Monkey, Porcupine, Sambar	
7	*Cassia fistula*	Kakke	Pods-Bear, Monkeys	
8	*Cordia macleodii*	Hadang	Fruits- Deer*, Gaur, birds	
9	*Cordia myxa*	Challe	Friuits-Deer*, Sambar, Bear, birds	
10	*Dillenia pentagyna*	Kanagalu	Fruits-Deer*, Sambar, Gaur, birds	
11	*Ficus* spp.	Atti	Fruit- Birds, including Hornbills, bats etc., and ungulates such as Deer*, Sambar, etc. Leaves- fodder for herbivores	Keystone species with one or the other tree flowering throughout the year and eaten by large number of wild animals, both big and small
12	*Grewia tiliaefolia*	Dhaman; Dadaslu	Leaves-Sambar, Deer*,Fruits-Monkey, birds	
13	*Hydnocarpus laurifolia*	Suranti; Toratte	Fruit-Porcupine	
14	*Spondias acuminate*	*Kaadmate*	Fruits: Sambar, Porcupine, Deer*	
15	*Kydia calycina*	Bende	Leaves –Ungulates	Seems to be eaten by ungulates as they are eaten by cattle.
16	*Moullava spicata*	Hulibarka	Fruits-Deer*, Sambar	Flowering spike is also eaten
17	*Mucuna pruriens*	Nasagunni kai	Leaves-Deer*	
18	*Phyllanthus emblica*	Nelli; Gooseberry	Fruits-Sambar, Deer*	
19	*Strychnos nux-vomica*	Kasarka	Fruits- pulp eaten by monkeys, Hornbills	
20	*Syzygium cumini*	Nerale	Fruits- wild Pig, Deer*, Bear and several birds	
21	*Tectona grandis*	Saaguvani; Teak	Bark- Elephants.	Elephants debark the tree in long strips and consume it.
22	*Terminalia belerica*	Tare	Fruits-Deer, Sambar	
23	*Tetrameles nudiflora*	Kadu bende	Bark-Elephants	Favourite tree for bees to make hives
24	*Xylia Xylocarpa*	Jamba	Seeds-Gaint Squirrel, Monkeys	
25	*Zizhiphus oenoplia*		Fruits-Jackels, Procupine, Deer*, Pangolin, birds	
26	*Ziziphus rugosa*	Kaare	Fruits-Bear, birds	

***Deer includes Mouse deer, Barking deer, Spotted deer**

Figure 5.1: Larger grasslands of Diggie region

Figure 5.2: Wet grassland drained, ploughed and being planted with *Acacia Auriculiformis*

CHAPTER 6: GRASSLAND DENSITY IN THE WILDLIFE RANGES

Grasslands can be visually identified in the field during actual field work. Satellite imageries provide good overall idea about the grasslands in a specified area. In the Anshi-Dandeli Tiger Reserve, it is actually a difficult task to count exactly the number of grasslands. There are small grasslands, less than one hectare larger ones over six sq. km each. In addition are savanna grasslands everywhere where trees are sparse to closer ones which almost would appear like forest. Moreover, often fallow fields overgrown with various herbs and grasses also appear as grasslands. In general, a grassland can be defined as “Grass and other herbs dominating a landscape from which trees are scarce or absent” (Brewer, 1988). Using Google Earth imagery we have listed easily identifiable grasslands/forest openings/rice fields (including even fallow fields overgrown with herbs) of one sq. km and above in size occurring in the different Wild Life ranges of the ADTR (Table 6-1).

Sl.	Range	1-3 Sq.km	3-6 Sq.km	6-9 Sq.km	>9 Sq.km
1	Diggi	25	3	1	
2	Kumbarwada	20	7	3	2
3	Phansoli	8	3		
4	Kulgi	5	2	0	
5	Gund	15	1		
6	Anshi	59	13	4	3
7	Kadra	4	1		

Table 6.1: Grassland/forest opening density in different Wild Life Ranges of ADTR

Anshi and Kumbarwada Ranges have some very large grasslands. Higher number of grasslands seen in Anshi range may be due to its larger range size and anthropogenic causes such as fields, either used or disused. Also the number of very small grasslands less than 1 sq km are more, although we have not listed them here. Details of forest Beats, Range-wise, having good grasslands are given in the Table 6-2.

Total number of beats having large number of grasslands are more in Anshi owing to, may be, its larger size. This is followed by Kumbarwada with 5 beats having large grasslands. Phansoli and Kulgi have the least (Table 6-2).

Beats	Diggi	Kumbarwada	Phansoli	Kulgi	Gund	Anashi
1	Kartoli	Gundali	Shidoli	Ambga(W	Kalane	Tirval
2	Kanangaon	Teloli	Chandrali	Ambga(C)	Tamange	Nanevada
3	Vageli	Nujji			Komba	Anashi
4		Kundal				Kelimala
5		Savant Matkarni				Bhakhi
6						Kailvada
7						Kodugali
8						Ulvi

Table 6-2: Range-wise names of Beats having good grasslands/forest openings

1. **Anshi Range:** This Range with its vast area and diverse habitats contributes substantially towards the safety of wildlife. The Kali River towards its east runs in southerly direction and turns westwards; its course is quite near the southern boundary of the Anshi Range. Rise of water in the river due to the construction of Kodsalli dam has submerged good tiger habitats of rugged rocks and pockets of tall grass and other wild growth. Several small openings can be seen in the satellite imagery (Google), most of them are human inhabited areas and fields with bits and pieces of grasslands adjoining agriculture. There are also grassy blanks in the otherwise largely forest covered Range. Evergreen forest areas are not very suitable for grazing animals. Naturally, we cannot expect the tiger population to increase in this Range (Anshi National Park has only three tigers estimated). Nevertheless the grasslands here are very critical for ungulates and their predators. They need to be protected from forest succession, nor any plantation activities to be carried out in the grassy blanks. Grasslands require more management interventions, including the use of controlled fire and restriction of grazing by domestic animals. The resettlement of villages will turn many fields into grasslands, meadows and marshes enhancing landscape heterogeniety favouring wildlife.

2. **Diggie range:** Kalinadi originates from near a 900 m peak in Diggi Range. As the river has been dammed at Supa, towards the east of the Range is a vast water body, the Supa reservoir. This Range has good grassland areas with less of human population. These grasslands have to be properly managed by periodical use of fire as otherwise most them would revert back to forest with high rainfall and no fire. There should be no raising of monoculture plantations in these grassland areas.

3. **Kumbarwada Range:** Kumbarwada range has more hill top and slope grasslands (Figure 6.3). North western areas also have some larger flat grassland areas with meager human population. Some areas of Khushavali and Keloli beat are sparsely habituated and have more grassland plains. In the 19th century Kalsai and Amboli (a small part of the village in this Range) had fine deciduous forests as well as good evergreen forests as well. Shifting cultivation was widespread in this Range and therefore we can see fine grasslands, savannas and secondary forests. The region has good potential for wildlife.

4. **Kadra Range:** This is a very hilly forested area with very less of grasslands and other openings However the Kali River flowing by the side, and the Kadra reservoir add considerable habitat heterogeneity to the region. There are also steep barren hill slopes that enhance such heterogeneity. During the 19th century, the forest stretch along the Kalinadi had good deciduous forests mixed with natural teak. There were also good evergreen forest patches. Teak plantation was started here as early as 1859. The presence of deciduous forests here is evidence of past fires and shifting cultivation. Today the evergreen species are dominating this Range and grasslands are hardly present.

5. **Kulgi Range:** This Range is also thickly forested with dry deciduous to moist deciduous forest mostly dominated by planted teak and monoculture plantations of teak (Figure 34). Hence it has very less of natural grasslands and the grasses occurring are forest grasses such as *Oplismenus compositus* or *Oplismenus burmanii*, along with *Leptuca radicans* which because of their low density, and less area can support very less wild life. To promote grass in this Range various kinds of openings including edges of water bodies, abandoned fields, forest clearance etc are to be preserved and managed without any further raising plantations inside them. Succession in forest plantations may be directed by promoting fruit and fodder trees natural to the region as well as through introduction of suitable species.

6. **Phansoli Range:** Virnolli and eastern Phansoli areas are highly populated places. Being in lower rainfall zone the most of vegetation consists of deciduous forests and savanna woodlands. Avurli-Mandorli area, on the north side of the Kaneri river had excellent teak forests in the 19th century. The Kasai-Usode forest covering Kalsai, Ambodi, Gangoda, Potoli, Virnoli etc. had not much natural teak, but there were fine mixed deciduous forests. Kalsai had good patches of evergreen forests also. Wildlife-human conflicts

seem to be more here because of the larger number of cattle kills. Such conflicts can be minimized by promoting better vegetation supportive of wildlife, including grasslands.

7. **Gund Range:** The Gund-Shivapur forests, on the plateau of the river Kali in the south-east, was, in the 19th century well known for its forests- “great teak forests of Gund and splendid evergreen forests of Shivapur” (Campbell, 1883). The Range does not have many grasslands and other open areas suitable for ungulate wildlife. (Figure 6.7). The forests of the Range along with the water bodies provide good habitat heterogeneity for wildlife. Table 6.3 lists the grasslands visited during the field investigations.

Table 6.3: Grassland study in Anshi and Dandeli W L Santuary

Sl.	Transect location		Lat	long	Alt
1	Goyar-Savadi		14.96731	74.28001	96
2	Kailwada-Dongrewada		14.97914	74.39934	480
3	Kailwada - Kailwada		14.98257	74.39884	466
4	Kailwada-Madgaon		14.98644	74.39588	467
5	Thayamaddi-Barpoli Cross		14.93885	74.3707	485
6	Burpalli-anshi		14.94459	74.37508	494
7	Shiroli-near Bamnia		15.21059	74.35571	589
8	Terali		15.18345	74.36704	693
9	Kundal		15.12269	74.31069	647
10	Kaneri damsite		15.1141	74.3544	638
11	Virnoli safari route		15.12485	74.59537	584
12	Shiroli mining area		15.12153	74.60146	587
13	Mandurlli (Kulagi)		15.16115	74.57316	578
14	Bommanahalli reservoir		15.16617	74.67917	441
15	Lande		15.04452	74.30956	652
16	Anshi		15.01100	74.39397	633

Figure 6.1: Anshi Range with village boundaries and land cover (source: Google Earth)

Figure 6.2: Diggie Range satellite imagery (Source: Google Earth)

Figure 6.3: Kumbarwada Range with village boundaries (based on Google Earth)

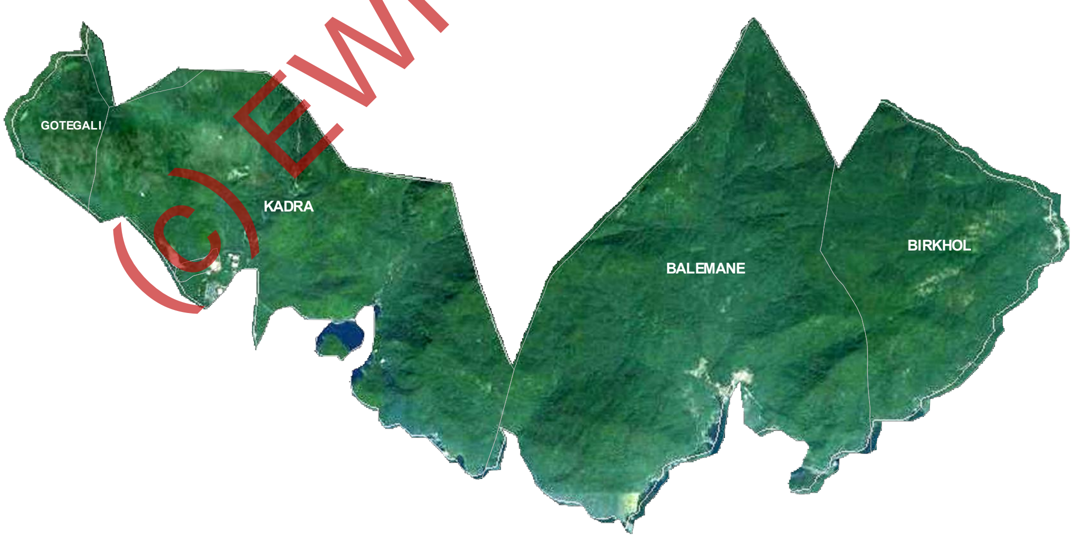


Figure 6.4: Kadra Range with village boundaries (based on Google Earth)

Figure 6.5: Kulgi Range with village boundaries (based on Google Earth)

Figure 6.6: Phansoli Range with village boundaries (based on Google Earth)

Figure 6.7: Gund Range with village boundaries

Figure 6.8: Khadra region with some wetland areas

Chapter 7: ECOSYSTEM MANAGEMENT IN ADTR FOCUSSING ON GRASSLANDS

LESSONS FROM HISTORY FOR TIGER CONSERVATION

A Land rich in tigers: The earliest official accounts of Uttara Kannada, and some of the adjoining places in neigbouring districts, covering mostly the 19th century, provides pictures of the richness of tigers and the chilling details of their largescale elimination. According to Colonel Peyton, Conservator of Forests for Kanara during late 19th century, and a great wildlife expert, the tiger's favourite haunts were near the Sahyadris where they breed in the wildest and most difficult parts. They love to rest in densely wooded river banks and safe cool spots in islands thick with thorns, rank grass, and creepers. According to present day tiger ecologists of tiger is a specilised predator of large ungulates. It is never found far from water. In Asia, the ungulate species diversity and biomass reach maximum where grasslands and forests form a mosaic and where many vegetation types mingle together. In such areas tiger density reaches its maximum. In these relatively closed habitats the tiger lives and hunts these large ungulates alone. On the other hand the lion is group living animal in open habitats and hunt in packs (Campbell, 1883; Seidensticker et al., 1999).

Uttara Kannada of pre-British period was one of pristine sacred groves in almost every village, large stretches of secondary and pre-climax forests, shifting cultivation areas in different stages of vegetational succession, *benas* or grasslands, maintained by farmers using fire periodically to eliminate woody plants and weeds. The valleys with perennial water sources were associated with rice fields and arecanut cum spice gardens. These were in addition to the natural topographical features of rugged terrain of mounts, and steep hillsides, gorges of rivers, densely wooded ravines and narrow valleys, innumerable streams that merged to form few important rivers, water falls and springs. Such landscape favoured the rich wildlife the district had (Chandran and Gadgil, 1993).

For the early inhabitants of the district hunting was never a sport, but carried out mainly for subsistence and crop protection. The British arrival in the district, first as traders and later as rulers, saw setting in of a new era of wanton hunting of wildlife, more for sport than for subsistence. The chilling statistics of tiger killing in the district as furnished in the *Kanara Gazetteer* (Campbell, 1883) are given in Tables 8-1 and 8.2.

Table 81: Incidents of tiger killing in Uttara Kannada and adjoining districts

No. of tigers/cubs killed	Year of kill	Place of kill
31 tigers	1840-41	Belgaum
1 tiger	3 April 1875	Supa
1 tigress, 1 cub	5 April 1875	Supa
1 tigress & 5 cubs	1878	Tinaighat
1 tiger	1881	Yellapur
1 tiger & 1 tigress	1882 march	Yellapur
2 killed, 1 wounded	?	Yellapur
1 tigress, 5 cubs	1882 April	Potoli, Supa

Source: Based on Campbell, 1883

Consolidated numbers of tigers killed in Uttara Kannada, during some years of 19th century, as is officially reported in the *Kanara Gazetteer* (Campbell, 1883) are given in (Table 8-2)

Table 8-2: Statistics of tigers killed in Kanara during 1856-1882

Year	Tigers killed (male, female)
1856-1877	510 (average 23/year)
1867-1877	352 (average 32/year)
1878	23
1879	18
1880	39
1881	28
1882	22
Total for 27 years	**992 (37 tigers/year)**

Source: Based on Campbell, 1883

The reasons for tiger decline: From the 19th century records it appears that the reasons for the great fall in the tiger numbers are:

i. ***For protection of humans from tigers:*** 22 persons were killed between 1856 and 1877. Rewards were paid to the hunters for each tiger and cub killed. Probably, such human kills, could have been due to widespread and intensified hunting of the ungulate animals by British sportsmen and local *shikaris*.

ii. ***For protection of cattle*:** 4041 cattle were killed during five years, 1878-1882 by tigers and 1617 by panthers. Instead of correlating the high number of cattle kills to the depletion of prey in the wild, it was made a reason for tiger hunting.

iii. ***Sports hunting*:** Hunting developed as a sport during the British period. Graphic descriptions on the growth of hunting 'technology' are found in the British records.

iv. ***Decline of fire as an ecological factor*:** The British saw *kumri* cultivation as a threat to the timber rich forests and failed to note that use of fire for clearing evergreen forests by the *kumri* cultivators was the reason for enrichment of the rainforests with deciduous timber species, leading with teak, which had great demand nationally and internationally. Fire-swept landscapes where grass grew plentifully in early successional stages of forests could have been significant in wildlife enrichment. The ban on shifting cultivation reduced the role of fire substantially, and itself would have reduced the carrying capacity of the landscape for ungulates, with adverse effects on tiger population.

v. ***Increase in human population:*** The general increase in human population increased pressure on forests and wildlife. Increase in forest based industries, forest logging related human influx, mining in forest areas, construction of a chain of hydel projects in Kali river, submersion of Supa town by the reservoir and resettlement of people in the newly created township of Ramnagar, growth of Dandeli as an important industrial town, the Karnataka Power Corporation settlements in Ambiganagar and Ganeshgudi etc. would have created spillover effects on the ADTR. Linear intrusions in the forests would have increased manifold due to newly developed road networks and power lines. However, in the ADTR Ranges the population growth curve appears to have leveled off or declined during 1991 and 2001 census (from total of 20805 in 1981 to 21496 in 1991 and 21293 in 2001). Except in Kumbarwada Range in the other Ranges the population has stabilized or is showing marginal decline (Table 8-3 and Figures 8.1 and 8.2).

Table: 8-3: Range-wise human population details for 1961-2001

Range	**1961**	**1971**	**1981**	**1991**	**2001**
Anshi Range	2815	3421	4385	5156	4784
Gund Range	987	1321	2145	1583	1686
Joida Range	1777	1803	2382	2904	2425
Kadra Range	775	564	1252	1252	1252
Kulgi Range	2850	3070	3423	3547	3487
Kumbarwada Range	2365	2802	4015	3982	4566
Phansoli Range	3777	3261	3203	3072	3093
Total	**15346**	**16242**	**20805**	**21496**	**21293**

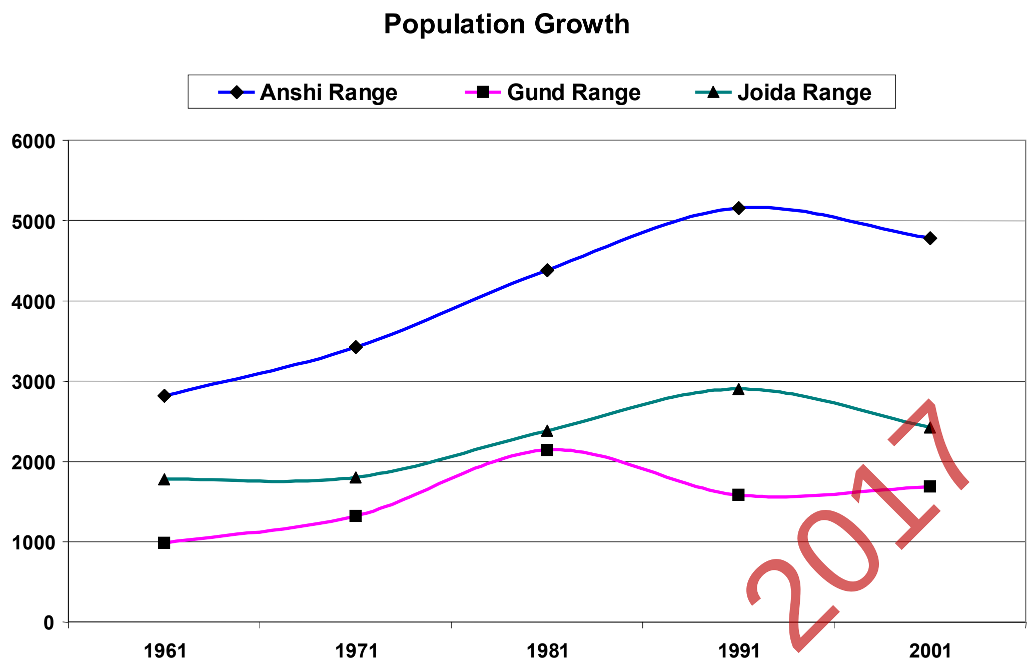


Figure 8.1: Range-wise human population growth in ADTR

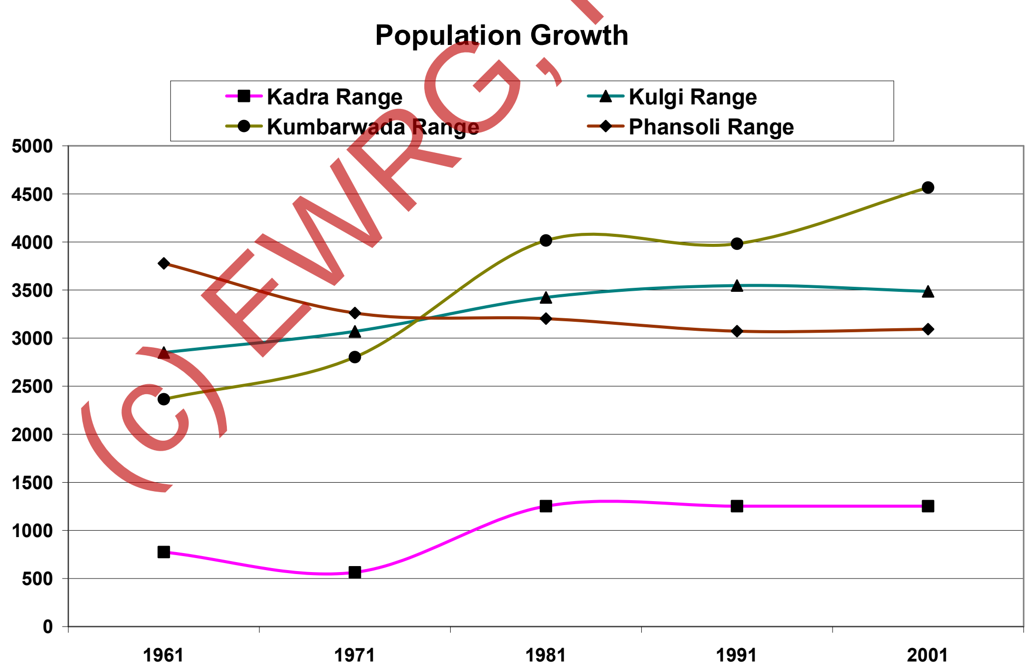


Figure: 8.2: Range-wise human population growth in ADTR

vi. ***Increase in cattle population*:** The prohibition on shifting cultivation necessitated more permanent cultivation in the valleys. As plant ash could not be added to hill soils, because of decline in the use of fire, the farmers had to keep more number of cattle, mainly for manure. Cattle obviously became competitors for wild ungulates in sharing the fodder resources. At the same time, during the latter half of 19th century, when there was drastic decline of prey animals due to over-hunting, cattle became important prey.

vii. ***Impoverishment of grasslands***: The stoppage of shifting cultivation gave prominence to settled cultivation and permanent grasslands along hill tops and slopes. Many of the nomadic cultivators, who had not maintained cattle earlier, were compelled to keep them for manure purpose. Constant grazing in the grasslands perpetually maintained by use of periodic fire, to eliminate rank growth, would have caused soil erosion and laterization. Such extensive laterite areas are seen all over the Joida taluk.

viii. ***Excess of teak monoculture:*** Intensive commercial working of forests for hardwood timbers from 19th century unleashed a saga of new wave interference into habitats teeming with wildlife. Timber extraction was followed by often clear-felling of forests to raise teak monoculture plantations. Some of the earliest plantations in the Western Ghats, dating back to 1859, were started in the Kadra Range. With systematic extraction of marketable timbers, according to the forest working plans, from the dawn of the 20th century, teak plantations were raised in portions of the worked forests almost in every coupe. The ecology of natural teak was altogether neglected and nothing was done to maintain a sustainable system of natural forests enriched with teak (Gadgil and Chandran, 1989). In fact the Gund plateau (part of the ADTR) was one of the three well known natural teak forests of the Western Ghats along with the Anamalais and the Wynad-Hegdedevankote forests (Cleghorn, 1861). Raising of teak in large scale impoverished the forest ecosystem as a whole because of: a. forest fragmentation and steep decline of forest biodiversity; b. conversion of healthy grasslands and successional forests into monoculture; c. intense erosion of soil, especially on steep slopes, as protection of the spongy soil mantle from teak canopy during the monsoon months would be insufficient, as compared to the denser canopy of natural forests; d. increased incidence of ground fires due to thick deposit of fallen leaves of teak during the summer months; e. weed invasion (mainly *Lantana* and *Eupatorium*) that replaced more benign ground vegetation of native species dominated by *Strobialanthus* and other native species prior to monoculturing; f. Impoverishment of watersheds and drying up of streams in the teak areas.

ix. ***Destruction of micro-habitats due to flooding**:* As Col. Peyton, Conservator of Forests for Kanara noted: the tiger's favourite haunts were near the Sahyadris where they breed in the wildest and most difficult parts. They love to rest in densely wooded river banks and safe cool spots in islands thick with thorns, rank grass, and creepers (Campbell, 1883). The rise of water level in the Kali and its tributaries due to construction of a series of hydel reservoirs would have submerges lot of tiger microhabitats alongside the rugged banks of the river in the Western Ghats and the small islands strewn with rocks and overgrown with vegetation.

REQUIREMENTS OF THE TIGER

Habitats and home ranges: A single tiger's home ranges may be anything from 20 to over 400 km², depending on the density and availability of the prey. Therefore protecting large populations will require extensive areas of habitat for conservation. The ecological requirements of tigers and their prey can be effectively used to design landscape-level land use options. Such options include conservation of core areas coupled with restoration of degraded lands, and sustainable natural resource use plans to meet the needs of the local people (Wikramnayake et al., 1998). Tiger can adapt to a variety of habitats. ADTR, receiving a range of rainfall regimes from western portions with extremely heavy seasonal rainfalls (up to 5000 mm) to much lower (barely over 1000 mm) towards the east has habitats ranging from tropical evergreen and semi-evergreen to moist deciduous and dry deciduous forests. Human impacts in these forests through ages have created a variety of derived habitats such as grasslands, savanna and scrub which, enmeshed in a matrix of forests, created the needed heterogeneity for the proliferation of tigers and their prey.

Prey animals and food needs: Mean weight of prey killed by tigers can vary from 15 to 65 kg, down to sometimes 5 kg in some protected areas. The low value perhaps reflects the scarcity of large prey animals (Sunquist et al., 1999). A tigress requires 5-6 kg of meat a day as its maintenance diet (Sunquist, 1981). It was estimated that the tigress' need of meat would be 1825-2190 kg/year; but as 30% of each carcass is inedible a tigress needs gross quantity of 2373-2847 kg/year of meat. The range of animals killed by tigress may range from 20 kg barking deer every 2-3 days or one 200 kg sambar every few weeks. Based on a study of three National Parks (two in India and one in Nepal) and one Sanctuary in Thailand, it was estimated that the mean mass of prey killed was 14.7 kg in Thailand to 65.5 kg in Nagarahole and 66 kg in Kanha (Sunquist et al., 1999). Details regarding the frequency of mammalian species in the food of tigers in the Nagarahole National Park, based on scat analysis is given in the Table 8-4 (ibid. 1999)

Table 8-4: Details regarding the frequency of mammalian species in the food of tigers in the Nagarahole National Park (based on Sunquist et al., 1999)

Species name	**Common name**	**Mean body mass, kg**	Relative no. killed
Axis axis	Chital, Spotted deer	55	22.8
Cervus unicolor	Sambar deer	212	11.4
Bos frontalis		287	7.5
Sus scrofa	Pig	38	8.4
Muntiacus muntjac	Barking deer	20	8.4
Semnopithecus entellus	Hanuman langur	9	11.3
Moschiola meminna	Indian chevrotain	8	13.6
Lepus nigricolis	Black-naped hare	3	1.5
Hystrix indica	Indian porcupine	8	0.6
Cuon alpinus	Asiatic wild dog	15	1.0
Unidentified items			13.5
Mean mass (kg) of prey killed =65.5 kg			

Nagarahole being more similar to ADTR than any other tiger reserve in India, we expect as well the same prey animals in the latter. We need to see how to increase the numbers of these animals. Most of these depend on grasslands and savannas for their food. Different other habitats also contribute towards the food of these animals; for instance, the langurs are mainly arboreal. Therefore, we need to work out in detail, the ideal combination of landscape elements to maintain and enhance the number of a spectrum of prey animals, from the smallest hare to the largest gaur. Grassland forms the base of the ecological pyramids of all the large prey animals, which are also part of forests and water bodies.

Ideal habitats: Unlike lions or cheetah which need vast grasslands for their prey capture, tigers rely on surprising a prey and capturing it. Hence tigers prefer to inhabit mosaic kind of landscape elements such as dense forest, grasslands, scrub, ravines, wetlands etc. Hence ADTR hosting large number of these landscape elements has good potential to be an ideal place for tiger conservation. In fact the tiger population was very good in the past and the reasons for its decline also have been discussed. According to Karanth (1993), tigers have the ability to live in very diverse natural habitats, where they tolerate a wide range of temperatures and rainfall regimes. They produce relatively large litters with relatively short inter-birth intervals. They can take prey differing considerably in size and their hunting tactics will vary based on prey size, prey species and habitat. Hence due to their diverse selection of prey and larger territorial activities, larger intact diverse habitats are required. However, tiger needs for its prey good population of large sized herbivorous mammals, mostly ungulates. To sustain these herbivores large and healthy grasslands are very essential. Good tiger population in a preserve would reflect good grasslands and large number of ungulate preys. Wildlife managers need to assess habitat requirements of different species, and bring the grasslands under careful management system, particularly with reference to their strategic locations, palatability of grasses and herbs, vegetational succession, willful alterations of them and about their vulnerability to weed menace.

Need for minimizing grazing pressure from domestic cattle: Overgrazed areas near many villages are dominated by weedy species and it is necessary to minimize the number of cattle. This objective could be fully achieved only when such villages are prioritized for rehabilitation of the inhabitants, at least towards reducing the present levels of pressure. Range-wise details of cattle population in the ADTR are furnished in the Table 8-5. Though apparently the cattle number (6170) is not that high for the ADTR, considering that the grasslands here are secondary and created from the forests in the past during the peak period of shifting cultivation, through slashing and burning natural vegetation, grass growth is poor in most of them. Because of the heavy rainfall the region receives, the grasslands, tend to revert to woody vegetation and are also subject to invasion to tall weeds like *Chromolaena.* Moreover, the substratum of many grasslands is rocky being abandoned *kumri* areas, and old pastures exposed to alternate intensive rainy season followed by prolonged dry period of six to seven months. These rocky area grasslands produce very less grasses, compared to genuine dry area grasslands of relatively lower rainfall, elsewhere. The protected *bena* grasslands of individual farmers are better in terms of height and density of grasses, although the grasses there die during the dry season.

Table 8-5: Range-wise details of cattle population in the ADTR

Sl No.	Range	Number of Cattle
1	Kulgi	2202
2	Phansoli	260
3	Gund	952
4	Kumbarwada	1342
5	Anshi	1414
	Total	**6170**

Because of heavy seasonal rainfall exceeding 4000-5000 mm per annum towards the western portions of the ADTR, evergreen-semi-evergreen forests not much favoured by the tigers, constitute the major vegetation types here. There are fairly large agricultural areas within this region and some of them need to be prioritized for rehabilitation of families. These villages can turn into very good secure habitats for tigers, especially during the drier months, due to better availability of water and reduced competition from domestic cattle, which are presently in good numbers. However, more efforts are to be made for maintenance of grasslands in all the heavy rainfall regions. If villages are shifted are entirely there will be no check on the succession of woody forest species and non grass weeds in the grasslands and fallow fields. Through regulated use of fire, involving the local population in such exercises, the succession of forests in abandoned grasslands and fallow fields can be checked.

FOOD NEEDS OF THE TIGER

Promoting plant species for faunal richness: Many kinds of habitats within the ADTR, presently not so favourable for or of below optimum utility for faunal richness can be selectively managed to increase the population of major and minor mammals, birds and bats and various invertebrates like butterflies and bees which add to the attractiveness of ADTR and render various ecosystem services. A list of forest trees, shrubs and climbers which provide food in various forms for the wildlife are given in the Table 8-6. The species can be planted in all the suitable habitats without destroying the existing vegetation. Such habitats to be considered include numerous monoculture plantations within the ADTR, barren rims of reservoirs of hydel projects, roadsides, rocky places with scanty growth of grasses etc.

Table 8-6: Wild woody plants of food value for wildlife

Sl.	Species	Local/common Name	Parts eaten and wild animals feeding on them	Remarks
1	*Acacia concinna*	Seege	Pods-Deer*, Sambar, Gaur	
2	*Acacia ferruginea*	Banni	Pods-Deer*, Sambar,	
3	*Artocarpus integrifolia*	Halasu, Jack	Fruits-Monkeys, Bear Leaves- fodder	Fallen fruits of *A.integrifolia* and *A.hirsutus* are relished by many ungulates
4	*Bauhinia sp.*	Basavanapada	Pods- Gaur, Sambar, Deer*	
5	*Bombax ceiba*	Buraga, Silk cotton	Flowers-Monkeys, Sambar, Deer*, Wild pig. Nectar for many birds	
6	*Careya arborea*	Kumbia, Kaul	Bark-Sambar, Fruits-Elephant, Monkey, Porcupine, Sambar	
7	*Cassia fistula*	Kakke	Pods-Bear, Monkeys	
8	*Cordia macleodii*	Hadang	Fruits- Deer*, Gaur, birds	
9	*Cordia myxa*	Challe	Friuits-Deer*, Sambar, Bear, birds	
10	*Dillenia pentagyna*	Kanagalu	Fruits-Deer*, Sambar, Gaur, birds	

11	*Ficus* spp.	Atti	Fruit- Birds, including Hornbills, bats etc., and ungulates such as Deer*, Sambar, etc. Leaves- fodder for herbivores	Keystone species with one or the other tree flowering throughout the year and eaten by large number of wild animals, both big and small
12	*Grewia tiliaefolia*	Dhaman; Dadaslu	Leaves-Sambar, Deer*,Fruits-Monkey, birds	
13	*Hydnocarpus laurifolia*	Suranti; Toratte	Fruit-Porcupine	
14	*Spondias acuminate*	*Kaadmate*	Fruits: Sambar, Porcupine, Deer*	
15	*Kydia calycina*	Bende	Leaves –Ungulates	Seems to be eaten by ungulates as they are eaten by cattle.
16	*Moullava spicata*	Hulibarka	Fruits-Deer*, Sambar	Flowering spike is also eaten
17	*Mucuna pruriens*	Nasagunni kai	Leaves-Deer*	
18	*Phyllanthus emblica*	Nelli; Gooseberry	Fruits-Sambar, Deer*	
19	*Strychnos nux-vomica*	Kasarka	Fruits- pulp eaten by monkeys, Hornbills	
20	*Syzygium cumini*	Nerale	Fruits- wild Pig, Deer*, Bear and several birds	
21	*Tectona grandis*	Saaguvani; Teak	Bark- Elephants.	Elephants debark the tree in long strips and consume it.
22	*Terminalia belerica*	Tare	Fruits-Deer, Sambar	
23	*Tetrameles nudiflora*	Kadu bende	Bark-Elephants	Favourite tree for bees to make hives
24	*Xylia Xylocarpa*	Jamba	Seeds-Gaint Squirrel, Monkeys	
25	*Zizhiphus oenoplia*		Fruits-Jackels, Procupine, Deer*, Pangolin, birds	
26	*Ziziphus rugosa*	Kaare	Fruits-Bear, birds	

*Deer includes Mouse deer, Barking deer, Spotted deer

Several kinds of grasses are associated with the ADTR; of them many are known as good or very good fodder grasses. The list of fodder grasses in general are given in the Table 8-7. Grasslands with such grasses need to be given special attention in management programmes. List of grasses for planting in Kulgi and Dandeli wild life Sanctuary is given in Tables 8.8 to Table 8.10.

NEED FOR STRICT PROTECTION OF PRIME HABITATS

Tigers are sensitive to high levels of human disturbance. In landscape management programme large core areas are to be earmarked for strict protection. Relocation/rehabilitation of villages, preferably should begin with these identified core areas. The core areas may be identified by abundance of wildlife in general, good water resources and reasonably large sized elements in natural landscapes. Good grasslands need to be linked to large patches of multi-species forests and perennial water bodies.

***Control on poaching*:** Tiger populations were severely depleted in Uttara Kannada due to heavy poaching/hunting during the latter part of 19th century. Panwar et al. (1987) state that tiger populations can recover relatively rapidly, with the sustained availability of food and water alongwith reduced or complete elimination of poaching. Tigers, in favourable situations, are considered to breed faster than their prey. Karanth and Smith (1999) consider prey depletion as a critical determinant of tiger population viability. This fact was not given much attention earlier in conservation circles, which highlighted poaching and habitat loss as the major causes for tiger decline. Their study results suggest that tiger populations can persist in relatively small reserves (300-3000 km²), even if there is low level of poaching, provided prey base is maintained at adequate density. Karanth and Sunquist (1992) and Seidensticker and McDougal (1993) affirm that in high prey-density habitats like the alluvial grasslands and deciduous forests of southern Asia, the necessary protected areas could be as small as 300 km², whereas in prey-poor habitats such as mangrove, evergreen or temperate forests, they may exceed 3000 km².

Suggestions: Core areas and corridors are to be identified on the basis of field studies, animal censuses/observations hitherto carried out and remote sensing data. Corridors to be devised and existing ones have to be strengthened/widened using suitable plant species.

Table 8-7: List of grasses of ADTR , noting those of fodder value

	Grasses of Anshi-Dandeli Tiger Reserve			
Sl	**Genus**	**Species**	**Distribution**	**Remarks as fodder**
1	Aristidia	Setacea	India, Sri Lanks, Mascsrene	Good
2	Arthraxon	Lancifolius	Paleotropics	Good
3	Arundinella	Leptochloa	Peninsular India, Sri Lanka	
4	Arundinella	nepalense	Oriental-Indomalaysia	
5	Arundinella	Metzii	Oriental-Western Ghats	Good
6	Bracharia	Miliiformis	Oriental-Indomalaysia, Sri Lanka	Good
7	Centotheca	Lappacea	Indo-Malaysia, China, Tropical Africa, Polynesia	Good

8	Chloris	Barbata	Tropics	
9	Coelachne	simpliciuscula	India, Sri Lanka, China, South East Asia	
10	Coix	Lacryma-Jobi	Tropics	
11	Cyanodon	Dactylon	India, Sri Lanka, Pantropics	Good
12	Cymbopogon	Caesius	Oriental-India, Sri Lanka, South West Asia, Africa	
13	Cyrtococcum	Muricatum	India, South East Asia	
14	Cyrtococcum	Oxyphyllum	Oriental-Indomalaysia	
15	Cyrtococum	Patense	Oriental-Indomalaysia, Pacific Islands	
16	Dactyloctenium	Aegyptium	Oriental-India, Sri Lanka	
17	Digitaria	Bicornis	Tropical Asia, Africa	Very Good
18	Dimeria	ornithopoda	India, Malaysia, Japan, Tropical Australia	
19	Dimeria	hohenackeri	Oriental-Peninsular India	Very Good
20	Echinochloa	Colona	Most warm countries	Very Good
21	Eleusine	Indica	Oriental and Paleotropic	Good
22	Elytrophorus	Spicatus	Oriental-India, Sri Lanka, old tropics	
23	Eragrostis	Uniloides	Asian Tropics	
24	Eulalia	Trispicata	Oriental-Indomalaysia, Australia	
25	Heteropogon	Contortus	Pantropics	
26	Hygrorhiza	Aristata	Oriental-India, Sri Lanka	Good
27	Isachne	Miliacea	Oriental-Indomalaysia	
28	Isacne	Globosa	Oriental-Indomalaysia	
29	Ischaemum	thomsonianum	Oriental-Western Ghats	
30	Ischaemum	Dalzelli		
31	Ischaemum	Indicum	South India	Good
32	Ischemum	semisagittatum	Oriental-India, Sri Lanka	
33	Jansenella	griffithiana	Oriental-India, Sri Lanka	
34	Leersia	hexandra	Tropics	
35	Oplismenus	Burmanii	Oriental and Paleotropic	
36	Oplismenus	Compositus	Pantropics	
37	Oryza	rufipogon	Oriental-India	
38	Panicum	Auritum	Oriental-Indomalaysia, China	
39	Echinochloa	crus-galli	India, S E Asia and Africa	Very Good
40	Panicum	Repens	Pantropics	Very Good
41	Paspalidium	Flavidum	S Asia	Very Good
42	Paspalum	Canarae	Peninsular India	
43	Paspalum	Conjugatum	India, Sri Lanka, old world world tropics	
44	Paspalum	scrobiculatum	Oriental-India	
45	Pennisetum	hoohanackeri	India, Pakistan, Tropical africa, Madagascar	
46	Pennisetum	pedicellatum	India, Tropical Africa	
47	Pseudanthistiria	umbellata	Oriental-India	
48	Pseudanthistiria	Heteroclite	Oriental-Western Ghats	Good
49	Pseudanthistiria	Hispida	Oriental-Western Ghats	
50	Sacciolepis	Indica	Oriental-Indomalaysia	Good
51	Sacciolepis	interrupta	Oriental-Indomalaysia	

52	Setaria	Pumila	Oriental-India, Sri Lanka, Old world Tropics	Good
53	Spodiopogon	rhizophorus	Oriental-Western Ghats	
54	Themeda	Tremula	Oriental-India, Sri Lanka	Good

RESTORATION OF DEGRADED HABITATS IN BUFFER ZONE

Buffer zone management is very critical in tiger conservation efforts. The buffer zone should not be one with intense human activities and grazing pressures from domestic cattle. The human activities here should be regulated and development guided towards complementing the objectives of ADTR. Activities suggested for the buffer zone are listed below:

- Formation of Village Forest Committees and Biodiversity Management Committees among all the peripheral villages
- Raising firewood and NTFP species to make peripheral villages self sufficient so as to take pressure of the ADTR core and buffer zones
- Starting village fodder farms, under Social Forestry schemes, especially in villages having numerous cattle and insufficient fodder resources
- Training enthusiastic youngsters as tourist guides, volunteers and communicators
- Fencing of small blocks of lands for three to five years from human impact and grazing by domestic cattle, will have very positive impact on forest succession and healthy growth of grasses in overgrazed areas. Once tall saplings are naturally established, the forest will flourish on its own. The protection may be shifted to other unprotected areas after the three to five year period. The forest lands thus protected may be named "Regeneration Blocks". The vegetational succession in such blocks to be monitored and recorded, preferably by local volunteers. Seeds of suitable tree and shrub species may be disseminated in such areas to promote diversity.

Suggestions: Application of GIS on wildlife distribution within ADTR is critical. Distribution data, to begin with, should cover primary and secondary reports on tigers, panthers and major herbivorous mammals. From existing and freshly collected data bird distribution details can be prepared as well. Birds are also good indicators of habitat quality. From distribution maps thus prepared, areas of importance for tigers and their prey may be demarcated. This would help in understanding ecosystem processes for preparing guidelines of future management of the Reserve. As it is difficult to get exact details of the very few tigers reported from the ADTR, it is very important to track their associate species and use them as proxy for demarcating likely tiger preference habitats within the Reserve.

GRASSLAND MANAGEMENT

It is necessary to maintain different kinds of grasslands within the Reserve as some grazing wild animals prefer short grass areas while others prefer tall grass areas. Mixed savanna-grasslands are favourites of yet others.

Controlled use of fire: ADTR receives high to moderate rainfall and the natural climax vegetation here is forest. Gradual vegetational succession in grasslands towards forest would effectively reduce carrying capacity for grazing animals and thereby affect prey supply for the carnivores. Therefore maintenance and management of grasslands would play a crucial role in sustaining wild fauna. Fire has been an important tool in grassland management in the humid Western Ghat regions. In the grasslands fire burns down the harsh, fibrous old bases and promotes a flush of new growth of fodder grasses. As it is time consuming and expensive to manage the large areas and keep the ecosystems in a dynamic stage to sustain maximum of the tiger population, with the available staff of the Forest Department, trained volunteers, NGOs and wildlife enthusiasts may be used in grassland management with regulated use of fire according to specifically prepared, site-centred management plans. Fire is to be used with caution as repeated fires can dry out a habitat, cause soil erosion and destroy many sensitive species.

Many tree species of food importance for herbivore prey animals of the tiger are associated with burnt savannas. These include *Acacia* spp., *Bombax ceiba, Careya arborea, Cordia* spp., *Dillenia pentagyna, Kydia calycina, Phyllanthus emblica* etc.

Afforestation in grasslands: Grassland within the Reserve, including fallow fields, should not be used for tree planting under normal conditions. The practice of raising block plantations in such grassy blanks is to be altogether dispensed with. Block plantations, and that too of fodder tree species and those trees that provide food for wildlife can be considered in rocky areas with scanty growth of grasses and other herbs. Providing designed corridors (using area specific trees and other life forms) for animal migration through such areas would be a good exercise for keeping the integrity of the ADTR by keeping the ecosystem processes alive. Dinerstein *et al.* (1999) consider the restoration of habitat integrity in wildlife, a prerequisite for effective dispersal of tigers.

THE PROBLEM OF MONOCULTURE PLANTATIONS

Ever-since commercial forestry began in the ADTR region, over one hundred years ago, during the British period, raising of teak plantations became an accepted practice, almost in every block of forest, after clear-felling the natural tree growth. We do not know exactly how much area has been brought under teak plantations in the ADTR. Teak plantations in general are low diversity areas, with scanty undergrowth of grass. The plantations are drier places than the natural forests, often subjected to soil erosion and ground fires. Despite the fact teak timber fetches fabulous market prices, there has been a moratorium on tree felling within the ADTR. With the objective of increasing the prey population of tigers, the food resources have to be increased. Without in anyway tampering with good teak plantations, the others can be subjected to enrichment planting with various fruit and fodder species, mainly the trees.

Adopting landscape level approach: In small and isolated protected areas the chances for long term survival of megafauna are slim, unless they are linked by natural habitat corridors to permit dispersal of tigers and their prey and are provided with buffer zones to minimize impacts from other land uses. Therefore landscape level approach is essential for tiger conservation (Karanth and Sunquist, 1995).

Suggestions: Evaluation of habitat quality in different parts of the ADTR with their suitability for wildlife in general and tiger in particular needs to be carried out. In such evaluation grassland quality and connectivity with different other landscape elements are important. Management plans have to be prepared to upgrade landscape elements, particularly poor quality grasslands.

GETTING PUBLIC SUPPORT

Tiger in India is a symbol of pride, power and strength. In Indian tradition it is both feared and respected animal and treated at par with the lion. In the local cultures associated with the wooded highlands tiger has been a worshipped animal. This holds good for the hilly terrain of Karnataka as well. In the Uttara Kannada district most villages and even towns have icons of tigers or *Hulidevaru* inside sacred forests, under sacred trees or in recently constructed small shrines. Tiger is famed as the *vahana* of the goddess Kali/Durga and Lord Aiyappa. Such incredible sentimental attachment among the public towards this magnificent animal needs to be appropriately utilized for gaining public support for tiger conservation in ADTR. Such support has to come from not only from outside but more so from the people living within the ADTR and its peripheral villages. Volunteers from among the youth, especially from these villages have to be enlisted to work for activities related to tiger conservation, and to develop a positive attitude among the local population. As the too few staff of the Forest Department are insufficient to manage and maintain the ADTR, especially in fire control, regulated use of fire, in grassland maintenance, tree planting, nursery activities, awareness creation, as local guides etc. it will be ideal to have a core group of such volunteers to assist the Department. If trained in bird watching, plant identification, and in disseminating wildlife related information to the visitors, ADTR can gain much from this reposition of confidence in the local population. In the words of wildlife conservationist Peter Jackson (1999): "if tigers are to be conserved, local people's feelings and needs must be a paramount consideration. Unless they support conservation, the tiger is doomed. They are not necessarily hostile to the tiger; they have greater problems with the deer and wild boar, which ravage their crops. A local tiger can even be seen as a protector against these pests. But people resent being excluded from forests and grasslands, which have been set aside for tigers and other wildlife, and which could provide them with basic necessities….If people's hostility is to be eliminated so that they can co-exist with tigers and other wild animals, they must be ensured the resources they need from land outside reserves….The tiger is still alive in the consciousness of the Asian peoples, many of whom retain respect for its place in culture and religion. This should be a powerful factor in enlisting public support, and should be used to convince political leaders that it should not be allowed to become extinct in their countries."

Table 8.8: List of grasses for planting in Kulgi and Dandeli wild life Santuary

{note: to be implemented under technical supervision]

S.No	Genus	Species	Best habitat	Common names
1	Arundinella	metzii	Open slopes	
2	Arundinella	leptochloa	slopes	
3	Brachiaria	mutica	moist	Para grass (cultivated)
4	Centotheca	lappacea	slight shades	
5	Chloris	gayana		Rhodes grass (cultivated)
6	Chrysopogon	hackelii	slopes	
7	Chrysopogon	fulvus	slopes	Ganjigorikahullu, Karada (Kan)
8	Coix	lachrymal-jobi	Wet, marshy areas	Job's tear grass
9	Cymbopogon	caesius	Open dry slopes	
10	Cymbopogon sp		Open dry slopes	
11	Dichanthium	annulatum	Open moist	
12	Digitaria	ciliaris	moist shady	
14	Eleusine	coracana	Open moist places, abandoned fields	Ragi
15	Eulalia	trispicata	slopes	
16	Heteropogon	contortus	Open slopes	Spear grass
17	Panicum	maximum	moist	Guinea grass (cultivated)
18	Panicum	auritum	river side, moist slopes	
19	Pennisetum	purpureum	Banks of rivers, moist places	Napier grass (cultivated)
20	Saccharum	spontaneum	Banks and wet places	Kan-kabbu
21	Sporobolus	indicus	Dry	
22	Themeda	tremula	Open slopes	
23	Themeda	triandra	Open slopes	

Notes on some important grasses

- ***Brachiaria mutica*** (Para grass) is a very tall (up to 2.5 m) grass native to South America and West Africa. The grass is a good fodder grass suitable for moist, swampy, open areas. Grass planting is to be done during the onset of monsoon or in cool months. The plants are raised from rooted, mature stem cuttings of 20-30 cm long having 2-3 nodes or from rooted runners. The cuttings root in about six days and begin to spread out. If this grass is to be maintained the soil has to be moist during dry months. The unirrigated grass though dries up sprouts with the beginning of rains. The grass is highly succulent, palatable and nutritious.
- ***Centotheca lappacea*** prolifically branched, perennial grass that attains up to 1.5 m height. It is found in open, dry stony regions, especially on laterite soils. If the soil is stony the grass remains stunted. The grass is a good fodder and can be stored as hay. The fodder value is high before flowering.
- ***Chloris gayana*** (Rhodes grass) is a fine stemmed, annual or perennial grass introduced as a fodder grass into India from South Africa. It is ideally suited for dryer part of the ADTR, where the rainfall does not exceed 125 cm. It is drought tolerant and good for light loamy soils than stiff clay or water logged areas. Seeds or rooted cuttings are used for propagation. It attains height of 1-1.5 m. Sowing of seeds to be done with the onset of monsoon. While sowing fine soil has to be mixed with seeds so as to have uniform spread. Rooted cuttings can also be planted in rows 60 cm apart. Below power lines with light soils would be ideal. The grass is nutritious and withstands grazing and trampling.
- ***Chrysopogon fulvus***: Perennial tufted grass up to 1.8 m.
- ***Eleucine coracana***: Ragi seeds can be dispersed in all suitable areas to promote growth of wildlings in due course of time. The plants, though seasonal, make good forage. Ragi was grown widely once by the shifting cultivators of ADTR in patches of forests cleared and burnt. Ragi plant is a nutritious fodder.

Table-8.9 : List of Leguminous plants for planting in Kulgi and Dandeli wild life Santuary			
Sl.No.	Genus	Species	
1	Bauhinia	purpurea	Basavanapada
2	Bauhinia	Racemosa	Banne
3	Bauhinia	variegata	Arisinatige
4	Cassia	fistula	Kakke
5	Crotolaria	juncea	Sunhemp
6	Desmodium	triflorum	
7	Entada	scandens	Hallekayiballi
8	Erythrina	spp.	Harivana
9	Indigofera	cassioides	
10	Pithecellobium	dulce	
11	Saraca	asoca	
12	Sesbania	grandiflora	Agase
13	Smithia	conferta	
14	Smithia	sensitiva	
15	Tephrosia	purpurea	
16	Tamarindus	Indicus	Tamarind

Some notable legumes

- ✓ ***Cassia fistula*** leaves have fodder value though the cattle are not fond of it. It is likely that some wild ungulates would feed on the leaves. Bears and monkey feed on the fruit pulp according to Talbot (1909), and therefore the tree renders good ecosystem services. Moreover the beautiful, golden yellow bunches of flowers are great attraction during the summer months. The tree can be extensively raised on roadsides and other open, even lateritic areas with poor grass growth. The seedlings are routinely raised in forest nurseries using well-established silvicultural practices.
- ✓ ***Desmodium triflorum:*** A small, trailing, perennial herb it is a good fodder. It spreads on the ground and forms a close mat; good for nitrogen enrichment and soil conservation.
- ✓ ***Entada scandens:*** A giant woody climber associated with deciduous and semi-evergreen forests. The leaves are fodder for elephants. Plants can be multiplied by layering or from seeds.
- ✓ ***Erythrina*** spp. Leaves make good fodder. The tree is good for deciduous forests, roadsides and open places. Stem cuttings are ideal for propagation. The flowers are visited by many birds for nectar.

PULSES FOR INTRODUCTION

Pulses are leguminous herbs and climbers the seeds of a great variety of which have been used as protein rich food by humans from ancient times. Not only are the seeds rich in proteins but the forage also is rich in proteins, mainly because of the association of the roots of these plants with nitrogen fixing bacteria. The very growth of the legumes enriches soils with nitrogen and they are ideal for reclaiming impoverished soils. Dispersing the seeds of relatively low cost pulses selectively, especially along roadsides, as well as raising them in small protected patches, and in canopy gaps of plantations, underneath power lines etc., in due course can increase the stock of these useful plants, as wildlings in the ADTR. The plants will provide excellent forage for many herbivores which constitute the prey stock of tigers. A list of these forage legumes are given below:

- ✓ ***Dolichos biflorus*** (Eng: Horse-gram; Kan: Kulthi): It grows on a variety of soils, including poor soils, and is hardy and drought resistant. It is considered a valuable green fodder crop and a good protienaceous substitute for grasses. The plants improve soil fertility, which is very necessary for many parts of ADTR where shifting cultivation was widely practiced leaving behind thin layer of poor soils impoverished of nutrients. Underneath poor grade plantations also the species can be raised.
- ✓ ***Dolichos lablab* var. *typicus*** (Kan: *Avare*). It is a good climber, cultivated for the tender pods and seeds used as human food. The plants, both fresh and dry, make good protein rich fodder for herbivores.
- ✓ The seeds of various pulses such as of blackgram, green gram, cowpea (alsande) etc may be dispersed in suitable localities so as to increase their number through natural propagation as wildlings.

Table -8.10 : Nonl-leguminous fodder trees and climbers

1	Artocarpus	integrifloia	Jackfruit
2	Caryota	Urens	Palm
3	Dillennia	pentagyna	Kanigala (Kan)
4	Emblica	officinalis	Nelli (Kan); gooseberry (Eng)
5	Ficus	religiosa	Pipal
6	Ficus	bengalensis	Banyan
7	Mallotus	phillippensis	Kumkumadamara (Kan)
8	Mangifera	Indica	Mango
9	Mimusops	elengi	Bakula (Kan)
10	Sygygium	Cumini	Jamun
11	Zizhiphus	Rhugosa	Mulla hannu

Note: Artocarpus integrifolia: The jack fruit tree can be raised in forest openings, roadsides, field bunds etc. The evergreen tee requires protection for some years from browsing by animals. There is good scope for raising thousands of trees in the ADTR. The leaves are eaten by elephants and most ungulates. The large fruits also make ideal food for many herbivores during summer months and early part of rainy season.

Bauhinia purpurea: A medium sized, tree suitable for savanna with hardened surface and roadsides especially in the ADTR. Apart from having ornamental value due to its deep pink to white, fragrant flowers the leaves have fodder value as well. The leaves contain 3.6% protein and 9.7% carbohydrates and are rich in minerals, especially calcium and phosphorus. It is raised from seeds and the seedlings are transplanted. It can be raised at site by line sowing. Light demand being moderate, should not be planted in fully open places (Talbot II, 1976; Wealth of India, vol. 2, 1988).

Bauhinia racemosa is a small, crooked bushy leguminous tree of moist and dry deciduous forests; useful for filling blanks in forest plantations. Propagation is done by line sowings. The young plants are kept weeded and the soil is loosened from time to time. The tree is a light demander. It produces root suckers and coppices well.

Bauhinia variegata: The tree is not natural to the ADTR. However, being indigenous tree present throughout India it is ideal for introduction, particularly along the roadsides. While the leaves are good fodder the showy flowers provide ornamental value. The leaves have by dry weight 3.58% digestible protein and 14.3% digestible starch and are rich in minerals. The flowers and flower buds have food value even for humans. Known as *Kovidara* in Sanskrit the plant is also reputed medicinally (Wealth of India, Vol. 2, 1988).

Caryota urens: Elephants are fond of the leaves and starchy pith of the palm that is often associated with evergreen-semi-evergreen forests. Fire protected moist deciduous forests can be planted with this species, especially in gullies and ravines and along the water courses. The palm is propagated through seeds. Self-sown seeds germinate in 150-180 days. Pre-soaking of seeds in cold water for 24 hours ensures the maximum germination in a minimum period. The palm lives for 20-25 years (Wealth of India, vol.3- 1992).

Dillenia pentagyna: Deciduous tree of deciduous forests and burnt savanna. Deer is fond of fruits; many birds also feed on fruits. The tree reproduces by seeds, and is ideal for planting in places subjected to fire. The species also produces coppice shoots.

***Dioscorea* spp.;** Tuber producing climbers. The tuber is eaten by deer. The plans can be raised from tubers.

***Emblica officinalis*:** Fruits eaten by a variety of wildlife. Leaves make fodder for wildlife. There is good scope for raising thousands of trees in ADTR using nursery raised saplings.

Ficus religiosa: The tree can be introduced in unproductive, open, non-grassy areas (as good grasslands should not be brought under any tree plantations). Elephants are fond of pipal leaves. *Ficus* sp. are considered keystone resources of ecosystems by providing food, in the form of ripe fruits, to birds and many herbivores, during times of scarcity of other seasonal fruits.

Ficus bengalensis: Same habitats as the previous one. Prolific producer of fruits for birds, monkeys and minor mammals. Elephants and ungulates feed on the leaves

Ficus racemosa: The wild fig grows in ravines, gullies, banks of water courses and different other habitats. Being a prolific producer of fruits a-seasonally, there is good scope for raising thousands of trees of this species in ADTR, which can benefit a variety of herbivores, including birds.

Mallotus phillippensis: A small tree that prefers partial shade. The leaves have fodder value. Seldom any importance has been given to this tree, that is also medicinally important, in forest planting. The tree can be propagated by seeds.

Mangifera indica: The mango trees, especially of the wild or semi-wild Appe-midi varieties can be propagated in the forest. The fruits are eaten by several herbivores, and the leaves, though not a good fodder, are sparingly eaten by many animals. The tree will have a great role in ecosystem enrichment.

Madhuca indica and M. longifolia : These are large trees associated with deciduous forests. Leaves make excellent fodder. The fruits are eaten by monkeys, large birds such as hornbills and also bats. The trees are raised from seeds. Even fallen flowers are eaten by herbivores. There is tremendous scope for increasing the population of this useful tree which is a light demander.

Mimusops elengi: Large evergreen tree suitable for planting in evergreen-semievergreen forest areas, in haps and openings. Leaves make medium quality fodder. Fruits constitute food for many birds, bats and other wildlife. The tee is propagated by nursery grown seedlings.

Odina wodier: Moderate to large sized deciduous tree. Leaves are readily browsed by ungulates and fruits eaten by birds. The light demanding and fire tolerant tree produces root suckers as well as coppices well. The tree can be grown from cuttings as well as seeds.

Spondias mangifera: Ctuttings and seeds, light demander.

Bamboos: Different species of bamboos need to be propagated in poor grade plantations. Young shoots and tender leaves of bamboos constitute good fodder for elephants and ungulates.

Appendix-1

Differentiating sedges (Cyperaceae members) and grasses: Grasses can be easily differentiated from other families, particularly in habit and in character of leaves, fruits, seeds and embryos. They are predominantly herbaceous, the woody bamboos being exceptions. Members of Cyperaceae share some of the common characteristics of grasses as they are their nearest relatives. Both are having herbaceous habit, with small flowers without sepals and petals. The flowers arise from the axils of boat shaped scales called glumes. The glumes are arranged in small units called spikelets. Each such spikelet may have a single flower as in rice, two in sugarcane or numerous as in many other grasses. However table 8.11 below shows the dissimilarities between sedges and grasses.

Table 8.11: Sedges vs. grasses

Sl no.	**Character**	**Sedges**	**Grasses**
1	Habitat	Relatively more primitive than the grasses and are mostly associated with wet places.	Occur in most habitats.
2	Stem	Triangular and solid stems.	Rounded and often hollow outline.
3	Leaves	Three rows of leaves	Only two rows.
4	Flower	Subtended by a single bract (glume).	Single concave glume or lemma is closed by another boat shaped scale called palea. The grass flower therefore is concealed within these two scales.
5	Fruit	An achene or a nut having a dry wall and seed remaining free from fruit wall.	Caryopsis type fruit with thin fruit wall, commonly known as bran, is fused with the seed itself.
6	Embryo	Embedded in the endosperm.	Attached outside endosperm.

Vegetative and floral morphology of grasses - The vegetative parts:

Habit: Grasses vary very much in their habit. Some grasses grow erect forming tufts and others form cushions with their branches creeping along the ground. Some grasses are annual while others are perennial. It is often difficult to determine whether a certain grass is annual or perennial. But by examining the shoot system this can be ascertained easily. In an annual all the stems and branches usually end in inflorescences and they will be of the same year. If, on the other hand, both young leafy branches and old branches ending in inflorescence are found mixed, it is a perennial grass. The presence of the remains of old leaves, underground stolons and rhizomes are also signs of perennial grasses.

Roots: Grasses being monocots do not produce tap roots. Their roots are tufts of fibrous structures from base of stems or from nodes of creeping stem. Grasses also might produce from nodes of horizontal branches aerial roots. Stilt like aerial roots from basal nodes of stout, tall stems are characteristic of *Andropogon, Sorghum* (Jowar)*, Zea* (maize)*, Saccharum* (sugarcane) etc. The root systems of the most grasses are superficial on the soil and so are best adapted for absorbing water and nutrients from top soils.

Stem: In annual grasses stems in most cases are erect or even if they are not entirely so they become erect at the time of flowering. But in perennials in addition to erect branches, creeping branches, stolons, and rhizomes may occur. The internodes in most cases are usually hollow. The younger parts of stems especially are protected sheathing base of leaves. Nodes may be pale or colored, glabrous, hairy or bearded with long hairs.

Leaf: Leaves are in two rows alternating left and right on the nodes of the stem. Leaves may be crowded towards stem base forming tufts, in many perennial grasses. The leaves are reduced to non-green scaly structures in the lower nodes in some of the grasses. The normal foliage leaves of grasses consist of two parts, the flat expanded portion called the blade and the lower part called the sheath that encircles the stem above the node. At the junction of sheath and blade is a scaly outgrowth called ligule. The ligule may be reduced to a tuft or fringe of hairs. The function of the ligule is probably to facilitate the shedding of water which may run down the leaf, and thus lessen the danger of rotting of the stem. The veins in the leaf blade can usually be seen running closely parallel from base to tip.

Inflorescence and flower: The flowers of grasses are reduced to just their reproductive parts the stamens (male) and pistil or gynoecium (female reproductive). The ovary of the pistil matures into the fruit containing the seed inside it. The flowers are aggregated together on distinct shoots constituting the inflorescence. Sooner or later all the branches of a grass-plant terminate in inflorescences which usually stand far above the foliage leaves. Inflorescences are of different types but its basic unit is called spikelet. In a spike inflorescence, as in ragi, spikelets are directly attached to the axis without a stalk. Raceme is like a spike but the spikelets are attached by stalks as in wheat. A branched inflorescence axis as in rice is a panicle. The spectacular, silken and fluffy white sugarcane inflorescence, for instance, is a large panicle.

The spikelet may be considered as a specialized branch consisting of a short axis, the rachilla bearing a series of scaly bracts, the glumes, the lowest pair being empty but the others bearing flowers in their axils (Figure 9.1). The lower two bracts are empty and are called glumes; above the glumes are one or more boat shaped bracts called lemma, arranged alternately towards right and left of the axis. The flower in the axil of lemma is closed by yet another bract like structure called 'palea'.

Figure 9.1: Dissected spikelet of *Arundinella metzii* showing different parts.

The grasses are self pollinated or wind pollinated and therefore they have no necessity of producing colorful flowers or nectar to attract butterflies or bees. Probably grasses were once, in their early stages of evolution attractive flowers. Today, most grasses still have two or three tiny 'lodicules' at the base of the ovary, which represent vestigial perianth. The stamens are three in number in majority of grasses and six are in rice*, Hygroryza* and bamboos. In mature flowers the stamens protrude out of the glumes and oscillate in the wind on their delicate stalks called filaments. The anthers produce plenty of pollen which are carried away by wind, the pollinating agency. The pistil consists of a bulged ovary topped with two delicate styles ending in feathery stigmas that are suited for capturing wind borne pollen. Ovary has just one chamber and a single ovule attached to its base.

Fruit: Typical fruit is usually a caryopsis, a dry one, where the seed cover is fused with the thin fruit wall constituting what is known as bran. The fruit covered by the husk which consists of two scaly and concave glumes, which were the original protective cover of the flower. Fruit is sometimes a nut, if the hard fruit wall is free from seed coat; fruit is a utricle if the fruit wall is membrane like and free from seed coat; in rare cases fruit may be a tiny, fleshy berry. The seed is with starchy endosperm and small embryo at base of it.

Pollination: Grasses in general are wind pollinated, though in few cases like rice self pollination occurs. Jowar has a combination of self and cross pollination. The terminal position of the inflorescence, its protrusion far above the level of the foliage leaves, the swinging and dangling anthers, the abundance of non-sticking pollen and the plumose stigmas are all intended to facilitate pollination by wind.

General aspects of flowering and fruiting: The beginning of monsoon in early June triggers germination and luxuriant growth of grasses and the Tiger Reserve in many places turn into green carpet of rolling grasslands. For most annual grasses of the Reserve flowering and fruiting start from late August, with some decline in the intensity of South West Monsoon. Flowering and fruiting are profuse from September and go on almost to January. Some of the perennials and wetland species in favorable moisture conditions, flowering and fruiting occur almost throughout the year.

Grassland communities: Although grasses are dominant, the grassland community includes also large number of other herbs from dicot and monocot families. The fodder quality of these herb communities also count in judging the forage importance of the grasslands. In many overgrazed pastures weedy and unpalatable herbs such as members of Asteraceae viz. *Chromolaena, Ageratum, Parthenium* etc., multiply at the expense of the original palatable herbs such as sedges, *Justicia*, *Rungia, Phyllanthus, Desmodium, Alysicarpus, Crotolaria* etc. This brings down the overall quality of the grasslands to support herbivores. Hence grasslands need to be managed to their best combinations of species diversity and biomass, in the interest of wildlife promotion, through periodic surveys and management interventions. Details regarding the other herbs noticed in the transect studies in the grasslands of ADTR are given in the Appendix 2 and 3 respectively.

Appendix II:

ILLUSTRATED MANUAL OF THE GRASSES OF ANSHI-DANDELI TIGER RESERVE

The grass family, Poaeae is one of the largest families of flowering plants in the number of genera, species, sub-species and varieties. Although many grasses, for example the ones that supply us with our staple food – the cereals and millets- such as rice, wheat, maize, jowar, ragi etc. and some others like sugarcane, lemon grass etc. are easier to identify bulk of the others requires specialised knowledge of taxonomy, grass taxonomy in particular. On very subtle floral features, with the help of good microscopes only, we can distinguish between many closely related grasses. Grasslands are of paramount importance in the management of any tiger reserve, because bulk of tiger's prey animals feed on grasses. There are grasses which are very palatable and of high nutritional value; and there also ones which are sparingly eaten or never eaten by these animals.

Within the ADTR there are several grasslands and microhabitats such as rocky crevices, roadsides, stream and rive banks, marshes etc where specialized grasses grow. There are common grasses universally present in vast areas. We have described in this manual most of the grasses of the ADTR to the species level. Since it is not an exhaustive taxonomic work on the grasses of ADTR we have not furnished here any keys for identification. A simple taxonomic description of grasses is given here and the scientific words are explained in the glossary of terms. Hand-drawn sketches or photographs are given for easy identification in the field of most of the grasses described here, at least to the generic level.

Aristida setacea Retz. (Figure 9.2)

A coarse perennial grass. Culms stout, erect from woody root stock, up to 120 cm high; nodes without hairs; ligule a fringe of hairs. Flowering panicle very narrow, 8-38 cm long; Spikelets 12-17 mm long. Glumes linear –lanceolate, 1-nerved, awned, up to 20 mm long; lemma 3-nerved, awned, 3-partite.

Occurrence: Common along road sides and road cuttings, hill slopes, waste lands, rocky places.

Figure 9.2: ***Aristidia setacea.*** **A. Habit with inflorescence; B. Spikelet; C. Lower glume**

Arthraxon lancifolius (Trin.) Hochst. (Figure 9.3) (*Andropogon lancifolius* Trin.)

Annual; culms very slender, trailing, short hairy below flowering branch. Leaves linear to lance shaped or ovate, 1-4 x 0.3-1 cm hairy, margins with short hairs which are bulged at base. Sheaths glabrous. Inflorescence of 2-6 branches, unequal, 0.7-2.5 cm long spikes; joints and pedicels with long hairs or cilia. Spikelets generally stalkless, 2.5-5 mm long, linear-lanceolate, laterally compressed. Lower glume or lemma with two narrow points towards tip and rounded at back; it has no central nerve (keel) and is feebly nerved. Upper glume equals the lower and ends in a narrow point up to 2.5 mm long. It has a bristle or awn, up to 10 mm long from near the base; Stamens 2; Some spikelets may be pedicelled.

Occurrence: Common along hill slopes, raised bunds, rocky places, and on compound walls, and fences; in moist situation

Figure 9.3: ***Arthraxon lancifolius*** **A. Habit with inflorescence; B. Spikelet; C. Upper glume**

Arundinella leptochloa(Nees ex Steud.) Hook. (Figure 9.4)

(*Panicum leptochloa* Nees ex Steud; *Arundinella gigantia* Dalz.; *A.lawsonii* Hook.)

Tall perennial; culms up to 2 m, not hairy; root stock hairy.; nodes not hairy. Leaves up to 60 x 3.5 cm, linear-lanceolate, rounded or heart-shaped (cordate) at base. Leaf sheaths striate, poorly hairy with tubercle based hairs; ligule a very narrow membrane. Panicle variable in size, up to 45 x 20 cm. Spikelets 2.5-3.5 mm long, Lower glume 2 mm long, ovate-acute, glabrous except on scabrid nerves. Upper glume not bearded. Lower glume with male of bisexual flower in the axil, broadly elliptic acute, 5-nerved. Upper lemma 1 mm long, bisexual, without awn.)

Occurrence: Rice field bunds, hill slopes, road cuttings, waste lands etc.; usually in shady places. Note: Very similar to *A.metzii* but can be differentiated by its robust and taller growth, purplish flowering branches unawned.

Figure 9.4: ***Arundinella leptochloa*- inflorescence**

Arundinella nepalensis Trin. (Figure 9.5), (*A.brasiliensis* Raddi, *A.hispida* Blatt.)

Perennials along stream courses, 1-1.5 m tall; culms stout with hard root stock. Leaves 10-25 x 0.4-1.0 cm, linear lanceolate, hairy. Panicles pyramidal, 10-16 cm long. Spikelets 0.4-0.5 cm long, ovate-laceolate, glabrous; lower glumes to 0.3 cm long, ovate. Upper glume to 0.5 cm long, ovate-lanceolate; lower lemma obtuse, bifid at apex.

Note: Grows in large population near streams and moist grasslands confused with *A.leptochloa* but can be distinguished by the large reed-like softly hairy culms below the inflorescence, distinctly awned spikelets.

Figure 9.5: ***Arundinella nepalensis.*** **A. Habit with inflorescence; B. Spikelet; C. Lower glume**

Arundinella metzii Hochst. (Figure 9.6), (*A.pygmaea* Hook; *A.lawii* Hook)

Annual; culms erect, 30-60 cm high, tufted, rounded with striations. Leaves 40 x 0.9 cm, linear, base rounded, softly hairy on both surfaces with tubercle-based hairs, densely ciliate on one margin. Floral panicle up to 50 x 25 cm. Spikelets in pairs, one short and one long pedicelled, 3-4.5 mm long. Lower glume 2-2.5 mm long, lanceolate or elliptic, 3-nerved, Upper glume 2.75 -4.25 mm long, elliptic, narrowing and ending in an abrupt tip. Lower lemma with male and upper lemma with bisexual flowers, 1 mm long, with 3 mm long awn.

Occurrence: Common in open grassland, cultivated fields, and other moist places.

Figure 9.6: Inflorescence of *Arundinella metzii*

Brachiaria miliiformis (J.S. ex C.B.Presl) A.Chase (Figure 9.7)

(*Panicum miliiforme* J.S. ex C.B.Presl)

Annual to perennial grasses. Culms slender, erect or creeping and rooting at lower nodes, 30-75 cm high. Leaves up to 17 x 1 cm, lanceolate, base cordate; sheaths glabrous, margin ciliate; ligule a fringe of hairs. Panicle consists of 4-6, horizontally spreading racemes up to 6.5 cm long; rachis flattened. Spikelets crowded, arranged on one side of axis, 3.25-3.75 mm long, oblong-ovate, tapering rather abruptly to a short point. Lower glume with margins overlapping at base, 5-7 nerved.

Occurrence: Common along roadsides, waste lands, bunds of paddy field, banks of rivers, usually in shade.

Figure 9.7: *Brachiaria miliiformis.* A. Habit with inflorescence; B. Spikelet

Centotheca lappacea(L.) Desvaux (Figure 9.8)

(*Cenchrus lappaceus L.; Holcus latifolius* Osbeck; *Centotheca latifolia* (Osbeck)Trin.)

Culms stout erect, 30-100 cm high. Leaves 5-25 x 1-3.5 cm, oblong-lanceolate, acute or acuminate, glabrous or sparsely hairy, many nerved, base narrowed with asymmetrical sides; ligule a lacerate membrane. Panicle up to 30 cm long. Spikelets 4-6 mm long, green, oblong-lanceolate. Glumes distant; lower 2.5-3 mm long, ovate, 3-nerved; Lemmas 7-nerved, lower lemma 4-5 mm long.

Seen in margins of forests, or in shades of trees and bushes.

Figure 9.8: *Centotheca lappacea.* A. Habit with inflorescence (partly shown); B. Spikelet

Chloris barbata Sw.

A perennial grass. Culms tufted, up to 90 cm high; nodes glabrous. Leaves 5-30 x 0.2-0.5 cm, flat, linear acuminate, sheaths compressed, junction of sheath and blade hairy. Inflorescence spike type 4-20 in number, each up to 10 cm long. Spikelets green or purplish, each 2.5 mm long; 3-awned; the spikelet axis bearded at base. Glumes translucent, the lower shorter than the upper. Fertile lemma 2-2.5 mm long, obovate concave, back sparsely hairy, margins densely ciliate above the middle, its awn up to 4 mm long. Empty lemmas 2; lower obovate, awned, ciliate above the middle; upper subglobose, awned, glabrous.

Occurrence: Very common along roadsides and in disturbed areas; in wetlands; a weed in cultivated fields

Coelachne simpliciuscula (Wight and Arn. ex Steud.) Munro ex Bth (Figure 9.9)

(*Panicum simpliciusculum* Wight and Arn. ex Steud.; *Ceolachne pulchella* sensu Hook.)

<table>
<tr><td>Annuals or perennials, 15-20 cm long, delicate, erect or prostrate with upper parts rising vertical. Leaves 1.0-3.0 x 0.1-0.3 cm, linear-lanceolate, somewhat rough, apex acute. Inflorescence, 2-5 cm long, of short spikes in panicles arranged on the axis with gaps in between. Individual spikelets ovoid, 0.15-0.2 cm long; upper glume suborbicular; lower lemma longer than glumes.</td><td></td></tr>
<tr><td colspan="2">Occurrence: Fairly common in marshes and paddy fields, ditches and other wetlands.</td></tr>
<tr><td colspan="2">Figure 9.9: Coelachne simpliciuscula</td></tr>
</table>

Coix lacryma-jobi L. (Figure 9.10)

<table>
<tr><td>Annual herbs, up to 1.5 m high, erect rooting at lower nodes. Leaves 15-40 x 0.8-1.6 cm, linear-lanceolate. Racemes 1-many with flat axis. Male and female spikelets relatively large; the latter in singles, 1 cm long; male 1.2 cm long. Grains flat, reddish-brown.</td><td></td></tr>
<tr><td colspan="2">Occurrence: Found growing near wet places and in standing waters. The hardened involucres surrounding female spikelets called, “job’s tears”, used for ornaments</td></tr>
<tr><td colspan="2">Figure 9.10: Coix lacryma-jobi</td></tr>
</table>

.

Cynodon dactylon (L.) Pers. (Figure 9.11)

(*Panicum dactylon* L.)

Weak, creeping perennials, rooting at nodes, with branches rising 5-40 cm into the air; Inflorescence of spikes 1.5-5.5 cm long. Spikelets *c* 0.2 cm long, stalkless; lemmas silken hairy on keels.

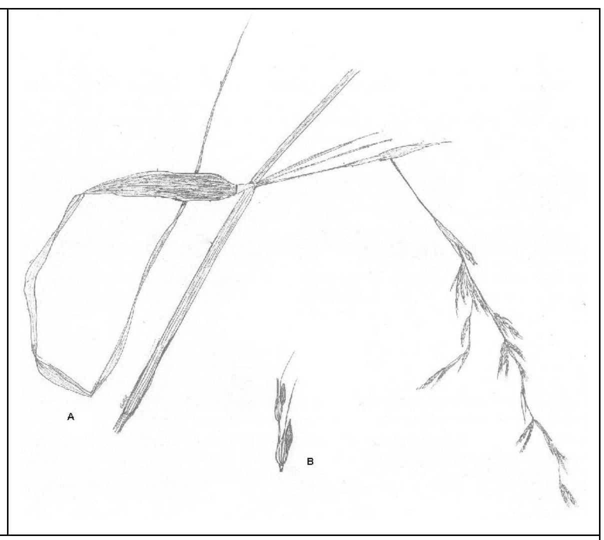
Occurrence: Common grass; *Garike* in Kannada.

Figure 9.11: *Cynodon dactylon*

Cymbopogon caesius (Nees ex Hook. & Arn) Stapf (Figure 9.12)

(*Andropogon caesius* Nees ex Hook; *A.schoenanthus var caesius* (Nees ex Hook. & Arn.); *A. schoenanthus var. gracillimus* Hook)

Perennials. Culms 50-200 cm high. Nodes glabrous. Leaves linear-lanceolate, 10-30 x 0.3-0.8 cm acuminate. Ligules ovate, acute, membranous, 3-5 cm long; Panicles narrow, contracted, 15-40 cm long; joints densely villous. Sessile spikelets linear-oblong, 3-4 x 0.75 mm, callus hairy; keels of lower and upper glumes narrowly winged in the upper half. Palea absent. Pedicelled spikelets elliptic, 3-4 x 1 mm, glabrous; pedicels 1-2 mm long, densely long villous. Stamens 3.



Occurrence: Seen in hill slopes and fringes of forests.

Figure 9.12: *Cymbopogon caesius.* A. Habit with inflorescence (partly shown); B. Spikelet

Cyrtococcum muricatum (Retz.)Bor (Figure 9.13) (*Panicum muricatum* Retz.)

Annuals. Culms 10-75 cm long, creeping or trailing, rooting at lower nodes, rarely upper parts rising; nodes glabrous. Leaves ovate-lanceolate, elliptic or elliptic-lanceolate, 1-10 x 0.4-1.8 cm, acuminate, softly hairy from minute tubercled bases, base conical and fringed with hairs; sheaths also fringed with hairs. Panicles 5-20 cm long lax. Spikelets obovate, 1.5-2 mm, brown or purplish. Lower glume ovate; upper glume boat shaped or ovate-oblong, 3-nerved, softly hairy with a few brown wart like outgrowths. Stamens 3, pale yellow.

Occurrence: Frequent along shaded margins of forests

Figure 9.13: ***Cyrtococcum muricatum***

Cyrtococcum oxyphyllum (Steud.) Stapf. (Figure 9.14)

Perennials, ascending; culms slender, 30-60 cm long, rooting below. Panicles 4-6 cm long, branches slender. Spikelets *c* 0.15 cm long; lower glume elliptic-oblong, brown; upper glume elliptic.

Occurrence: Frequent in forest edges and openings.

Figure 9.14: ***Cyrtococcum oxyphyllum*. A. Habit with inflorescence; B. Upper lemma; C. Spikelet**

Cyrtococcum patens (L.) A. Camus (*Panicum patens* L.)

Perennials, trailing; culms reclining with upper parts rising, branching, interlaced below, branches erect. Leaves 2.5 -5.0 cm long, linear-lanceolate. Panicles 2.5-4.0 cm long, contracted. Spikelets *c* 0.15 cm long, elliptic shortly pedicelled, glumes and lemmas dissimilar; lower glume half the length of lemmas, 3-nerved, pale-brown, so also upper one; lower lemma 5-nerved, pale brown, upper naked or bearded at tip.
Occurrence: Along forest margins, scrub jungles and moist shady places.

Dactyloctenium aegyptium . Willd. (*Cynosurus aegyptius* (L.) Desf.

Tufted annuals, erect, suberect or geniculately rising, 15-45 cm high. Leaves 2.5 -12.0 x 0.1 -0.5 cm, linear. Spikes 2-6, bearded at base, digitately radiating, 1-4.5 cm long. Spikelets 3- 0.4 cm long.
Occurrence: Common in open areas, field bunds.

Digitaria bicornis (Lamk.) Roem. & Schult ex Loud
(*Paspalum bicorne* Lamk. *Digitaria biformis* Willd.)

Annual with culms up to 80 cm high, ascending from a geniculate or prostrate branched base; nodes glabrous. Leaves 5-15 x 0.4-0.9 cm, linear-lanceolate, glabrous, or sparsely hairy; sheaths glabrous or pilose; ligule a short membrane. Racemes 2-8, from the tip of a short common axis, each up to 15 cm long; raceme axis (rachis?) flat, margins winged. Spikelets in dissimilar pairs, one stalked and the other stalkless. Former glabrous to slightly hairy, the stalked one softly hairy may or may not be pectinate (where?), 2.5 -3.5 mm long, oblong. Lower glume a minute scale. Upper glume fringed with hairs. Lower lemma 5-7 nerved, densely bearded with soft spreading hairs.
Occurrence: Very common in open places, as weeds in arecanut gardens.

Dimeria hohenackeri Hochst. ex miq.   (Figures 9.15-9.16)

A slender annual grass to 60 cm high; nodes bearded. Leaves short, forming a rosette at base, 3-6 x 0.2-0.4 cm, linear-acute, covered with bulbous based hairs, margins hairy; sheaths glabrous in the lower half but pilose in upper half, keeled margins translucent. Racemes 2-9, sub-digitately arranged, up to 12 cm long. Spikelets 3-3.5 mm long, very narrow, compressed, with a short bearded callus. Upper glume not winged, margins translucent, with stiff hairs at apex. Lower lemma margins ciliate at apex. Upper lemma forked at apex and awned from the sinus.

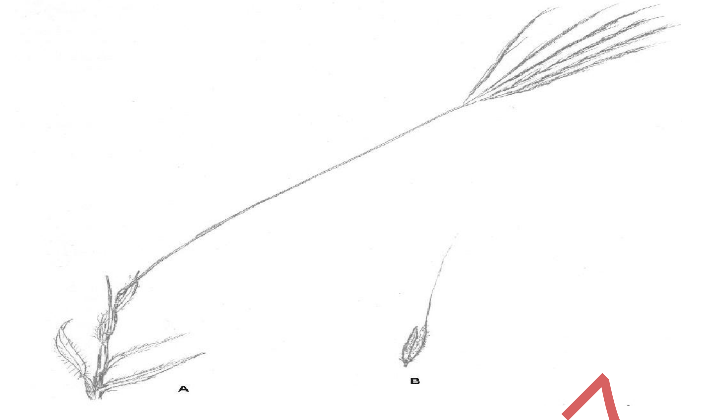


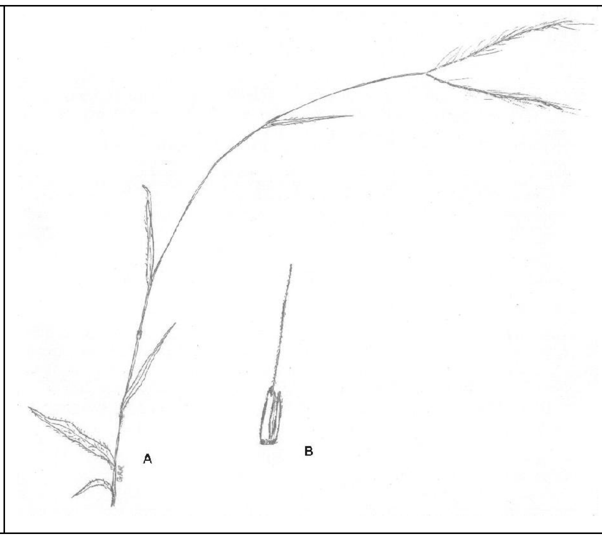
Figure 9.15: *Dimeria hohenackeri.* A. Habit with inflorescence; B. Spikelet

Figure 9.16: Inflorescence of *Dimeria hohenackeri*

Occurrence: Common grass in open areas.

Dimeria ornithopoda Trin.   (Figure 9.17) (*Dimeria tenera* Trin.)

An annual grass, up to 40 cm high, slender; nodes bearded. Leaves 2-7 x 0.1-0.2 cm, linear-acuminate, covered with bulbous based hairs, especially in midrib and margins, midrib prominent. Racemes 2, rarely 3; erect or spreading rachis triangular in section. Spikelets linear, compressed; callus bearded. Upper glume not keeled, softly hairy, sometimes with stiff hairs towards apex. Upper lemma awned from sinus; awn 4-10 mm long.



Occurrence: Very common in wet places, uncultivated paddy fields etc.

Figure 9.17: *Dimeria ornithopoda.* A. Habit with inflorescence; B. Spikelet

Echinochloa colona (L.) Link (Figure 9.18) (*Panicum colonum* L.)

Slender annual grass, prostrate to shortly creeping with branches rising to 60 cm. Leaves 5-20 x 0.3 -1 cm, linear-lanceolate; ligule absent. Racemes 8-20, simple, up to 3 cm long; rachis angular. Spikelets ovoid, 2.5-3 mm long with rough hairs. Upper glume as long as lower, ending in sharp point, concave, 5-7-nerved, with rough hairs. Lower lemma broadly ovate or sub-orbicular, 3-nerved.	
Occurrence: A common weed of paddy fields, and in wet places.	
Figure 9.18: ***Echinochloa colona*** **A. Habit with inflorescence; B. Spikelet; C. Upper glume**	

Echinochloa crusgalli (L.) P.Beauv.
Panicum crusgalli L.

An annual grass. Culms tufted, up to 1 m high, nodes glabrous. Leaves 10-50 x 0.6-1.2 cm, linear-lanceolate, acuminate, glabrous; sheaths keeled; ligule absent. Panicle up to 20 cm long; contracted and pyramidal; racemes many. Spikelets 3-4 mm long, subglobose or ovoid, hairy with tubercled based hairs. Upper glume cuspidate or shortly awned, hispidulous. Lower lemma short- or long awned.
Occurrence: In wet and marshy areas.

Eleusine indica (L.) Gaertn.
(*Cynosurus indicus* L.)

Culms tufted, 15-75 cm high, erect, slightly compressed. Leaves 8-50 x 0.2-0.6 cm, flat or folded, linear, acuminate, sparsely hairy. Spikes 2-9, up to 14 cm long 5 mm wide. Spikelets 2-5 mm long, 3-6-flowered, closely overlapping in two rows, pointing upwards at an acute angle with the rachis. Upper glume longer than the lower.
Occurrence: Very common in damp places.

Elytrophorus spicatus (Willd.) A. Camus (Figure 9.19)
(*Dactylis spicata* Willd.; *Elytrophorus articulatus* P.Beauv.)

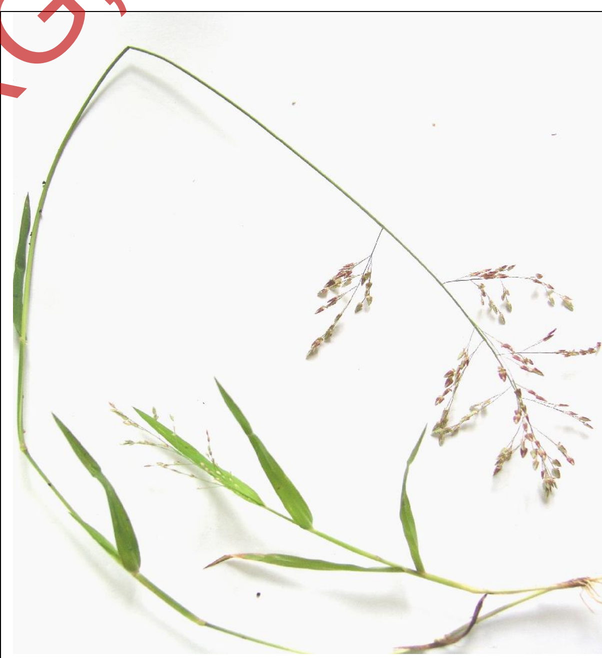
Annual herbs, 12-35 cm tall; Leaves 5-17 x 0.15-0.5 cm, linear, acute, smooth. Inflorescence 1.5-3.0 cm long, interrupted spikate. Spikelets 0.5 cm long, ovoid.

Occurrence: In paddy fields and other wet places.

Figure 9.19: *Elytrophorus spicatus.* A. Habit with inflorescence; B. Palea; C. Spike with awned glumes.

Eragrostis unioloides (Retz.) Nees ex Steud. (Figure 9.20)
(*Poa unioloides* Retz.; *Eragrostis amabilis* Stapf)

Tufted annual herbs to 25 cm high; culms erect or geniculately ascending. Leaves 3-7 x 0.2-0.4 cm, linear or linear-lanceolate; ligules absent or obscure. Panicles 4-8 cm long. Spikelets 0.2-0.7 cm long, straw colored, tinged with purple.



Occurrence: Common in wet places, dry or open

Figure 9.20: *Eragrostis unioloides*

Eulalia trispicata (Retz.) Nees ex Steud. (Figure 9.21)
(*Poa unioloides* Retz; *Eragrostis amabilis* Stapf)

Stout, tufted perennials, 60-150 cm tall, erect or geniculate. Leaves 10-25 cm long, linear, soft textured; sheaths bearded at sides; ligules short, membranous, fringed with long hairs. Racemes 6-12, 4-6 cm long. Spikelets 0.3-0.4 cm long, elliptic-oblong, densely clothed with white hairs. Upper lemma hardly wider than its awn, bifid into 2 subulate lobes; awn up to 20 mm long.	
Occurrence: In open grasslands, with some disturbances like repeated fire, digging etc., and in wastelands.	
Figure 9.21: Inflorescence tip of *Eulalia trispicata* grass	

Heteropogon contortus (L.) P. Beauv. Ex R. & S. (Figure 9.22)
(*Andropogon contortus* L.)

Densely tufted, perennials; culms 10-90 cm tall, creeping below. Leaves 5-14 x 0.2-0.3 cm, linear, acuminate, flat; sheaths compressed. Racemes 3-7.5 cm long. Spikelets closely overlapping. Sessile female spikelets 0.4-0.6 cm long, callus bearded with reddish brown hairs; upper lemma reduced to an awn up to 7.5 cm long or more, awns often twisted about each other. Pedicelled male spikelet *c* 0.8 cm long.	
Occurrence: Common on open hill slopes and in waste lands.	
Figure 9.22: *Heteropogon contortus*	

Hygroryza aristata (Retz.) Nees ex Wight & Arn (Figure 9.23)
(*Pharus aristatus* Retz.)

A floating aquatic grass. Floating culms up to 30 cm long; branches short, erect and leafy. Leaves 2-8 x 0.5-1.8 cm, ovate to ovate-oblong, obtuse, subcordate; sheaths glabrous, inflated, compressed, margin hairy. Panicle up to 5 cm long and broad; branches slender, smooth. Spikelets few, sessile or pedicelled. Lemma 6-8 mm long, narrowly lanceolate; awn up to 14 mm long.

Occurrence: Common in ponds and slow moving streams forming dense floating masses.

Figure 9.23: *Hygroryza aristata*-Habit

Isachne globosa (Thunb.) Kuntze (Figure 9.24)
Milium globosum Thunb

A slender grass to 45 cm high, erect or ascending from a creeping base; nodes glabrous. Leaves narrowly lanceolate, 2-10 x 0.4-0.8 cm acuminate, base rounded; ligule a fringe of long hairs. Panicle up to 12 cm long, lax. Spikelets 2-2.5 mm long, subglobose. Glumes subequal, equal to or slightly shorter than lemmas, broadly ovate or suborbicular. Lemmas unequal.

Occurrence: Very common in marshes; a weed in paddy fields.

Figure 9.24: Isachne globosa. A. Habit with inflorescence B. Leaf with ligule. C. Spikelet.

Isachne miliacea Roth
A slender grass to 30 cm high, ascending from a creeping and branched base; nodes glabrous or ciliate. Leaves 2.5-5 x 0.3-0.8 cm, ovate-lanceolate to lanceolate, base rounded; ligule a fringe of hairs. Panicle lax. Spikelets 1.4-1.8 mm long, globose. Glumes subequal, as long as or slightly shorter than lemmas, suborbicular. Lower lemma longer than the upper.
Occurrence: Common in marshes; a weed in paddy fields.

Ischaemum thomsonianum Stapf
Perennial herbs, to 1 m high. Leaves lanceolate, 7-15 x 0.9-1.3 cm, lower leaves sessile. Racemes to 5 cm long. Sessile in pairs, one stalked and other stalkless. Lower glume *c* 0.4 cm long, awned; upper glume oblong, keeled and rounded above, with tufts of hairs in middle. Pedicelled spikelets oblong-lanceolate, 5-6 mm long, awned.
Occurrence: Rare along bunds of paddy fields, wet waste lands and banks of rivers.

Ischaemum dalzellii Stapf ex Bor (Figure 9.25)

Annuals or perennials. Culms 3-60 cm or more long, creeping or trailing, rarely erect; nodes glabrous or sparsely bearded. Leaves lanceolate or linear lanceolate, 4-15 x 0.8-1.5 cm, long acuminate, deeply cordate or hastate at base, lower ones distinctly petiolate. Racemes 2, slender, 3-6 cm long; joints linear-clavate, 3-4 mm long, densely ciliate along margins. Sessile spikelets linear-oblong 5-6 x 1mm, densely villous in the upper half of the spikelet and glabrous on the lower; awned; callus densely bearded. Pedicelled spikelets oblong-lanceolate, *c* 6 mm long, awned or awnless.	
Occurrence: Along rocky hill slopes, shades and near wetlands.	
Figure 9.25: Inflorescence of *Ischaemum dalzellii*; note lower glabrous and upper hairy Spikelets	

Ischaemum indicum (Houtt.) Merrill (Figure 9.26)
Phleum indicum Houtt
Ischaemum ciliare Retz
I.aristatum auct. Non L.

A perennial grass. Culms up to 70 cm high, slender, erect or often creeping at base. Leaves up to 15 x 1.2 cm, linear-lanceolate, sparsely to densely hairy. Sheaths compressed. Racemes 2, rarely 3, up to 8 cm long. Sessile spikelets ovate-oblong, green, reddish or splashed with violet, up to 6 mm long; callus bearded. Lower glume papyraceous towards top, apex 2-toothed or cuspidate, margins inflexed, auricled at base, sides broadly winged at apex, wings often auriculate. Upper lemma bifid with a geniculate awn from sinus; awn up to 12 mm long. Pedicelled spikelets rather smaller than sessile. Upper lemma awned.	
Occurrence: Common grass found in more drier situation such as waste lands, roadsides, common lands, grasslands etc.	

Figure 9.26: ***Ischaemum indicum grass***

Ischaemum semisagittatum Roxb. (Figure 9.27, 9.28)
Ischaemum conjugatum Roxb.

An annual grass. Culms slender, often decumbent at base, than ascending up to 50 cm high or more. Leaves 2.2-9.5 x 0.5-2.0 cm, oblong-lanceolate, base deeply cordate to acutely sagittate. Lower leaves long petioled. Racemes 2, very rarely 1. Sessile spikelets 4-8 mm long. Lower glume ovate or oblong, lower half cartilaginous, with 3-6 marginal nodules, usually connected by irregular and shallow transverse ridges, the upper half with green veins with ciliolate margins, tip usually bifid. Upper lemma 2-fid with a geniculate awn from the sinus, sometimes awnless. Pedicelled spikelet shorter than sessile and almost awnless.

Figure 9.27: *Ischaemum semisagittatum*

Occurrence: Forest openings, edges and other shady places.

Figure 9.28: *Ischaemum semisagittatum*. A. Habit with inflorescence; B. Pedicelled and sessile spikelet; C. Lower glume of sessile spikelet.

Jansenella griffithiana (C.Muell.) Bor (Figure 9.29, 9.30)
Danthonia griffithiana C.
Arundinella avenacea Munro ex Thw.

Herbs, slender, erect, 15 cm high, rooting at lower nodes. Leaves 2.5-4.5 x 0.4-0.5 cm, ovate-lanceolate; ligules linear. Inflorescence a compact panicle of crowded spikelets. Spikelets subsessile, 4-6 mm long. Upper lemma with 4-5.5 mm long, oblong, with 2 lateral tufts of white hairs above the middle; median awn up to 9 mm long.

Figure 9.29: ***Jansenella griffithiana***

Occurrence: This grass is common in grassy hill slopes, marshy areas and along small irrigation canals.

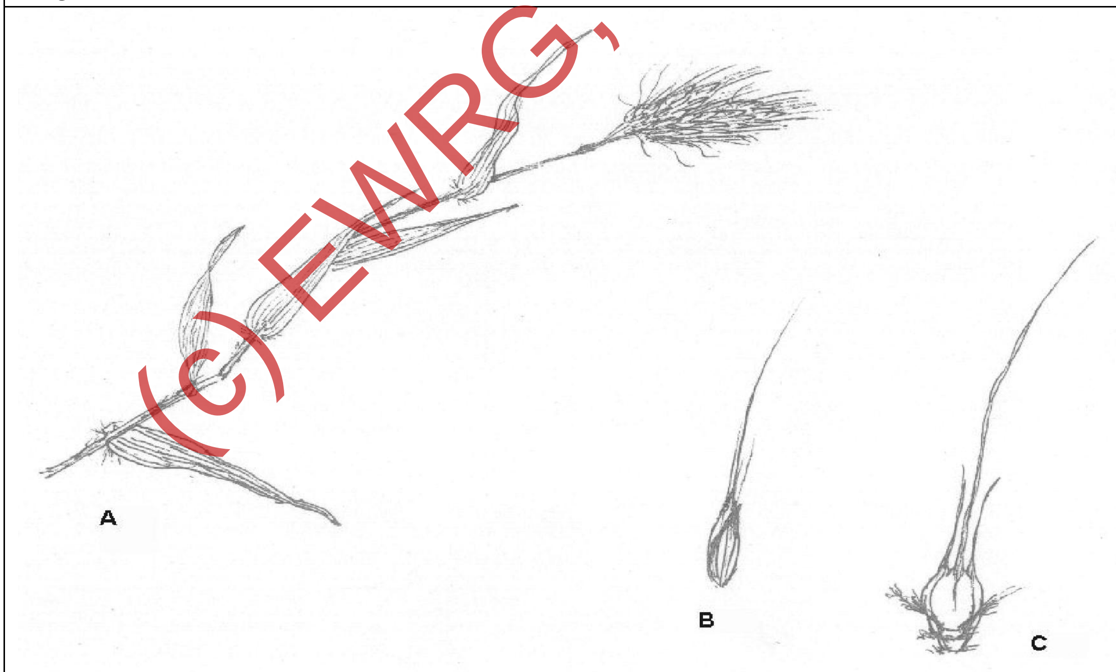
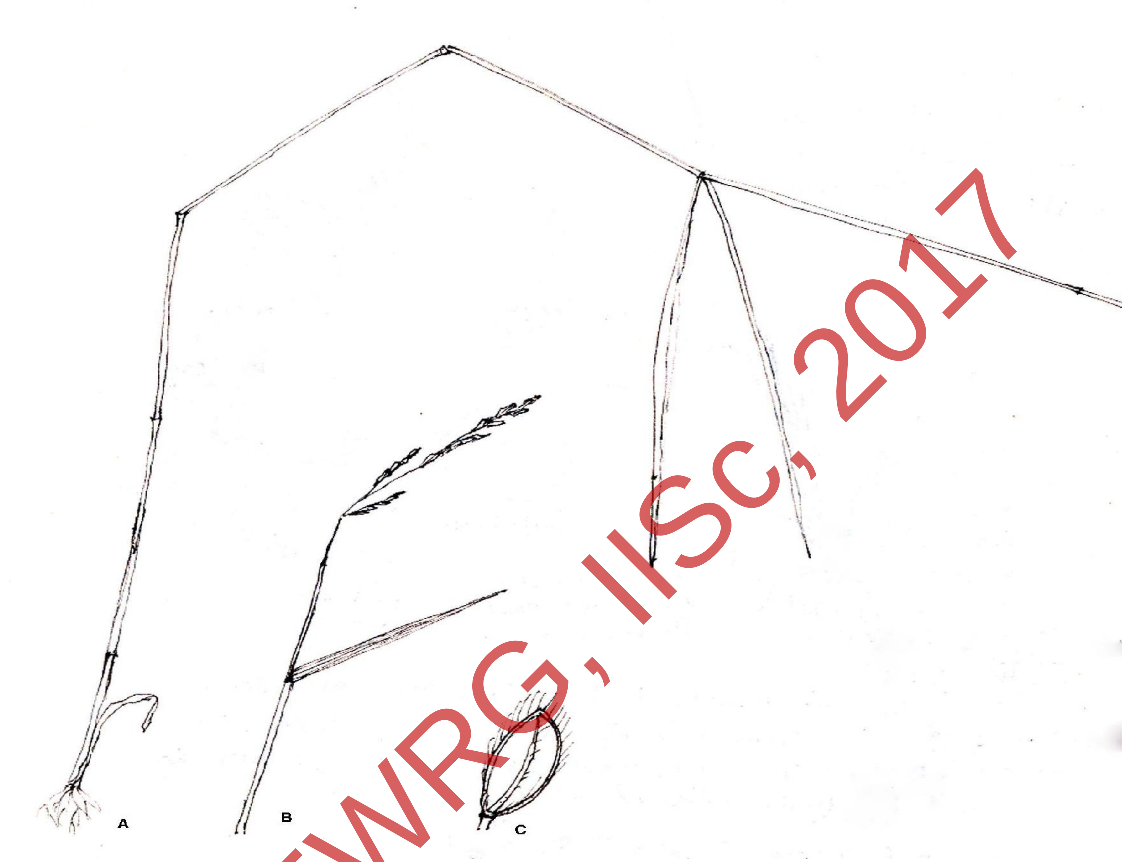


Figure 9.30: ***Jansenella griffithiana.*** **A. Habit with inflorescence; B. Spikelet; C. upper lemma**

Leersia hexandra Swartz. (Figure 9.31)
Homacenchrus hexandrus (Swartz) O.Kuntze

A slender, perennial grasses. Culms up to 1.2 m high, geniculate and ascending, rooting at lower nodes; nodes hairy with deflexed hairs. Leaves 7-20 x 0.2-1 cm, linear; ligule a short obliquely truncate or two lobed membrane. Panicle up to 13 cm long. Spikelets *ca*. 4 mm long. Lemma strongly keeled, keel ciliate.



Occurrence: Common in ponds, swamps and in paddy fields.

Figure 9.31: *Leersia hexandra*. A. Habit B. with inflorescence C. Spikelet

Lepturus radicans (Steud.) A. Camus (Figure 9.32)
Ophiurus radicans Steud.

A perennial, slender grass. Culms branched and widely creeping below; branches ascending; nodes glabrous. Leaves flat, linear-lanceolate, acuminate, glabrous, 12 x 0.4 cm. Spike 3-5 cm long, 1-flowered. Lower glume absent.

Grasses common as undergrowth in moist to dry deciduous forests.

Figure 9.32: *Leptuca radicans*

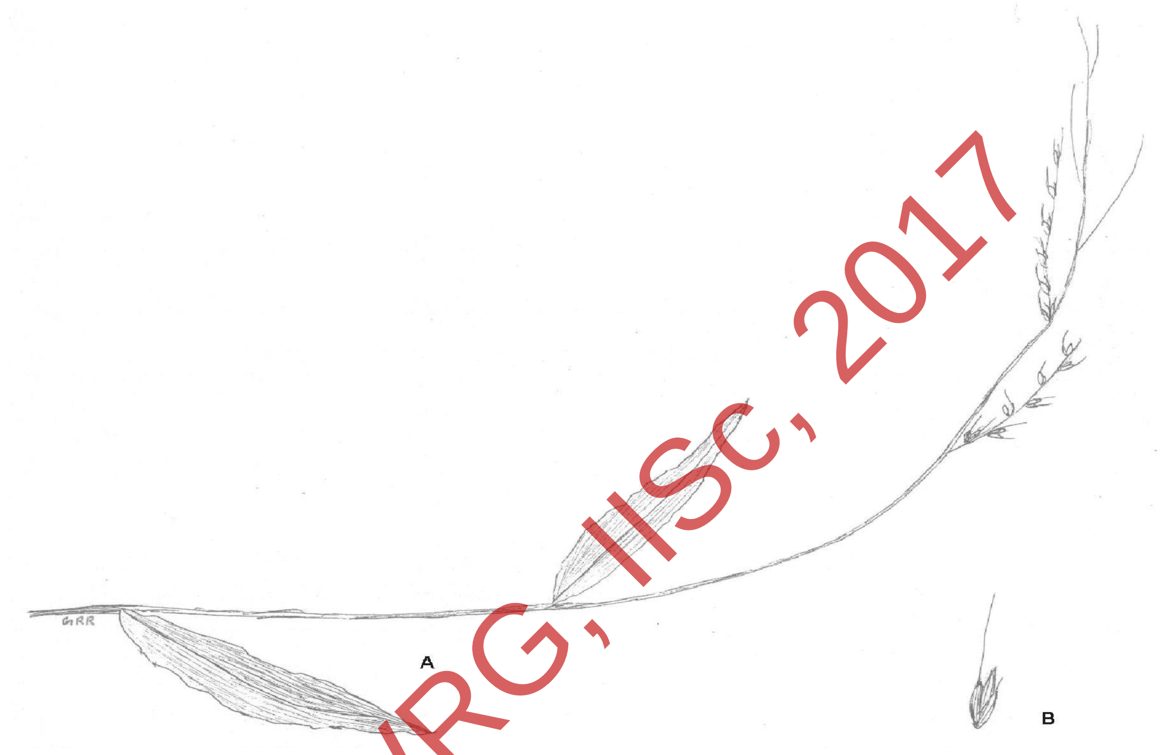
Oplismenus burmannii (Retz.) P.Beauv.
Panicum burmannii Retz.

A slender annual grass. Culms slender, creeping and rooting below. Panicle up to 10 cm long; peduncle very long, up to 1.8 cm long. Spikelets up to 2.5 mm long, second. Lower glume ovate, awned, barbellate. Upper glume awned. Lower lemma shortly awned, ciliate.

Occurrence: Common undergrowth in semievergreen to deciduous forests, and other open areas.

Oplismenus compositus (L.) P.Beauv. (Figure 9.33)
Panicum compositum L.

A perennial grass. Culms rather robust, creeping and rooting below; branches ascending. Leaves 2-16 x 0.5-2.5 cm, ovate to ovate-lanceolate, acuminate; sheaths with ciliate margins. Panicles up to 30 cm long, racemes distant, up to 7.5 cm long; rachis angular. Spikelets, lanceolate, awned; awn to 11 mm long, stout and viscid. Upper glume mucronate or shortly awned.



Occurrence: Common in open shady places.

Figure 9.33: *Oplismenus compositus.* A. Habit with inflorescence (partly shown); B. Spikelet

Oryza rufipogon Griff.

An aquatic grasses. Culms rooting in mud and the floating branches up to 80 cm long. Leaves up to 50 x 1.1 cm, linear-lanceolate, acuminate, striated; ligule long membranous, 2-partite. Panicle compound, up to 25 cm long. Spikelets *ca.* 9 mm long, oblong, long awned. Fertile lemma dorsally spinescently ciliate.

Occurrence: Seen in ponds, paddy fields and other small water bodies.

Panicum auritum Presl. (Figure 9.34)

A perennial, tall, erect grass. Culms up to 1.5 m high. Leaves linear-lanceolate, up to 35 x 3 cm, base broadly cordate; sheaths glabrous or sparsely hairy with bearded mouth. Panicle contracted or more or less open, up to 45 cm long. Spikelets 2-3 mm long, oblong or ovate-oblong, sessile or shortly pedicelled. Lower glume broadly ovate, one third to half the length of lower lemma, 3-nerved.

Occurrence: Found in marshy areas.

Figure 9.34: *Panicum auritum* Presl. A. Habit with inflorescence B. Spikelet

Panicum repens L. (Figure 9.35)

A perennial grass. Culms creeping and stoloniferous at base, up to 1.3 m high; nodes glabrous, lower nodes rooting. Leaves distichous, glacous, lanceolate, 5-25 x 0.2-0.8 cm, margin finely serrate, glabrous or hairy on upper surface, base rounded and ciliate; sheaths with ciliate margins; ligule a short thin membrane with a very short cilia on free margin. Panicle up to 20 cm long. Spikelets oblong-lanceolate, 2-5-3.3 mm long, glabrous; pedicels long with copular tips. Lower glume suborbicular, hyaline.

Occurrence: Common in sandy soils, field bunds and tank margins.

Figure 9.35: Inflorescence of *Panicum repens* grass

Paspalidium flavidum (Retz.)A. Camus
Panicum flavidum Retz.

Annual with tufted culms, rising from a reclining base, up to 1 m high. Leaves 2.5-20 x 0.2-1 cm, flat, linear-lanceolate, base rounded or slightly cordate with long white hairs on the small basal lobes; sheaths compressed, ligule a fringe of hairs. Racemes few to many, distant, one sided on the axis, shorter than internodes, up to 3 cm long. Spikelets 2.5-3.2 mm long, ovoid or subglobose, obtuse or acute, hardly compressed. Lower glume suborbicular, about half the length of the spikelet.

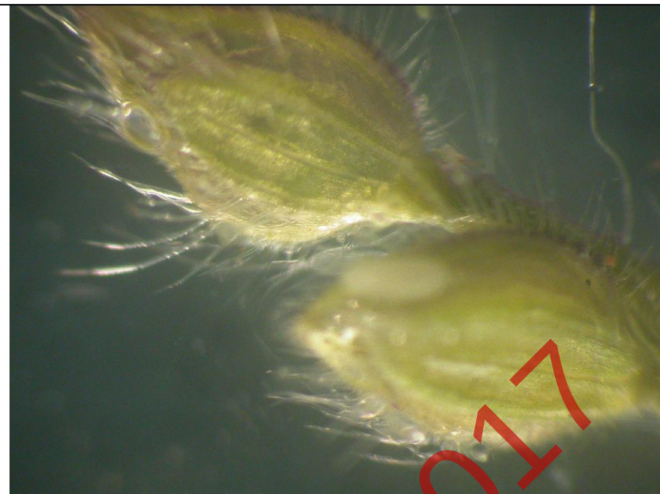
Occurrence: Common in wet situations.

Paspalum conjugatum Berg

A perennial grass. Culms up to 90 cm high, creeping and branching below. Leaves up to 20 x 1.5 cm, linear-lanceolate, acuminate; sheaths glabrous, margins ciliate. Racemes 2, up to 15 cm long, usually divergent; rachis flat. Spikelets in two rows, subsessile, imbricate, plano-convex, 1.4-2 mm long. Lower glume absent. Upper glume hyaline, fringed with fine white hairs from margins.

Occurrence: Grows in moist and shady situation.

Paspalum canarae (Steud.) Veldkamp (Figure 9.36)
Paspalum compactum Roth.

<table>
<tr><td>Annual slender grasses. Culms 5-30 cm tall. Decumbent and branched below. Leaves 1.5-7.5 x 0.5-1.6 cm, elliptic-lanceolate, acute, hairy on both sides; sheaths densely covered with bulbous based hairs. Racemes 6-many, alternate, spreading; rachis triquetrous, setose. Spikelets closely arranged up to 1.25 mm long, obtuse. Lower glume absent.</td><td></td></tr>
<tr><td colspan="2">Occurrence: In open grasslands and in wet situation.</td></tr>
<tr><td colspan="2">Figure 9.36: Paspalum canarae; setose spikelets.</td></tr>
</table>

Paspalum scrobiculatum L. (Figure 9.37)
P.orbiculare Forst.
P.commersonii Lamk.
P.cartilagineum J.S.Presl ex. C.B.Presl.

<table>
<tr><td>An annual or a perennial grass. Culms up to 90 cm high, tufted, erect or creeping and rooting below; nodes glabrous. Leaves 10-45 x 0.2-0.8 cm, linear-lanceolate, acuminate, margin serrulate, glabrous; leaf sheaths compressed, glabrous, keeled. Racemes 2-6, alternating, spreading, 2-15 cm long; rachis, broad, winged, with a median keel. Spikelets in 2-rows, orbicular or ovate-oblong, 1.8-2.8 mm long. Lower glume absent. Upper glume 5-nerved.</td><td></td></tr>
<tr><td colspan="2">Occurrence: Common in wet and waste places.</td></tr>
<tr><td colspan="2">Figure 9.37: Paspalum scrobiculatum</td></tr>
</table>

Pennisetum hohoenackeri Hochst. ex Steud (Figure 9.38)
P.alopecuros Nees ex Steud

Perennials. Culms 30-150 cm high, erect, densely tufted; nodes glabrous. Leaves narrowly linear, acuminate, 10-60 x 0.2-0.8 cm narrow or rounded at base, convolute, glaucous. Sheaths keeled, distichous. Panicles spiciform, 5-25 cm long, involucre enclosing one sessile spikelet, bristles glabrous or scaberulous, 3-20 cm long. Spikelet elliptic-lanceolate or lanceolate, 6-8 mm long. Lower glume ovate. Upper glume ovate-lanceolate, 5-7 nerved.

Occasional along the banks of streams and other water-courses, paddy field bunds and on river beds etc.

Figure 9.38: *Pennisetum hohoenackeri* grass

Pennisetum pedicellatum Trin. (Figure 9.39)

An annual grass. Culms up to 1 m high, branched from base. Leaves flat, up to 35 x 1.5 cm; sheaths glabrous. Panicle up to 20 cm long; involucres sessile; outer bristles few, inner bristles numerous, longest up to 16 mm long; densely villous below middle. Spikelet solitary and pedicelled, or in groups of 2-5, with one sessile and other pedicelled, or in groups of 2-5, with 1 sessile and other pedicelled, up to 4.25 mm long. Lower glume very small, wooly.

Occurrence: Seen in hill slope grasslands, roadsides etc.

Figure 9.39: Inflorescence of *Pennisetum pedicellatum* grass

Pseudanthistiria umbellata (Hack.) Hook (Figure 9.40)

Andropogon umbellatus Hack.

A very slender grass. Culms very weak, straggling, creeping and rooting at nodes. Leaves up to 6 x 0.75 cm, lanceolate, glabrous on both sides, rounded at base, primary and secondary nerves indistinguishable; sheaths shorter than blade. Panicle leafy, very lax, interrupted, 12-20 cm long; fascicles of spikelets few, axillary, 6-12 mm wide, raceme 3-6 in a fascicle; proper spathes 8-15 mm long, margins finely ciliate from minute tubercles. Sessile spikelets 3.5-4.5 mm long; lower glume 7-nerved. Awn up to 20 mm long. Pedicelled spikelets lanceolate, 4-6 mm long.

Occurrence: Common in shady places.

Figure 9.40: *Pseudanthistiria umbellata.* A. Habit with inflorescence (partly shown); B. Spikelet

Pseudanthistiria hispida Hook.

Annuals. Culms 30-100 cm high, tufted, nodes glabrous. Leaves lanceolate or linear-lanceolate 5-20 x 0.2-0.8 cm, acuminate, rounded at base. Panicles oblong, 2-3 mm long, awned. Lower glume oblong or elliptic-oblong, 2-3 mm long. Upper glume linear-oblong, upper lemma awn up to 3 cm long. Pedicelled spikelets lanceolate, sparsely setose at apex. 0-25 cm long,

Occurrence: Seen in hill slope grassland.

Pseudanthistiria heteroclita (Roxb.) Hook. (Figure 9.41)
Anthistiria heteroclita Roxb.

Annuals, culms up to 70 cm high, erect or geniculate at base. Leaves linear, 15-30 x 0.3-0.5 cm, more or less hairy from tubercles on both sides. Panicles 20-30 cm long, leafy, compound with many shortly peduncled fascicles; proper spathes 7-10 mm long, margin setose, usually from minute tubercles; racemes 6-8 mm long. Sessile spikelets 3-4 mm long, linear-oblong, hispid. Upper glume as long as the lower; upper lemma awn up to 20 mm long. Pedicelled spikelets 2.5-3 mm long.

Occurrence: Occasional in grassy hill slopes, open grasslands etc.

Figure 9.41: *Pseudanthistiria heteroclita.* A. Habit with inflorescence (partly shown); B. Raceme with lower pair of sessile and pedicelled spikelet, and upper group of 3 spikelets with 1 sessile awned and 2 pedicelled unawned spikelets

Sacciolepis indica (L.) A. Chase (Figure 9.42)
Panicum indicum Mill
Panicum indicum L.

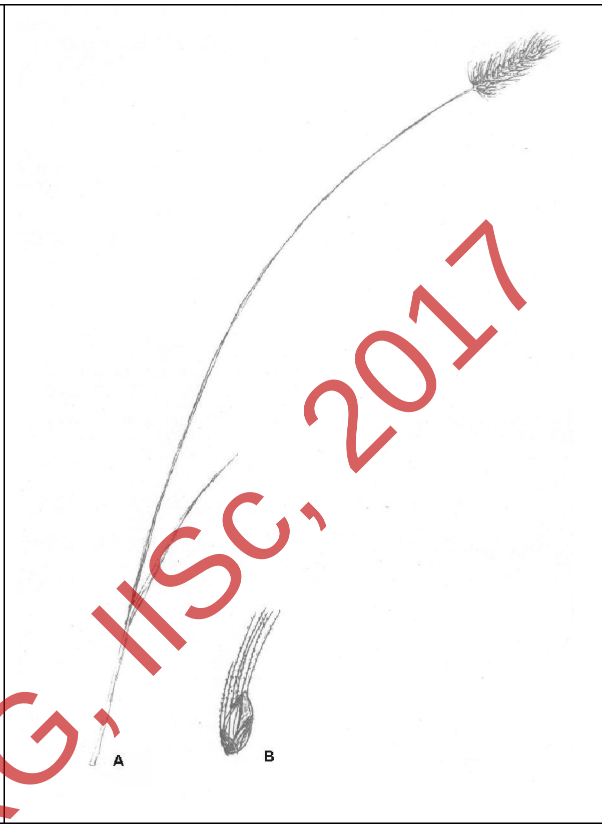
<table>
<tr><td>A slender grass. Culms erect, up to 60 cm high. Leaves 2.5-15 x 0.2-0.5 cm, linear. Panicle 1-14 cm long, continuous, cylindric, spiciform; branches very short. Spikelets ovate-lanceolate, acute, usually curved, 2.5-3.5 mm long. Lower glume half as long as spikelet. Upper glume 7-9 nerved.</td><td></td></tr>
<tr><td colspan="2">Occurrence: Very common in marshes and as a weed in paddy fields.</td></tr>
<tr><td colspan="2">Figure 9.42: Inflorescence of Sacciolepis indica grass</td></tr>
</table>

Sacciolepis interrupta (Willd.)Stapf. (Figure 9.43)
Panicum interruptum Willd.

<table>
<tr><td>A large, perennial aquatic grass. Culms up to 1.8 m high, stout and spongy below, ascending from a creeping and rooting or floating root stock. Leaves 15-35 x 0.5-1.3 cm, linear, acuminate, base rounded or subcordate. Panicle 10-30 cm long, cylindric, interrupted below. Spikelets 4-5 mm long, ovoid-lanceolate, subsessile or shortly pedicelled. Lower glume hyaline, less than half the length of spikelet, broadly ovate. Upper glume 9-nerve</td><td></td></tr>
<tr><td colspan="2">Occurrence: This grass is frequent in swampy situations.</td></tr>
<tr><td colspan="2">Figure 9.43: Habit of Sacciolepis interrupta grass</td></tr>
</table>

Setaria pumila (Poir.) Roem. & Schult (Figure 9.44)
Panicum pumilum Poir.
Setaria pallide-fusca (Schumach.) Stapf & C. E. Hubb.
Panicum pallide-fuscum Schumach.

An annual grass. Culms tufted, simple or branched, erect or ascending, up to 1 m high. Leaves 6-32 x 0.3-1 cm, linear-lanceolate, base rounded; ligule a ridge of hairs. Panicle cylindric, continuous, sometimes almost capitate with few spikelets, up to 16 cm long., Involucral bristles 6-12, usually yellow, rarely reddish-brown, up to 9 mm long, antorsely barbed. Spikelets *ca.* 2.25 mm long, ellipsoid. Lower glume less than half the length of the lower lemma, broadly ovate, hyaline. Upper lemma dorsally gently curved.



Occurrence: Seen in wetlands, bunds of paddy fields, roadsides, along the margin of forest, open grassland and waste places.

Figure 9.44: *Setaria pumilla.* A. Habit with inflorescence; B. Spikelet

Spodiopogon rhizophorus(Steud.) Pilger (Figure 9.45)
Andropogon rhizophorus Steud.
Spodiopogon albidus Benth.

Annuals or perennial straggling grass. Culms tufted, much branched, rooted at lower nodes, up to 1.25 m tall. Leaves flat, up to 25 x 3 cm, oblong-lanceolate, acuminate, base narrowed into a slender petiole up to 8 cm long; sheaths glabrous, ligule oblong. Panicle at first enclosed in a long spathaceous sheath; rachis and pedicels compressed, ciliate. Spikelets up to 10 mm long, lanceolate, densely covered with white hairs. Lower glume 7-9 mm long, ovate-lanceolate, minutely 2-mucronate or aristate, densely ciliate. Upper lemma 5-7 mm long, its palea broad, awn up to 2.5 cm long.

Occurrence: Occasional on old fort walls and on road cuts in Ghats.

Figure 9.45: *Spodiopogon rhizophorus.* A. Habit with inflorescence; B. Sessile and pedicelled Spikelet; C. Anther; D. Palea enclosing nut and anther; E. Palea opened; F. Upper lemma

Themeda tremula (Nees ex. Steud.) Hack. (Figure 9.46)
Anthistiria tremula Nees ex Steud.

A perennial grass. Culms erect or ascending from a creeping root stock, up to 1.25 m high, leafy, smooth, brown. Leaves up to 50 x 1.4 cm, finely acuminate, rigid, suberect, glabrous or nearly so, margins scabrid; sheaths compressed. Panicle 30-60 cm long, racemiform; fascicles of racemes rather subflabelliform, 1-3.5 cm wide, on flexuous capillary peduncles; outer spathes 1-3.5 cm long, more or less hairy with simple or tubercle based hairs; proper spathes 1-2 cm long, compressed, finely setose from large tubercles, margins scarious. Involucral pairs in superposed pairs, up to 8 mm long. Lower glume 6.5-8 mm long, linear-lanceolate. Pedicelled spikelets lanceolate, smaller than involucral spikelets and similar to them. Bisexual spikelets 2, sessile, bearded with reddish hairs. Upper lemma with awn up to 3 cm long.

Occurrence: In open grassland, hill slopes, road cuttings etc.

Figure 9.46: ***Themeda tremula*** Presl. **A. Habit with inflorescence**

Appendix III

Herb species (grass not included) in transect plots in Anshi and Dandeli wild life santuary

Sl	Family	Genus	Species	Habit	Geographical distribution
1	Fabaceae	Acacia	sinuata	Shrub	Oriental-Indomalaysia, China
2	Asteraceae	Ageratum	conyzoides	Herb	Pantropical
3	Amaranthaceae	Alternanthera	sessilis	Herb	Paleotropics
4	Fabaceae	Alysicarpus	bupleurifolius	Herb	Oriental-Indomalaysia, China, Polynesia, Pakistan
5	Euphorbiaceae	Aporosa	lindleyana	Tree	Oriental-Peninsular India, Sri Lanka
6	Scrophulariaceae	Bacopa	monnieri	Herb	Tropics
7	Elatinaceae	Bergia	ammanioides	Herb	Warmer and Tropical regions of Africa, Asia and Australia
8	Oxalidaceae	Biophytum	sensitivum	Herb	India, Sri Lanka, Tropical Asia, Africa, America
9	Acanthaceae	Blepharis	asperrima	Herb	Oriental-Western Ghats
10	Gentianaceae	Canscora	decussata	Herb	Tropical Africa, Madagascar, India
11	Lecythidaceae	Careya	arborea	Tree	Oriental-Himalayas to Sri Lanka
12	Caesalpinieae	Cassia	tora	Herb	Oriental-Asia
13	Apiaceae	Centella	asiatica	Herb	Tropics
14	Scrophulariaceae	Centranthera	indica	Herb	Oriental-Indomalaysia
15	Papilionaceae	Crotalaria	filipes	Herb	Oriental-Western Ghats
16	Liliaceae	Curculigo	orchioides	Herb	India, Java
17	Zingiberaceae	Curcuma	neilgherrensis	Herb	Oriental-Wester Ghats
18	Cyperaceae	Cyperus	rotundus	Herb	Almost cosmopilitan
19	Cyperaceae	Cyperus	pilosus	Herb	Old World tropics
20	Cyperaceae	Cyperus	tenuispica	Herb	Old World tropics
21	Faboideae	Desmodium	triflorum	Herb	Tropics
22	Cyperaceae	Diplacrum	caricinum	Herb	Tropical Asia and Australia
23	Droseraceae	Drosera	burmanii	Herb	West Africa to North east Africa
24	Cyperaceae	Eleocharis	dulcis	Herb	Old World tropics
25	Cyperaceae	Eleocharis	retroflexa	Herb	Tropics of old Worlds
26	Cyperaceae	Eleocharis	spiralis	Herb	Tropics of old Worlds
27	Asteraceae	Elephantopus	scaber	Herb	Pantropical
28	Asteraceae	Emilia	sonchifolia	Herb	Pantropical
29	Asteraceae	Epaltes	divaricata	Herb	W Peninsular India, China, Myanmar
30	Eriocaulaceae	Eriocaulon	xeranthemum	Herb	Oriental-India
31	Eriocaulaceae	Eriocaulon	truncatum	Herb	S and S E Asia
32	Eriocaulaceae	Eriocaulon	heterolepis	Herb	West India
33	Asteraceae	Eupatorium	odoratum	Shrub	Neotropical
34	Convolvulaceae	Evolvulus	nummularius	Herb	Neotropics
35	Cyperaceae	Fimbristylis	acuminata	Herb	Indomalaysia to Philippines
36	Cyperaceae	Fimbristylis	tetragona	Herb	Tropical Asia and

					Australia
37	Cyperaceae	Fimbristylis	dichotoma	Herb	Tropical and warm temperate regions
38	Faboideae	Flemingia	strobilifera	Shrub	Oriental-Indomalaysia
39	Papilionaceae	Geissaspis	cristata	Herb	South West India to Indo-China
40	Thymeliaceae	Gnidia	glauca	Shrub	Paleotropics, Oriental-India, Sri Lanka
41	Rubiaceae	Hedyotis	corymbosa	Herb	Oriental,Tropical Africa, America
42	Sterculiaceae	Helicteres	isora	Shrub	Paleotropics, India to Australia
43	Asclepiadaceae	Hemidesmus	indicus	Climber	Oriental-Peninsular India, Sri Lanka
44	Gentianaceae	Hoppea	fastigiata	Herb	Oriental-India, Sri Lanka, Myanmar
45	Balsaminaceae	Impatiens	lawii	Herb	Oriental-Western Ghats
46	Acanthaceae	Justica	simplex	Herb	India,Abyssinia,Malay Islands
47	Cyperaceae	Kyllinga	melanosperma	Herb	Old world tropics and subtropics
48	Anacardiaceae	Lannea	coromandelica	Tree	Oriental-South Asia, Indomalaysia
49	Leeaceae	Leea	indica	Shrub	Oriental to Australia
50	Acanthaceae	Lepidagathis	prostrata	Herb	Oriental-India
51	Lamiaceae	Leucas	lavandulifolia	Herb	India, Mauritius, Malay Islands
52	Scrophulariaceae	Limnophila	indica	Herb	Palaeotropics
53	Scrophulariaceae	Limnophila	repens	Herb	Tropical Asia
54	Scrophulariaceae	Lindernia	ciliata	Herb	Oriental-Indomalaysia
55	Scrophulariaceae	Lindernia	crustacea	Herb	Palaeotropics
56	Campanulaceae	Lobelia	alsinoides	Herb	Oriental-Indomalaysia
57	Onagraceae	Ludwigia	perennis	Herb	Oriental-Indomalaysia
58	Sterculiaceae	Melochia	corchorifolia	Shrub	Tropics
59	Convolvulaceae	Meremia	tridentata	Herb	Oriental-Indomalaysia, Tropical Africa
60	Scrophulariaceae	Microcarpae	minima	Herb	Tropical Asia and Australia
61	Fabaceae	Mimosa	pudica	Herb	Neotropics
62	Loganiaceae	Mitrasacme	pygmaea	Herb	India to Japan
63	Caesalpiniaceae	Moullava	spicata	Climber	Oriental-South India
64	Commelinaceae	Murdannia	spirata	Herb	Indomalesia
65	Melastomaceae	Osbeckia	truncata	Herb	Oriental-Western Ghats
66	Acanthaceae	Phaulopsis	imbricata	Herb	India, Africa, Sri Lanka, Madagascar
67	Euphorbiaceae	Phyllanthus	debilis	Herb	Western Peninsula, Tropical Africa
68	Portulacaceae	Portulaca	oleracea	Herb	Pantropics
69	Cyperaceae	Pycreus	sanguinolentus	Herb	Old world tropics and subtropics
70	Rubiaceae	Randia	dumetorum	Tree	Paleotropics
71	Cyperaceae	Rhynchospora	wightiana	Herb	Oriental-Indomalaysia
72	Lythraceae	Rotala	densiflora	Herb	Oriental-Indomalaysia
73	Lythraceae	Rotala	indica	Herb	India, Korea, Sri Lanka
74	Acanthaceae	Rungia	pectinata	Herb	India, Burma, Srilanka

75	Asteraceae	Senecio	belgaumensis	Herb	Oriental-Western Ghats
76	Malvaceae	Sida	rhombifolia	Herb	Oriental-Indomalaysia
77	Rubiaceae	Spermacoce	mauritiana	Herb	Indomalaysia, Tropical America and Africa
78	Rubiaceae	Spermacoce	articularis	Herb	Oriental-Indomalaysia
79	Scrophulariaceae	Striga	lutea	Herb	Palaeotropics
80	Euphorbiaceae	Trewia	nudiflora	Tree	Oriental-Indomalaysia, Myanmar, China
81	Tiliaceae	Triumpheta	rhomboidea	Herb	Tropical Africa, Asia
82	Fabaceae	Xylia	xylocarpa	Tree	Oriental-Indomalaysia
83	Xyridaceae	Xyris	pauciflora	Herb	Oriental-Indomalaysia
84	Rhamnaceae	Ziziphus	rugosa	Shrub	Oriental-India, Sri Lanka

Acuminate …	…	applied to the apex of a leaf having a gradually diminishing point.
Acute …	…	applied to the apex of a leaf distinctly and sharply pointed but not drawn out.
Adventitious roots		roots which do not arise from the radicle or its subdivision, but from parts other than these.
Amplexicaul	…	applied to the base of the leaf when it embraces the stem.
Apiculate …	…	said of the apex when it has a sharp, short point.
Appressed …	…	lying flat for the whole length of the part or organ.
Articulate …	…	jointed.
Auricle …	…	outgrowth at the sides close to the region.
Awned …	…	having an own, that is, a bristle-like appendage, especially on the glumes of grasses .
Bifarious…	…	disposed in two rows or ranks on the sides.
Binate …	…	in pairs.
Blade …	…	the expanded portion of a leaf.
Bristles …	…	stiff hairs.
Bulbous based	…	having an inflated base.
Callus …	…	the projecting part or an extention of the flowering glume below its point of insertion.
Caryopsis	…	a one-celled, one- seeded superior fruit in which the pericarp has fused with hairs.
Chartaceous	…	papery, i e., thin and somewhat rough.
Ciliate …	…	fringed with hairs.
Ciliolate …	…	very sparsely fringed with hairs.
Clavate …	…	club-shaped.
Clavellate	…	thickened towards the apex.
Collar …	…	the white or colorless band at the base of the blade of a grass leaf just where it joins the sheath.
Conduplicate	…	folded together lengthwise.
Convolute	…	rolled round from the margin to the other ,so that one margin

is inside , and the other outside.

Coriaceous	…	leathery.
Corymbosely	…	arranged in corymbs, i.e., flat- topped flower clusters.
Crisped …	…	Curled.
Cuneate …	…	wedge-shaped or triangular.
Cuspidate	…	tipped with a small triangular piece at the apex.
Decumbent	…	reclining but with the upper part ascending.
Digitate …	…	fingered, arranged at the end of the stalk.
Dioecious	…	having the sexes separated on two distinct individuals.
Distichous	…	two ranked or two-rowed.
Endodermis	…	the innermost layer of the cortex abutting on and forming a sheathing layer round the stele.
Extra vaginal	…	applied to shoots branches that come out piercing the leaf sheath in grasses.
Fascicle …	…	a cluster or bundle.
Filiform …	…	thread shaped, slender and thin.
Flexuous…	…	bent alternately in opposite directions.
Foveolate	…	marked with small pits.
Geniculately	…	bent abruptly so as to resemble a knee-joint.
Geminate …	…	in pairs.
Gibbous …	…	convex or rounded.
Glabrescent	…	slightly hairy but becoming glabrous.
Glabrous	…	quite smooth without hairs.
Glaucous	…	covered with a bloom.
Glume	…	the chaffy two-ranked members found in the inflorescence of grasses.
Hispid…	…	Rough hairs.
Hirsute …	…	covered with fairly long distinct hairs.
Hyaline …	…	colorless or translucent.
Imbricate	…	overlapping.
Internode	…	portion of a stem between two nodes.
Intravaginal	…	growing out from inside the sheath.
Involucel	…	a ring of bracts surrounding several spikelets.
Keeled …	…	having a ridge along the length.

Lemma … … the flowering glume of a grass.

Ligule … … the thin scarious projection found at the leaf sheath. Where it joins the blade in grasses.

Lodicule … … a small scale outside the stamens in the flower of grasses.

Membranous … thin and semi-transparent.

Mucronate … possessing a short and a straight point.

Node … … the part of the stem which has a leaf, or the knot in the grass stem.

Palea … … the inner glume in the spikelet of grasses.

Pectinate … … pinnatifid with narrow segments which are close like the teeth of a comb.

Pistil … … the female organ of a flower, consisting of the ovary, style and Stigma.

Plumose … … feathered.

Prophyllum … the first scale-like leaf of a branch found where it joins the main stem.

Puberulous … slightly hairy.

Pubescent … … clothed with soft hair.

Punctuate … … marked with dots pits or glands.

Pungent … … ending in a rigid and sharp point.

Raceme … … a centrifugal or indeterminate inflorescence with stalked flowers.

Rachilla … … a secondary axis in the inflorescence of the grasses, the axis of the spikelet.

Rachis … … axis of an inflorescence.

Retuse … … with a shallow notch at the apex.

Rhizome … … root-stock or under ground stem prostrate on the ground.

Rugulose … somewhat wrinkled.

Scaberulous … slightly rough due to the presence of short hairs.

Scabrid … … somewhat rough.

Scale … … a reduced leaf.

Secund … … directed to one side only.

Serrate … … beset with small teeth on the margin.

Setose … … beset with bristles.

Spathaceous… … having a large bract enclosing a flower cluster.

Spiciform … … Spike-like.

Spike … … an inflorescence with sessile flowers on an elongated axis, the older flower being lower down and the younger towards the top.

Squarrose … … rough with outstanding processes.

Stipe … … a short stalk of gynaecium

Stipitate … … having a short stalk.

Stolon … … any basal branch which is disposed to root.

Sub-coriaceous … some what leathery.

Subulate … … finely pointed.

Truncated … … as if cut off at the end

Turbinate… … cone shaped or top shaped.

Villous… … with long hairs

References

1. Achariyar, Ranga K Bahdur Rai. 1921. A Handbook of some south Indian Grasses. Bishen Singh Mahendra Pal Singh. Dehra Dun. India.
2. Bhat, K. G and C.R. Nagendran. (2001). Sedges and grasses of Dakshina Kannada and Udupi districts. Bishen Singh Mahendra Pal Singh, Dehra Dun.
3. Bhat, K. G. (2003). Flora of Udupi. Indian Naturalist, Udupi.
4. Cook, C.D.K. (1996). Aquatic and wetland plants of India. Oxford University Press. New York.
5. Cooke, T. 1903: The Flora of the Presidency of Bombay Vol. 1; Tailor and Francis, London. (Bishen Singh Mahendra Pal Singh, Dehradun.
6. Gamble, J. S. 1915-1936. Flora of the Presidency of Madras, Adlard and Son, London.
7. http://www.berkeley.edu/exhibits/biomes/grasslands.php#savan
8. http://www.pages-igbp.org
9. http://www.hamiltonnature.org/habitats/grasslands
10. http://www.ucmp.berkely.edu/exhibits/biomes/grasslands
11. http://www.blueplanetbiomes.org/grasslands
12. Sreekumar, P. V., & V. J. Nair. 1991. FLORA OF KERALA – GRASSES. Botanical Survey Of India, Calcutta.
13. Gustavsson, Eva, Tommy Lennartsson, Marie Emanuelsson. 2007. *BIOLOGICAL CONSERVATION* 138 (2007) 47 –59

14. Misra, K. C. 1980. MANUAL OF PLANT ECOLOGY (second edition). Oxford and IBH Publishing co. New Delhi.
15. Nayar, T. S., A. Rasiya Beegam, N. Mohanan, G. Rajkumar. 2006. Flowering plants of KERALA-A handbook. TBGRI, Thiruvanathapuram. Kerala.
16. Saldanha, C. J. 1984: Flora of Karnataka (2 volumes). Oxford & IBH Publishing Co. New Delhi.
17. Mukherjee Biswarup. 1996. ENVIRONMENTAL BIOLOGY. Tata McGraw-Hill Publishing Company Limited. New Delhi.
18. *Gelbard L..Jonathan*. 2003. Grasslands at a Crossroads: Protecting and Enhancing Resilience to Climate Change. *In* L. S. Hansen, J.L.Biringer, and J.R. Hoffman. (Eds.). BUYING TIME: A user's Manual for Building Resistance and Resilience to Climatic Change in Natural Systems. WWF.
19. Misra M. K., and B. N. Misra. 1981. Species diversity and dominance in a tropical grassland community. *Folia Geobotanica*. Volume 16, Number 3 / September, 1981. Springer Netherlands.
20. Rawat, G.S., Goyal S.P. (1989) & Johnsingh, A.J.T. (1997). Ecological Observations on the Grasslands of Corbett Tiger Reserve, India. *Indian Forester*, 958-963.
21. Kotwal P.C and R.K. Pandey (1981) Dynamics of Grass Production and Consumption by wild Herbivores in Kanha National Park, (M.P) *Paper presented in Silver jubilee Symposium*, international Society for Tropical Ecology, Bhopal.
22. Lehmkuhl . J.F. (1989) .The ecology of South Asian tall –grass community (*unpub.Ph.D. Thesis*) university of Washington .195p.p.
23. Rodgers W.A (1990) Grasslands production and Natural Implications for wild grazing Herbivores in Rajaji National Park India. *Tropical Ecology* .**31**(2): 41-49.
24. Rawat, G.S., Goyal, S.P. and Johnsingh, A.J.T. 1997. Ecological observations on the grasslands of Corbett Tiger Reserve, India. *Indian Forester*. Vol.123(10): 958-963.
25. Rahmani A.R.(1992) threatened fauna of Indian Grasslands K.P.Singh and J.S. Singh (eds) *Tropical Ecosystems :Ecology and Management* . Wiley Eastern Limited, New Delhi. pp Rodgers 143-151.
26. Panwar H.C (1986) A study of management requirements in Corbett National Park, *Proc. 25th working Session IUCN's Commission on National Parks and Protected Areas*. Corbett National Park, India, 4-8 Feb, pp. 169-176
27. Rodgers W.A. and V.B.Sawarkar (1988) Vegetation Management in wildlife Protected Area in India Aspects of Applied Biology **16**: 407-422.
28. Wagner, F.H. 1989. Grazers, past and present. Pages 151-162 *In* L.F. Huenneke and H. Mooney (Eds.). Grassland structure and function: California annual grassland. Kluwer Academic Publishers, Dordrect, The Netherlands.
29. Sala, O. E., F. S. Chapin III, J. J. Armesto, E. Berlow, J. Bloomfield, R. Dirzo, E. Huber-Sanwald, L. F. Huenneke, R. B. Jackson, A. Kinzig, R. Leemans, D. M. Lodge, H. A. Mooney, M. Oesterheld, N. LeRoy Poff,

30. M. T. Sykes, B. H. Walker, M. Walker, and D. H. Wall. 2000. Global biodiversity scenarios for the year 2100. Science **287**:1770-1774.

31. Lele, Sharachchandra., and Gurupada, T. Hegde. 1997. Potential herb layer production and grazing effects in anthopogenic savanna-grasslands in the moist tropical forests of the Western Ghats of India. *Tropical grasslands*. Vol.31, 574-587.

32. Bhat, D. M., K. S. Murali., and Ravindranath, N. H . 2005. Herb layer productuctivity under different light gaps in the forests of Western Ghats of Karnataka, India. *Int.J.Agricultural Resources,* Governance and Ecology, Vol. 4. No.1. pp. 93-100(8).

33. Schlesinger, W. H. 1997. Biogeochemistry: an analysis of global change. Academic Press, San Diego. 588 pp.

34. Lejune, K. D., and T. R. Seastedt. 2001. *Centaurea* species: the forb that won the west. Conservation Biology **15**:1568-1574.

35. Mooney, H. A. and R. J. Hobbs. 2000. Invasive species in a changing world. Island Press, Washington D. C. 457 pp.

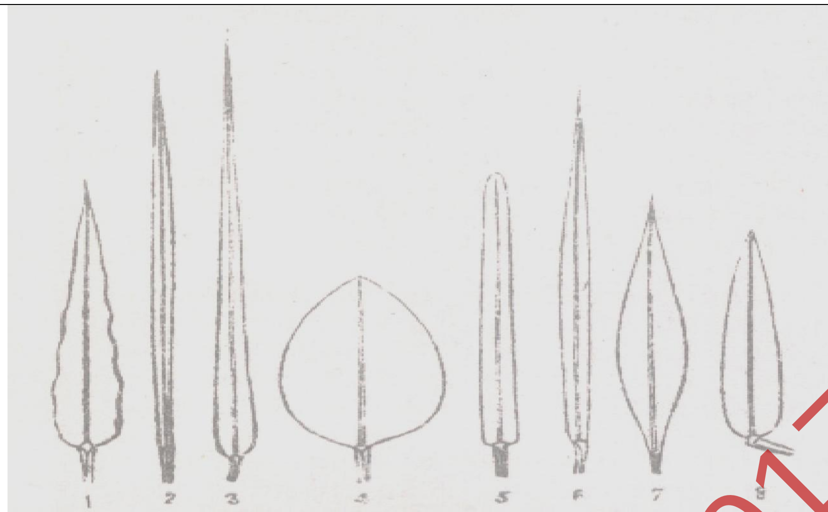
36. Sarmiento, G. (1984) The Ecology of Neotropical Savannas. Harward University Press, Cambridge, MA.

37. Dandeli-Anshi Tiger Reserve Core/Critical Tiger Habitat. Proposal on Delineation/Identification of Core/Critical Tiger Habitat. Wild life division. Karnataka forest department. Dandeli. Karnataka.

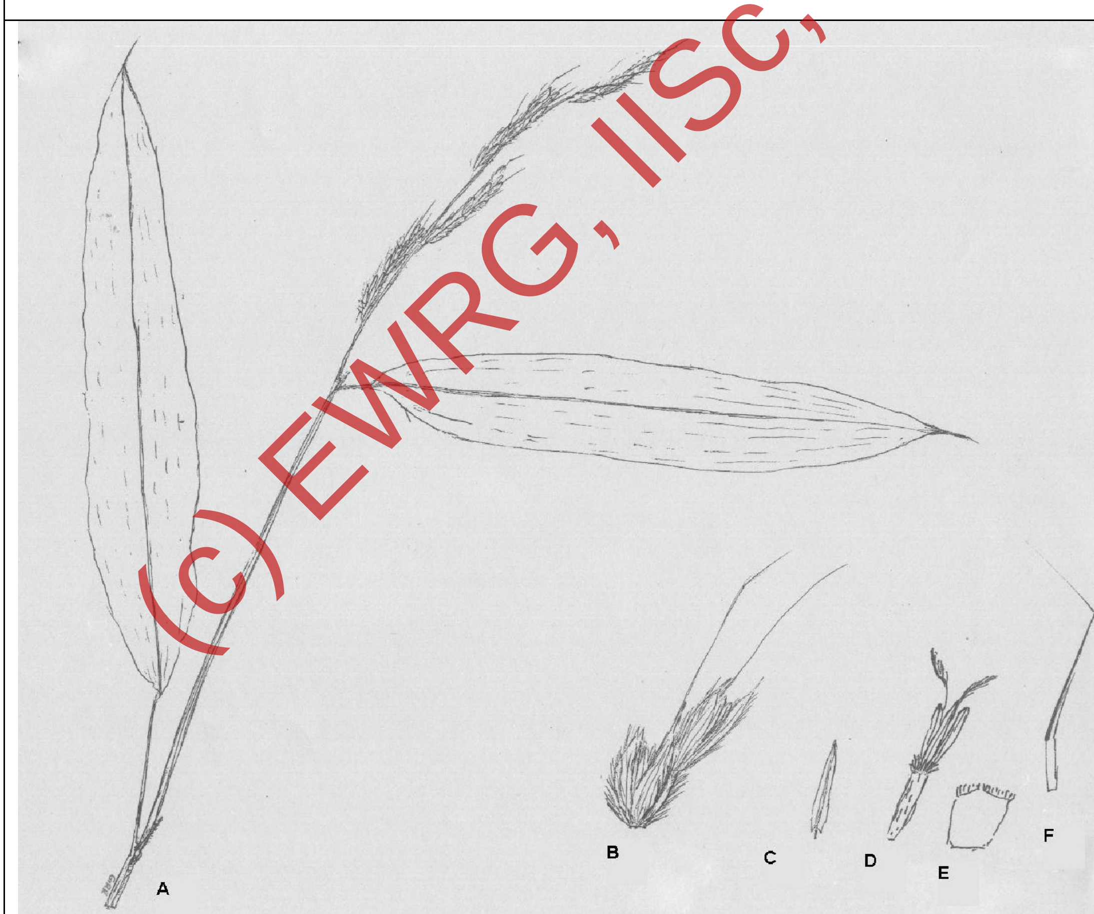
38. Wikramanayake, Eric., Meghan McKnight, Eric Dinerstein, Anup Joshi, Bhim Gurung, and David Smith. 2004. Designing a Conservation Landscape for Tigers in Human-Dominated Environments. *Conservation Biology*, Vol.18. No.3. PP-839-844.

39. Whyte, R.O., 1955, Grasslands in soil conservation, *Journ. Soil and Water Cons. India* 3 : pp. 70-71; !957, The grassland and fodder resources of India, ICAR. Monogr. No. 22; 1968, Grasslands of the monsoons, Faber and Faber, London.

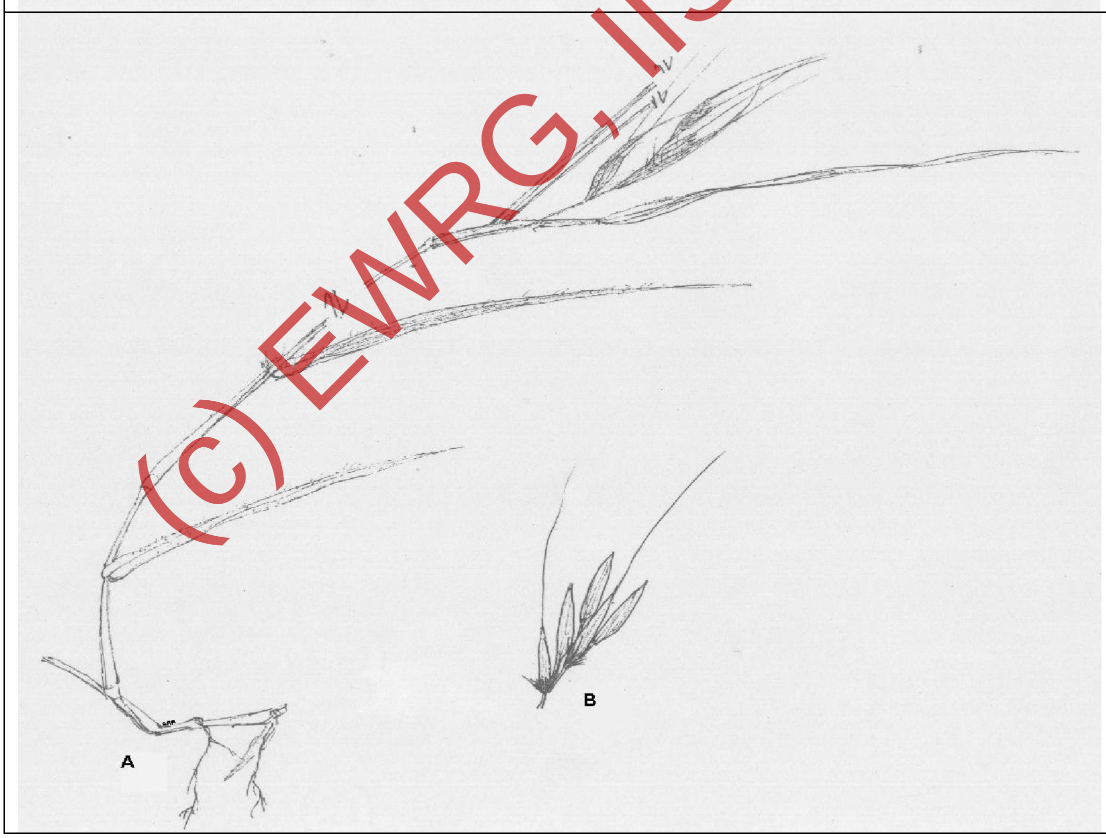
40. Chandran MDS (1997) Shifting cultivation, Sacred groves and conflicts in colonial forest policy in the Western Ghats. In *Nature and the Orient: The environmental History of South and Southeast Asia.* (eds. Grove, R. H., Damodaran, V. and Sangwan, S.). Oxford University Press, New Delhi, PP.674-707.



Shapes of leaf-blades.
1, 7 and 8. Lanceolate ; 3 and 6. lanceolate-linear ; 2 and 5. linear ; and 4. ovate.




A
B


A
B

ENERGY AND WETLANDS RESEARCH GROUP
CENTRE FOR ECOLOGICAL SCIENCES
INDIAN INSTITUTE OF SCIENCE
BANGALORE 560 012

Telephone : 91-80-23600985/22932506/22933099
Fax : 91-80-23601428/23600085/23600683[CES-TVR]
Email : cestvr@ces.iisc.ernet.in,
energy@ces.iisc.ernet.in
Web: http://ces.iisc.ernet.in/energy
http://ces.iisc.ernet.in/biodiversity
Open Source GIS: http://ces.iisc.ernet.in/grass

Taylor & Francis
Taylor & Francis Group

J Biodiversity, 8(1): 12-33 (2017)
DOI: 10.1080/09766901.2017.1346160

Appraisal of Forest Ecosystems Goods and Services: Challenges and Opportunities for Conservation

T. V. Ramachandra[1,2,3], Divya Soman, Ashwath D. Naik[1] and M. D. Subash Chandran[1]

[1]Energy & Wetlands Research Group, Centre for Ecological Sciences (CES)
[2]Centre for Sustainable Technologies (ASTRA)
[3]Centre for infrastructure, Sustainable Transportation and Urban Planning (CiSTUP)
Indian Institute of Science, Bangalore 560 012, Karnataka, India
Telephone: 91-80-23600985, 22932506, 22933099, Fax: 91-80-23601428, 23600085, 23600683[CES-TVR], E-mail: <cestvr@ces.iisc.ernet.in>,<energy@ces.iisc.ernet.in>

KEYWORDS Economic Valuation. Provisioning Services. Regulating Services. Tropical Forests

ABSTRACT Valuation of ecosystem goods and services is essential to formulate sustainable development policies oriented towards the protection or restoration of ecosystems. The present study estimates the value of forest ecosystem of Uttara Kannada district by market price method. The total value of provisioning goods and services from the forests of Uttara Kannada district was estimated at Rs. 15,171 crores per year, which amounts to about Rs. 2 lakh per hectare per year. The study highlights the undervaluation of forest goods and services that is evident when the estimated total economic value of forest and the value of forest resources calculated in national income accounting framework are compared. The quantification of all benefits associated with the forest ecosystem goods and services would help in arriving at an appropriate policy and managerial decisions to ensure conservation while opting sustainable development path.

INTRODUCTION

An ecosystem is a complex of interconnected living organisms inhabiting a particular area or unit space, together with their environment and all their interrelationships and relationships with the environment having well-maintained ecological processes and interactions (Ramachandra et al. 2007, 2015). Ecosystem functions include the exchange of energy between the plants and animals that are needed for the sustenance of life. These functions include nutrient cycling, oxygen regulation, water supply etc. The flow of goods or services which occur naturally by ecological interactions between biotic and abiotic components in an ecosystem is often referred as ecosystem goods and services. These goods and services not only provide tangible and intangible benefits to human community, but also are critical to the functioning of ecosystem. Thus, ecosystem goods and services are the process through which natural ecosystems and the species that make up sustain and fulfill the human needs (Newcome et al. 2005). Ecosystems are thus natural capital assets supporting and supplying services highly valuable to human livelihoods and providing various goods and services (MEA 2003; Daily and Matson 2008; Gunderson et al. 2016). The tropical forests are the rich source of biodiversity and are probably thought of containing more than half of world's biodiversity. Biodiversity is important to human kind in fulfilling its needs by way of providing food (80,000 species), medicine (20,000 species), drug formulations (8,000 species) and raw materials (90% from forests) for industries (Ramachandra et al. 2016a, b; Ramachandra and Nagarathna 2001: Ramachandra and Ganapathy 2007). Among the terrestrial biomes, forests occupy about 31 percent (4,033 million hectare) of the world's total land area and of which 93 percent of the world's forest cover is natural forest and 7 percent is planted (FAO 2010; TEEB 2010; Villegas-Palacio et al. 2016). Forest ecosystems account for over two-thirds of net primary production on land – the conversion of solar energy into biomass through photosynthesis, making them a key component of the global carbon cycle and climate (MEA 2003). The forests of the world harbor very large and complex biological species diversity, which is an indicator for biological diversity and the species richness increases as we move from the poles to the equatorial region. Forest ecosystem services can provide both direct and indirect economic benefits. India's forest has been classified into four major groups, namely, tropical, sub-tropical, temperate, and alpine (Champion and Seth 1968). Tropical forest in particular contributes more than the other terrestrial biomes to climate relevant cycles and biodiversity related processes. These forests constitute the earth's major genetic reservoir and global water cycles (Anderson and Bojo 1992; Gunderson et al. 2016).

The ecosystem provides various fundamental benefits for our survival such as food; soil production, erosion and control; climate regulation; water purification; bioenergy, etc. These benefits and services are very crucial for the survival of humans and other organisms on the earth (MEA 2003; de Groot et al. 2002; Villegas-Palacio et al. 2016). It includes provisioning services such as food and water, regulating services such as flood and disease control, cultural services such as spiritual, recreational and cultural benefits, and supporting services such as nutrient cycling that maintains the conditions for life on earth. Sustainable ecosystem service delivery depends on the health, integrity and resilience of the ecosystem. Policy-makers, interest groups and the public require reliable information on the environmental, social and economic value of regulating services to make informed decisions on optimum use and on the conservation of ecosystems (Kumar et al. 2010). The prime reason for ecosystem mismanagement is the failure to realise the value of ecosystem. Valuation of ecosystem is essential to respite human activities apart from accounting their services in the regional planning (Ramachandra et al. 2011). The range of benefits derived from ecosystem can be direct or indirect, tangible or intangible, can be provided locally or at global scale – all of which makes measurement particularly hard (TEEB 2010). Economic valuation of natural resources aids the social planners to design and better manage the ecosystems and related human wellbeing. Figure 1 shows the interrelationship of ecosystem, ecosystem functions, economic values and its impact on ecosystem through incentive/disincentive.

Valuation of ecosystems enhances the ability of decision-makers to evaluate trade-offs between alternative ecosystem management regimes and courses of social action that alter the use of ecosystems and the multiple services they provide (MEA 2003; Villegas-Palacio et al. 2016). Valuation reveal the relative importance of different ecosystem services, especially those not traded in conventional markets (TEEB 2010).The ecosystem goods and services are grouped into four categories as provisioning, regulating, supporting and information services (MEA 2003; de Groot et al. 2002), based on the Total Economic Value (TEV) framework with significant emphasis on intrinsic aspects of ecosystem value, particularly in relation to socio-cultural values (MEA 2003). TEEB (2010) excludes the supporting services (such as nutrient cycling and food-chain dynamic) and incorporates habitat service as a separate category.

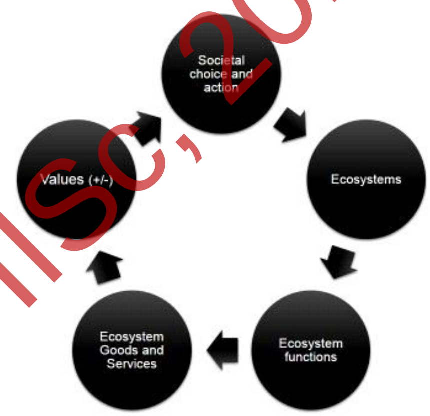


Fig. 1. Ecosystems health and economic values
Source: Author

Integrated framework for assessing the ecosystem goods and services (TEEB 2010; de Groot et al. 2002; Villegas-Palacio et al. 2016) involves the translation of complex structures and processes into a limited number of ecosystem functions namely production, regulation, habitat and information. These goods and services are valued by humans and grouped as ecological, socio-cultural and economic values. All values are estimated using the common metric, which helps in aggregating values of different goods and services (DEFRA 2007). When the market does not capture the value of environmental goods or services, techniques associated with 'shadow pricing' or 'proxy price' are used to indirectly estimate its value. Estimation of the economic values for 17 different ecosystem services (Costanza et al.1997; Villegas-Palacio et al. 2016) highlight that the annual value of the ecosystem services of the terrestrial and aquatic biomes of the world to be 1.8 times higher than the global gross national product (GNP). About 63 percent of the estimated values of ecosystem services were found to be contributed by the marine ecosystems while, about 38 percent of the estimated values were found to be contributed by the terrestrial ecosystems, mainly from the forests and wetlands.

Forests, particularly tropical forests, contribute more than other terrestrial biomes to climate relevant cycles and processes and also to biodiversity related processes (Nasi et al. 2002). Forest ecosystem services with great economic value (Ramachandra et al. 2011, 2016b; Costanza et al. 1997; Pearce et al. 2002), are known to be critically important habitats in terms of the biological diversity and ecological functions. These ecosystems serve as a central component of Earth's biogeochemical systems and are a source of ecosystem services essential for human well-being (Gonzalez et al. 2005; Villegas-Palacio et al. 2016). These ecosystem provides a large number of valuable products such as timber, firewood, non-timber forest product, biodiversity, genetic resources, medicinal plants, etc. The forest trees are felled on a large scale for using their wood as timber and firewood. According to FAO (2010) wood removals valued just over US$100 billion annually in the period 2003–2007, mainly accounted by industrial round wood. Further, 11 percent of world energy consumption comes from biomass, mainly fuel wood (CBD 2001). 19 percent of China's primary energy consumption comes from biomass and 42 percent in India. Non-commercial sources of energy (such as fire wood, agricultural and horticultural residues, and animal residues) contribute about 54 percent of the total energy in Karnataka (Ramachandra et al. 2000).

Timber and carbon wealth assessment in the forests of India (Atkinson and Gundimeda 2006) show the opening stock of forest resources as 4,740,858,000 cubic meters and about 639,600 sq. km of forest area. Biomass density/ha in Indian forests is about 92 t/ha and carbon values of Indian forests is 2933.8 million tones assessed considering a carbon content of 0.5 Mg C per Mg oven dry biomass (Haripriya 2002). The closing stock of the timber is 4704 million cum and the estimate of value is Rs. 9454 billion, the stock of the carbon is 2872 million tons with a value estimate of Rs.1811 billion. Apart from serving as a storehouse of wood which is used for various purposes, there are also equally important non-wood products that are obtained from the forests. The botanical and other natural products, other than timber extracted from the forest system are referred to as non-timber forest products (NTFPs). These resources/products have been extracted from the forest ecosystems and are being utilized within the household or marketed or have social, cultural or religious significance (Falconer and Koppell 1990; Schaafsma et al. 2014; Pittini 2011). NTFP is a significant component due to its important bearing on rural livelihoods and subsistence. NTFPs are also referred 'minor forest produce' as most of NTFP are consumed by local populations, and are not marketed (Arnold and Pérez 2001). These include plants and plant materials used for food, fuel and fodder, medicine, cottage and wrapping materials, biochemical, animals, birds, reptiles and fishes, for food and feather. Unlike timber-based products, these products come from variety of sources like: fruits and vegetables to eat, leaves and twigs for decoration, flowers for various purposes, herbal medicines from different plant parts, wood carvings and decorations, etc. The values of NTFPs are of critical importance as a source of income and employment for rural people living around the forest regions, especially during lean seasons of agricultural crops. NTFPs provide 40-63 percent of the total annual income of the people residing in rural areas of Madhya Pradesh (Tewari and Campbell 1996) and accounted 20-35 percent of the household incomes in West Bengal. The net present value (NPV) of the forest for sustainable fruit and latex production is estimated at US$6,330/ha considering the net revenue from a single year's harvest of fruit and latex production as US$422/ha in Mishana, Rio Nanay, Peru (Peters et al. 1989) on the assumption of availability in perpetuity, constant real prices and a discount rate of 5 percent.

Evaluation of the direct use benefits to rural communities' from harvesting NTFPs and using forest areas for agriculture and residential space, near the Mantadia National Park, in Madagascar (Kramer et al. 1995) through contingency valuation (CV) show an aggregate net present value for the affected population (about 3,400 people) of US$673,000 with an annual mean value per household of USD 108.

Estimation of the quantity of the NTFPs collected by the locals and forest department based on a questionnaire based survey in 21 villages of four different forest zones in Uttara Kannada district (Murthy et al. 2005), indicate the collection of 59 different plant species in the evergreen forests, 40 different plant species in the semi-evergreen forests, 12 different plant species in moist deciduous and 15 different plant species in dry deciduous forests and about 42–80 NTFP species of medicinal importance are marketed in herbal shops. Valuation reveal an annual income per household depending on the goods availability ranges from Rs. 3,445 (evergreen forests), 3,080 (moist deciduous), 1,438 (semi-evergreen) to Rs. 1,233 (dry deciduous).

Assessment of the marketing potential of different value added products from *Artocarpus* sp. in Uttara Kannada district based on field surveys and the discussions with the local people and industries (Ramana and Patil 2008), revealed that *Artocarpus integrifolia* collected from nearby forest area and home gardens is most extensively used for preparing items like chips, *papad*, sweets, etc. *Chips* and *papads* are commercially produced and sold in the markets, and primary collectors get 25 percent and the processing industry get 50 percent of the total amount paid by the consumers.

Forest ecosystems also provide other indirect benefits like ground water recharge, soil retention, gas regulation, waste treatment, pollination, refugium function, nursery function etc. in addition to the direct benefits (de Groot et al. 2002). Forest vegetation aids in the percolation and recharging of groundwater sources while allowing moderate run off. Gas regulation functions include general maintenance of habits through the maintenance of clean air, prevention of diseases (for example, skin cancer), etc.

Forests act as carbon sinks by taking carbon during photosynthesis and synthesis of organic compounds, which aids in maintaining CO_2/O_2 balance, ozone layer and also sulphur dioxide balance. Carbon sequestration potential of 131t of carbon per hectare with the above ground biomass of 349 ton/ha has been estimated in the relic forest of Uttara Kannada (Chandran et al. 2010) and 11.8 metric ton (1995) in forests in India (Lal and Singh 2000) with the carbon uptake potential of 55.48 Mt (2020) and 73.48 Mt (2045) respectively (projected the total carbon uptake for the year 2020 and 2045). The carbon sequestration potential was found to be 4.1 and 9.8 Gt by 2020 and 2045 respectively.

Vegetative structure of forests through its storage capacity and surface resistance plays a vital role in the disturbance regulation by altering potentially catastrophic effects of storms, floods and droughts. Soil retention occurs by the presence of the vegetation cover which holds the soil and prevents the loss of top soil. Pollination is an important ecological service provided by the forest ecosystem and the studies have revealed that forest dwelling pollinators (such as bees) make significant contribution to the agricultural production of a broad range of crops, in particular fruits, vegetables, fiber crops and nuts (Costanza et al. 1997).

Forest also helps in aesthetic benefit, recreational benefit, science and education, spiritual benefits, etc. The scenic beauty of forests provides aesthetic and recreational benefits through psychological relief to the visitors. An investigation of cultural services of the forest of Uttaranchal (Djafar 2006) considering six services namely aesthetic, recreational, cultural heritage and identity, inspirational, spiritual and religious and educational function, highlight the recreational value of forests US$ 0.82/ha/yr for villager's per visit. Aesthetic value derived by the preference of the villagers was estimated as US$ 7-1760 /ha/yr, derived by the preference of the villagers to live in the sites where there is good scenery. Cultural heritage and identity value was estimated as USD 1-25/ha/yr based on 24 places, 43 plant species and 16 animal species. Spiritual and religious areas was about USD 1-25/ha/yr. Educational value was obtained from the research activity and value was similar to spiritual and religious values.

Ecotourism benefit of the domestic visitor using the travel cost method in the Periyar tiger reserve in Kerala is Rs. 161.3 per visitor (Manoharan 1996), with average consumer surplus at Rs. 9.89 per domestic visitor and Rs. 140 for foreign tourists. The value of eco-tourism (as per 2005) is extrapolated as Rs. 84.5 million. The recreational value assessment of Vazhachal and Athirappily of Kerala (Anitha and Muraleedharan 2006) reveal that visitor flow on an average is 2.3 lakh (at Vazhachal) and 5.3 lakh (Athirappily) visitors/year and the average fee collection ranges from Rs. 10 (Vazhachal) to Rs.23.5 (Athirappily) lakh / year. Parking fee for vehicles itself is about Rs. 1.39 (Vazhachal) lakh /year and Rs. 2.7 (Athirappily) lakh/ year. About Rs. 5.6 lakh is earned from visitors entrance fee and parking charges. The estimated aggregate recreation surplus of the sample is equal to Rs 20, 69,214 with an average recreation surplus per visitor of Rs. 2,593.

Recreational value in the protected site of Western Ghats (Mohandas and Rema Devi 2011) based on the relationship between travel cost and visitation rate and the willingness to pay is Rs. 26.7 per visitor and the average consumer surplus per visit is Rs. 290. A similar study carried out in the valley of a national park show the net recreational benefit as Rs. 5,88,332 and the average consumer surplus as Rs. 194.68 (Gera et al. 2008). The total recreation value of Dandeli wildlife sanctuary using travel cost method during 2004-05 shows the total recreation value of Rs. 37,142.86 per Sq. km with the total value of Rs. 1,76,43,600 (Panchamukhi et al. 2008). Similarly, based on the willingness to pay for the preservation of watershed in Karnataka indicate a value of Rs.125.45 per hectare and the total value of Rs. 480 million (for 2004-05).

Valuation of forest in Uttarakhand, Himalayas using the benefit transfer method (Verma et al. 2007) shows a total economic value of Uttrakhand forests as Rs. 16,192 billion, accounting Rs. 19,035 million from the direct benefits (including tourism) and Rs. 173,120 million from the indirect benefits and silt control service is accounted as Rs. 2062.2 million. Carbon sequestration is accounted as Rs.2974 million at US $ 10 per t of C considering the net accumulation of 6.6 Mt C per year in biomass. Aesthetic beauty of the landscape is estimated as 10,665.3 million and pollination service value is accounted to be Rs. 25,610 million/yr. Natural ecosystems also provide unlimited opportunities for environmental education and function as field laboratories for scientific research (de Groot et al. 2002).

Sacred groves present in varied ecosystems viz., evergreen and deciduous forests, hill tops, valleys, mangroves, swamps and even in agricultural fields in Uttara Kannada district represent varied vegetation and animal profiles (Ray et al. 2011, 2015). The protection of patches of forest as sacred groves and of several tree species as sacred trees leads to the spiritual function provided by the forest (Chandran 1993). Sacred groves also play an important role in the cultural service provided by the forest. The groves do not fetch any produce which can be used for direct consumptive or commercial purpose. Creation of hypothetical market fetches price worth Rs. 600/quintal for a woody species and Rs. 40/quintal for non-wood product. The value of sacred grove assessed through willingness to pay to preserve the sacred grove in Siddapur taluk of Uttara Kannada district (Panchamukhi et al. 2008), show the value of Rs. 7280/ per hectare.

The major threat to the forests today is deforestation caused by several reasons such as rise in the population, exploitation activities which include expansion of agriculture land, ranching, wood extraction, development of infrastructure. Shifting cultivation is considered to be one of the most important causes of deforestation (Myers 1984). The loss of biodiversity is the second most important problem in nearly every terrestrial ecosystem on Earth. This loss is accelerating driven by the over-exploitation of natural resources, habitat destruction, fragmentation and climate change (MEA 2003). Even though the Convention on Biological Diversity (CBD) has adopted a target of reducing the rate of biodiversity loss at global, regional and national levels by 2010 (Mace 2005), still the loss of biodiversity is at a high pace. Nearly, 75 percent of the genetic diversity of domesticated crop plants has been lost in the past century. About 24 percent of mammals and 12 percent of bird species are currently considered to be globally threatened. Despite the essential functions of ecosystems and the consequences of their degradation, ecosystem services are undervalued by society, because of the lack of awareness of the link between natural ecosystems and the functioning of human support systems.

Objectives

Forest ecosystems are critical habitats for diverse biological diversity and perform array of ecological services that provide food, water, shelter, aesthetic beauty, etc. Valuation of the services and goods provided by the forest ecosystem would aid in the micro level policy design for the conservation and sustainable management of ecosystems. Main objective of the study is to value the forest ecosystems in Uttara Kannada forest. This involved computation of total economic value (TEV) of forest ecosystem considering provisioning, regulating, supporting and information services provided by the ecosystem.

MATERIAL AND METHODS

Study Area

The Uttara Kannada district with a spatial extent of 10,291sq.km is situated at $74^0 9'$ to $75^0 10'$ E and $13^0 55'$ to $15^0 31'$ N in the north-western part of Karnataka state (Fig. 2). It extends from north to south to a maximum of 180 km, and from west to east a maximum width of 110 km. Uttara Kannada is bounded by Belgaum district and Goa state in the north, Dharwad and Haveri districts in the east, Shimoga and Udupi districts in the south and the Arabian Sea to the west.

The district has the coastline of 120 km. in the western part. The coast stretches in a long nearly straight line to the south except the shallow Karwar and Belekeri bays (Kamath 1985). The topography of the region can be divided into three distinct zones. The coastal zone, comprising of a narrow strip of the coastline is relatively flat and starts sloping gently upwards towards the east. The ridge zone abruptly rises from the coastal strip, is much more rugged and is a part of the main range of the Western Ghats. Compared to other parts of the Western Ghats, the altitude of the ridge is much lesser and rises to about 600msl. The third zone is the flatter, geographically more homogenous zone that joins the Deccan plateau.

The four major rivers of the district are Kalinadi, Gangavali, Aghanashini and Sharavathi. Varada, Venkatapura, Belekeri, Badagani are some of the minor river and streams in the district. Apart from these river system, large number of other wetlands such as lakes, reservoirs, ponds, puddles, lateritic bogs, wet grasslands, marshes, swamps are present in the district (Ramachandra and Ganapathy 2007; Rao et al. 2008). The district comprises of 11 *Taluks* namely, Supa, Haliyal, Mundgod, Yellapur, Karwar, Ankola, Sirsi, Siddapur, Honnavar, Kumta and Bhatkal. Supa is the largest taluk in Uttara Kannada in terms of area. The district has 11 *taluks* (an administrative sub-division for dissemination of the government programmes) spread over the

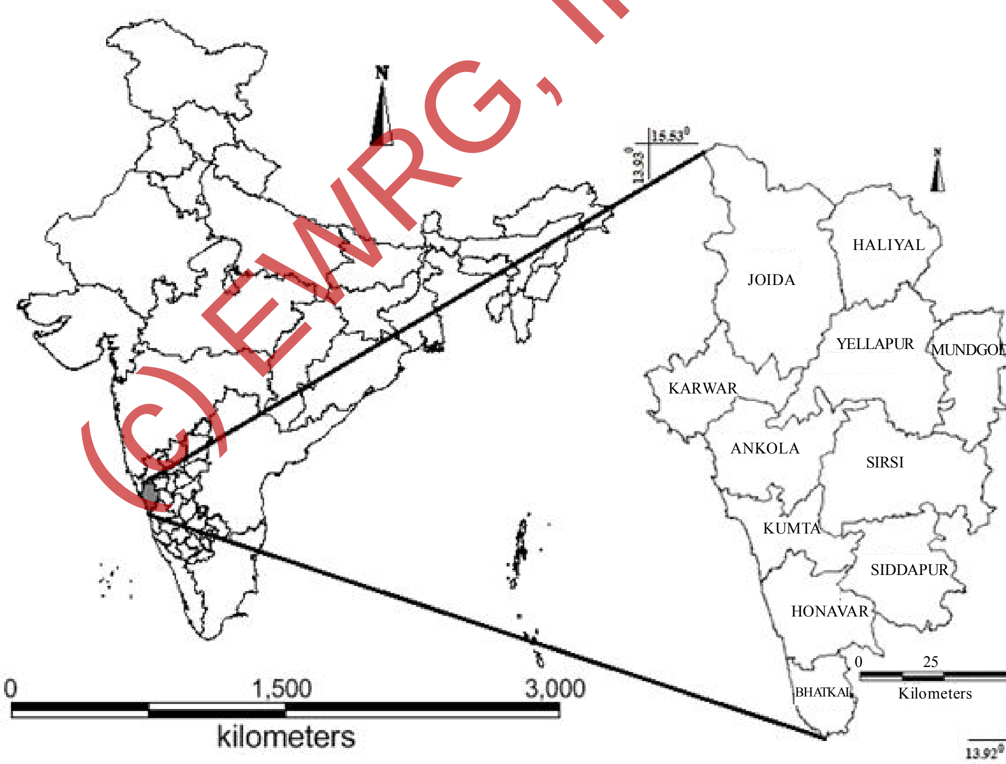


Fig. 2. Uttara Kannada district, Karnataka state

three regions described above. The coast lands comprise of Karwar, Ankola, Kumta, Honnavar and Bhatkal taluks, the forested interior areas which are part of the Western Ghats range comprises of Supa, Sirsi, Siddapur, major parts of Yellapur taluk and the eastern areas which are plateau regions comprises of Haliyal, Mundgod and parts of Yellapur taluks. The climate of the region is tropical monsoon. Generally, the weather is hot and humid in the coastal areas throughout the year. The district experiences south-west monsoon and the rainfall are received mostly between June and September. Average annual rainfall in the district is about 2887 mm which ranges from 4172 mm in Bhatkal *taluk* to 1345 mm in Haliyal taluk. Population density ranges from 0.26 (Supa) to 4.28 (Bhatkal) persons/hectare with an average of 1.69 ±1.09. Spatial extent of forest ranges from 48.14 (Mundogod) to 86.5 (Supa) percent of the respective *taluk.*

Vegetation of Uttara Kannada District

There are mainly five different types of forest in the district – Evergreen, Semi-evergreen, Moist deciduous, Dry deciduous and Scrub land. The district's high rainfall supports lush green forests, which cover approximately 70 percent of the district. Uttara Kannada vegetation is divided into 5 broad zones by Daniels (1989) namely, Coastal zone, Northern evergreen zone, Southern evergreen zone, moist deciduous zone and dry deciduous zone. Uttara Kannada has 21 habitat types according to Daniels (1989), based on a study in 181, 5x5 km grids. They are, Evergreen forests (65 percent), Rocky cliffs (14%), Degraded evergreen thickets (17%), Moist grasslands (9%), Moist/dry teak (29%), Humid *betelnut* (50%), Freshwater marshes (25%), Exotic tree plantations (25%), Rivers (10%), Hill streams (55%), Coastline (9%), Beaches (6%), Coastal coconut (9%), Estuaries (5%), Scrub (2%), Dry deciduous forest (5%), Moist/Dry Bamboo forests (6%), Moist/Dry cultivation (31%), Moist/Dry Eucalyptus (10%), Moist Deciduous forests (18%), Urban population > 1000 (22%). However, in the last few years the evergreen forests of the district have undergone tremendous changes. Most of the evergreen forested area has been transformed into semi-evergreen forests, and some have been converted into plantations such as, Teak, Arecanut, Acacia spp., etc. (Ramachandra and Ganapathy 2007). It is found that evergreen and semi-evergreen to moist deciduous forest types predominate the forested area of Uttara Kannada (Fig. 2). The complete stretch of the central ridge zone (Ghats section), which was once dominated by the evergreen forests, is now dominated by the semi-evergreen forest. Evergreen is seen in patches mainly towards the south-west and in the Ghats section. Moist deciduous is seen in almost all places distributed throughout the district. It is more common in the eastern Sirsi, south of Yellapur, eastern Siddapur and western region of the coastal taluks. Dry deciduous forests are spotted in the taluks of Mundgod, Haliyal, western Sirsi and north-eastern part of Yellapur.

Figure 3 depicts the land use in the district based on the analysis of IRS P6 (Indian remote sensing) multi spectral data of spatial resolution 5.8 m. Area under forest covers 72 percent of the total geographic area of the district (Fig. 4). The forest cover ranges from 50 percent in Mundgod *taluk* to 88 percent in Supa and Yellapur

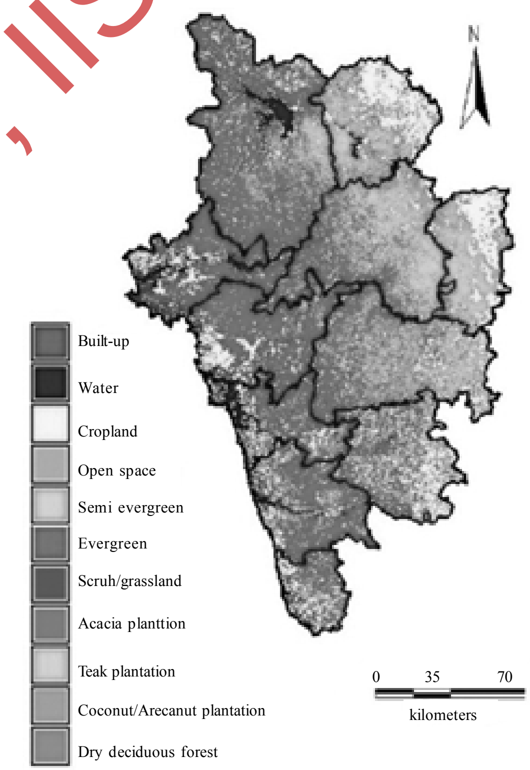


Fig. 3. Land-use classification map of Uttara Kannada district

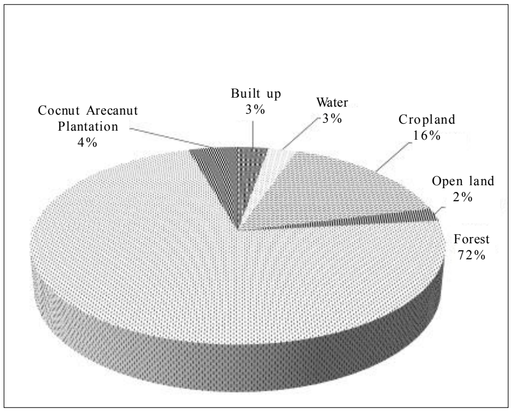


Fig. 4. Share of different land use in Uttara Kannada district

Source: Author

taluks. The forest was categorized as evergreen, semi evergreen to moist deciduous, dry deciduous, teak and bamboo plantations, scrub forest and grasslands and acacia plantations. Table 1 illustrates that about 53 percent of the total forest land in the district is of evergreen type followed by 21 percent of semi-evergreen to moist deciduous forests. Dry deciduous forests are very less and are found in the eastern part of Haliyal and Mundgod taluk. There has been a significant amount of forest loss owing to various developmental activities across district and conversion of natural forests into plantations. Taluks such as Ankola, Bhatkal, Honnavar, Karwar, Siddapur and Supa has rich presence of evergreen forest out of the total forest area, whereas the least share of evergreen forest is found in Mundgod and Haliyal *taluks.* The share of semi evergreen to moist deciduous forest out of total forest area is found to be highest in Sirsi taluk. A considerable share of forest area in Haliyal and Mundgod *taluks* is comprised of plantations of teak, acacia and bamboo.

Method

The framework for incorporating the true value of forest requires thorough valuation of the benefits derived from forest ecosystems. *Taluk* wise forest valuation has been done through the quantification of goods, estimation of values based on the market price, and compilation of values of ecosystem services from literatures. Total economic value of the forest ecosystems in Uttara Kannada has been done considering i) provisioning services, ii) regulating services, iii) supporting services and iv) information services (MEA 2003). Various components of provisioning, regulating, cultural and supporting services are listed in Figure 5. The research includes compilation of data from primary (field investigations) and secondary sources (government agencies, published scientific literatures in peer reviewed journals). Data on quantity of timber and non – timber forest products harvested were collected from Divisional Office (Sirsi) of Karnataka Forest Department, Government of Karnataka. Data on the prices of various marketed forest products were collected through market survey. Data on various other provisioning goods and services were compiled from literature pertaining to ecological and socio-economic studies in the district and also through interview with the subject experts.

Framework of Valuation

Figure 6 outlines the method adopted for valuing forest ecosystems (taluk wise) in Uttara Kannada district. The work entails:

i. Assessment of Different Land Uses in the District: This was done considering remote sensing data of space borne sensors (IRS P6) with spatial resolution of 5.8m. The remote sensing data were geo-referenced, rectified and cropped pertaining to the study area. Geo-registration of remote sensing data has been done using ground control points collected from the field using pre calibrated GPS (Global Positioning System) and also from known points (such as road intersections, etc.) collected from geo-referenced topographic maps published by the Survey of India (1:50000, 1:250000).

Table 1: Vegetation Distribution in Uttara Kannada

Evergreen forest	*Semi evergreen to moist deciduous forest*	*Dry deciduous forest*	*Teak / Bamboo plantations*	*Scrub forest/ Grass lands*	*Acacia/ Eucalyptus plantations*	*Total*
53.02	20.60	0.19	4.75	4.19	17.24	100.00

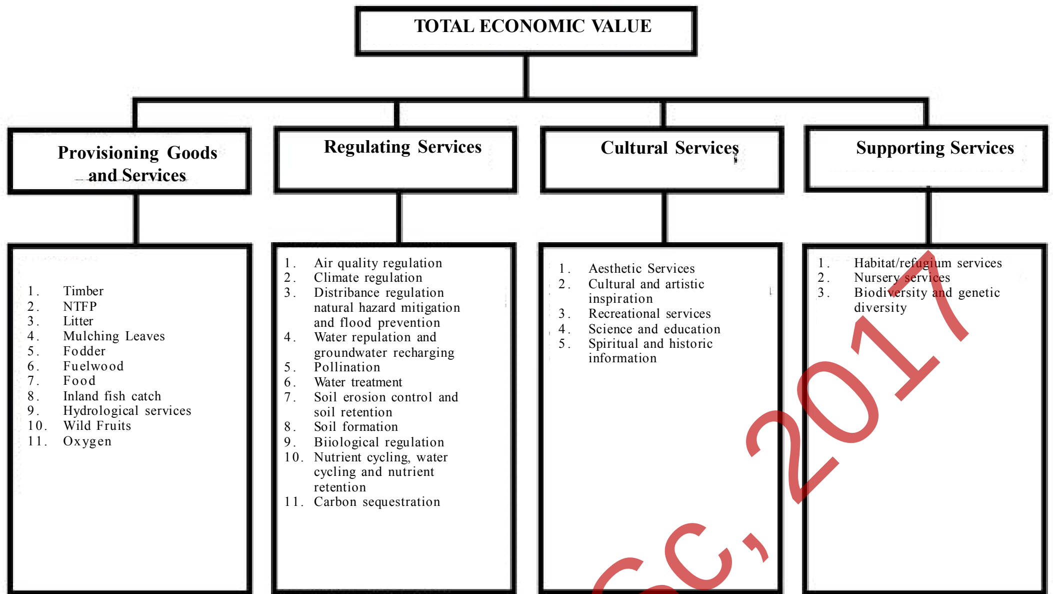


Fig. 5. Classification of forest ecosystem goods and services
Source: Author

Remote sensing data analysis involved i) generation of False Colour Composite (FCC) of remote sensing data (bands – green, red and NIR). This helped in locating heterogeneous patches in the landscape; ii) selection of training polygons (these correspond to heterogeneous patches in FCC) covering 15 percent of the study area and uniformly distributed over the entire study area; iii) loading these training polygons co-ordinates into pre-calibrated GPS; vi) collection of the corresponding attribute data (land use types) for these polygons from the field. GPS helped in locating respective training polygons in the field; iv) supplementing this information with Google Earth (http://earth.google.com); and v) 60 percent of the training data has been used for classification, while the balance is used for validation or accuracy assessment. Land use analysis was carried out using supervised pattern classifier - Gaussian maximum likelihood algorithm based on probability and cost functions (Ramachandra et al. 2012, 2016a). Accuracy assessment to evaluate the performance of classifiers was done with the help of field data by testing the statistical significance of a difference, computation of kappa coefficients and proportion of correctly allocated cases. Statistical assessment of classifier performance based on the performance of spectral classification considering reference pixels is done which include

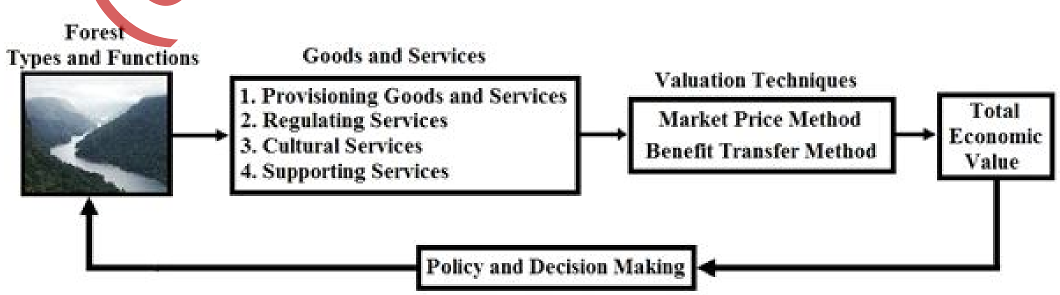


Fig. 6. Framework for valuation of goods and services from forest ecosystem
Source: Author

computation of kappa (κ) statistics and overall (producer's and user's) accuracies.

The forest was classified as evergreen, semi evergreen to moist deciduous, dry deciduous, teak and bamboo plantations, scrub forest and grasslands and acacia plantations. The extent of forest fragmentation was assessed for estimating the carbon sequestration potential of forests through the quantification of the extent of interior and fragmented forests at *taluk* level.

ii. Quantification of Goods and Services: compilation of data from primary (field investigations) and secondary sources (government agencies, published scientific literatures in peer reviewed journals). Data on quantity of timber and non – timber forest products harvested were collected from Divisional Office (Sirsi) of Karnataka Forest Department, Government of Karnataka.

iii. Valuation of Goods and Services: Various functions of forests are the results of interaction between structure and processes, which may be physical (for example, infiltration of water, sediment movement), chemical (for example, reduction, oxidation) or biological (for example, photosynthesis and de-nitrification). Further, various goods and services obtained from the functioning of forest ecosystem were classified as provisioning goods and services, regulating services, cultural services and supporting services. The study uses two approaches of valuation for the computation of TEV of forest ecosystem, namely: 'market price' method and 'benefit transfer' method of valuation.

a. *Market Price:* This technique estimates the economic values of those goods and services that are bought and sold in established markets. Valuation of provisioning goods and services has been done through 'market price' valuation. For those goods and services which do not pass through market transaction process (viz. water utilization for irrigation and power generation, ecological water, wild fruits) well adopted technique of proxy/shadow prices have been used.

b. *Benefit Transfer:* This technique involves the application of value estimates, functions, data and/or models developed in one context to address a similar resource valuation question in an alternative context. The cost of surveys in terms of time and money could be avoided by this approach. Benefit transfer method of valuation is used to compute the value of regulating, cultural and supporting services. Some of the components of these services were computed based on unit values of those services for different types of forest based on the discussion and interview with subject experts.

***iv. Quantification of Goods and Services*:** The detailed procedure of valuation of different components of ecosystem services is discussed below:

a. *Provisioning Services from Forest Ecosystem:* Goods derived from the forests are quantified as follows:

- *Timber:* Timber is an important component of value on forestland properties. In many cases, the value of the timber can be several times the value of the land. Timber includes rose wood, teak wood, jungle wood, etc. Timber is mainly prominent in deciduous forest while it is found in less amount in Evergreen forest patches. Plantation forest is mainly abundant in timber producing trees like Acacia, Teak etc. Industrial produce is also present from the forest which includes round wood, soft wood, match wood etc. The data regarding the quantity of timber harvested and sold was obtained from the Karnataka Forest department (KFD 2015) and the valuation is based on the current market price.
- *Non Timber Forest Product:* The data on the harvesting of non-timber forest product was obtained from the Forest department. The total value of NTFP includes the value of a) NTFPs extracted by Forest Department, b) NTFPs collected by households (Murthy et al. 2005), c) bamboo extracted by the Karnataka Forest department, d) annual bamboo productivity in the forest (NABARD 2015; WCPM 2016), e) cane extracted by Forest department and f) annual cane productivity in the forest .
- *Litter:* Litter is used as manure in horticulture and agriculture fields. Quantity of litter productivity per year for different taluks was based on the earlier work (Ramachandra et al. 2000).
- *Mulching Leaves:* Mulching leaves is used as manure in arecanut gardens. Per year requirement of mulching leaves from forest were quantified by the area of areca-

nut gardens in each taluka multiplied by the minimum quantity of mulching leaves per hectare of arecanut garden.

- *Fodder:* Total value of fodder supplied from forest were quantified by using the data from literature (Prasad et al. 1987a,b) on herb layer productivity in different types of forests, extent of different types of forest and unit market price of the fodder in the district.
- *Medicinal Plants:* Various medicinal plants used by the local people were identified (Harsha et al. 2005; Hegde et al. 2007) and the value of medicinal plants per unit area of forest area (Simpson et al. 1996; Database of Medicinal Plants 2015; SCIL 2015) was extrapolated to different types of forest in the district.
- *Fuel Wood:* The total value of fuel wood includes the value of fuel wood used for domestic purpose, that is, for cooking and water heating and also the value of fuel wood used for various industrial and commercial purposes like jaggery making, areca processing, cashew processing, restaurants and bakery, parboiling, cremation, etc. The quantity of fuel wood for domestic usage in different locations of the district was obtained from Ramachandra et al. (2000) and the quantity of fuel wood required for various other purpose were based on field experiments (Ramachandra et al. 2000; Ramachandra 1998).
- *Food:* 22 varieties of food products derived from forest were identified and the value of food extracted per unit area of forest obtained from literature (Hebbar et al. 2010; PSP 2016; SCIL 2015) was extrapolated to the total forest area in the taluk. Also, the household honey collection which is an important provisioning service from forest was quantified (Ramachandra et al. 2012) for all *talukas* and valued.
- *Inland Fish Catch:* Inland fishing is an important economic activity and a determinant of nutritional requirement of large number of people. Inland fishing happens in rivers, rivulets, streams, reservoirs, lakes, etc. which are inseparable part of the forest area in the district. The quantities of inland fish catch in different taluks were obtained from Fisheries Department, The Government of Karnataka and the economic value of it was determined.
- *Hydrological Services:* Most of the water resources come from the forested catchments. Hydrological services is quantified by the quantity of domestic water utilization, water for irrigation purpose (Ramachandra et al. 1999, 2012, 2016a), water for industrial use and water used for power generation (5 hydro power stations and 1 nuclear power station). The quantity of water required for sustenance of forest ecosystem that is, ecological water available for different types of forest was quantified as per the following equation (Ramachandra et al. 1999; 2016a; 2016b; Raghunath 2006; KPCL 2016; NPCIL 2016; Ray et al. 2015).
- Quantity of Ecological Water = Run off Coefficient x Annual Precipitation x Forest Area

The value of 'runoff coefficient' for different types of forest varied from 0.1 to 0.4.

- *Wild Fruits*: Information on various wild fruits were obtained from literature (Hebbar et al. 2010; Bhat et al. 2003). The productivity of wild fruits was estimated based on Bhat et al. (2003), transect survey data in different types of forest and information from local people. For economic valuation of wild fruits proxy price (in comparison with the price of fruits collected as NTFP) was used.
- *Oxygen Provision*: Value of oxygen provision from forests was quantified based on the values of oxygen production per hectare of subtropical forest (Maudgal and Kakkar 1992).

These provisioning services were valued as per the equations in Table 2 based on market price method.

b. Regulating Services from Forest Ecosystem: Regulating services provide many direct and indirect benefits to humans. The maintenance of the Earth's biosphere in a hostile cosmic environment depends on a delicate balance between these regulating services (de Groot et al. 2002). However, regulating services unlike provisioning services poses much greater challenges in valuation. Though regulating services are seldom marketed, the economy heavily depends upon the utility of these services. In the present study,

Table 2: Valuation method for comonents of provisioning services of forest

Provisioning services	*Equation*	*Details*
Timber	$V_{Timber} = \sum_{i=1}^{11} \sum_{j=1}^{6} Q_{i,j} \times P_{i,j}$	Q=Quantity of timber; P = Price of timber; i = no. of taluks; j = variety of timber
NTFP	$V_{NTFP} = \sum_{i=1}^{11} \sum_{j=1}^{30} Q_{i,j} \times P_{i,j}$	Q=Quantity of NTFP; P = Price of NTFP; i = no. of taluks; j = variety of NTFP
Litter	$V_{Litter} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of litter; P = Price of litter; i = no. of taluks
Mulching Leaves	$V_{Mulch} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of mulching leaves; P = Price of mulching leaves; i = no. of taluks
Fodder	$V_{Fodder} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of fodder; P = Price of fodder; i = no. of taluks
Fuelwood	$V_{Fuelwood} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of fuelwood; P = Price of fuelwood; i = no. of taluks
Food	$V_{food} = \sum_{i=1}^{11} \sum_{j=1}^{22} Q_{i,j} \times P_{i,j}$	Q=Quantity of food; P = Price of food; i = no. of taluks; j = variety of food product
Inland Fish Catch	$V_{Fish} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of fish catch; P = Price of fish; i = no. of taluks
Hydrological Services	$V_{water} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of water utilization for different purpose; P = Price of water used for different purpose; i = no. of taluks
Wild Fruits	$V_{wild\ fruits} = \sum_{i=1}^{11} Q_i \times P_i$	Q=Quantity of wild fruits; P = Price of wild fruits; i = no. of taluks
Oxygen	Value of oxygen provision from forests was quantified based on the values of oxygen production per hectare of subtropical forest (Maudgal and Kakkar 1992).	

ten variables of regulating services were quantified as per the published literatures (Costanza et al. 1997; Maudgal and Kakkar 1992; Seema and Ramachandra 2010), given in Table 3 and the value of carbon sequestration was estimated for each taluk

Table 3: Unit values of regulating services from forests (Rs. per hectare)

Regulating services	*Unit value (Rs. per hectare)*
Air quality regulation	6384
Climate regulation	10704
Disturbance regulation, natural hazard mitigation and flood prevention	217872
Water regulation and groundwater recharging	261360
Pollination	1200
Waste treatment	4176
Soil erosion control and soil retention	11760
Soil formation	480
Biological regulation	1104
Nutrient cycling, water cycling and nutrient retention	44256

based on the biomass stock and productivity (Ramachandra et al. 2000, 2004; Maudgal and Kakkar 1992; Seema and Ramachandra 2010).

The value of carbon sequestration has both flow and stock value. The productivity of biomass per hectare per year and the volume of standing biomass for different types of forests of Uttara Kannada were obtained from literature (Ramachandra et al. 2000, 2004; Seema and Ramachandra 2010). The volume of carbon was computed with the assumption that 50 percent of the dry biomass contains carbon (Seema and Ramachandra 2010). The value of carbon sequestration was calculated by considering 10 Euros per tonne of CO_2 (EEC 2012). The total value of carbon sequestration per year for different taluks includes the value of per year increment in the carbon sequestration and per year value of interest (considering 5% interest rate) over the total stock/ volume of carbon in the forest till date.

c. Cultural Services from Forest Ecosystem: Forest has a high cultural value; the main reason can be attributed to the aesthetic

Table 4: Unit values of cultural services from forest

S. No.	Cultural services	Value (in Rs./ hectare)	Source
1.a	Recreational services (for interior evergreen forest)	2,88,000	de Groot et al. 2002
1.b	Recreational services (for other types of forest)	28,944	Costanza et al. 1997
2.a	Spiritual and historic information (for interior evergreen forest)	72,000	Discussion with subject experts
2.b	Spiritual and historic information (for interior evergreen forest)	1,200	de Groot et al. 2002
3	Aesthetic Services	1,500	Discussion with subject experts
4	Cultural and artistic inspiration	480	Discussion with subject experts
5	Science and education	48,000	Discussion with subject experts

beauty, recreational benefit and Kan forest which are the sacred groves present in the district. Sacred groves are communally-protected forest fragments with significant religious connotations (Ray and Ramachandra 2011; Ray et al. 2015). Further, recreational benefits provided by the forest include gaming, walking, hunting etc. Aesthetic beauty of the forest is valuable, the presence of waterfalls and caves adds to the aesthetic value in the district. Science and educational value provided by the forest are also indispensable. The unit value for the services, listed in Table 4 was derived from de Groot et al. (2002) and Costanza et al. (1997), and also the values were finalized in consultation with subject experts.

d. *Supporting Services From Forest Ecosystem:* The supporting service provided by the forest includes the habitat/refugium function, nursery function and biodiversity and genetic diversity function. The forest provides living space for a large number of plants and animals thus, playing an important role in the refugium function. It also acts as a nursery for immense plants and animals. The forest also serves as a store house of information. To maintain the viability of this genetic library, the maintenance of natural ecosystems as habitats for wild plants and animals is essential. The unit value of habitat/ refugium function and nursery function were derived from literature and the unit value of biodiversity and genetic diversity was estimated (Table 5) based on the flow value of selected provision services that represent the least value stock of biodiversity and genetic diversity.

Total Economic Value

The total economic value (TEV) of forest ecosystem is obtained by aggregating provision goods and services (provisioning, regulating, cultural and supporting services).The total economic value that has been calculated for one year is divided by the area of forest in each taluk to obtain the per hectare value of forest in respective *taluk.*

RESULTS AND DISCUSSION

Ecosystem services and the natural capital stocks of the Western Ghats forests make significant direct and indirect contributions to national economies and human welfare. Forests, both natural and planted, and including trees spread across the terrain, have a critical role in the ecology, aesthetics and recreational benefits. The goods and services derived from forest ecosystem are categorized as provisional goods and services, regulating services, cultural services and supporting services (MEA 2003). Land

Table 5: Unit value of supporting services from forest

S. No.	Supporting services	Value (in Rs./ hectare)	Source
1	Habitat/ refugium services	73104	de Groot et al. 2002
2	Nursery services	9360	de Groot et Al. 2002
3	Biodiversity and genetic diversity	40000	Calculated from the flow value selected provisioning services like NTFP, medicinal plants, etc.

Table 6: Talukwise area under different types of forest (in hectares)

S. No.	*Taluk*	*Evergreen forest*	*Semi evergreen to Moist deciduous*	*Dry deciduous forest*	*Teak / Bamboo Plantations*	*Scrub forest/ Grass lands*	*Acacia/ Eucalyptu splantations*	*Total*
1	Ankola	53943	8227	0	62	4598	6911	73741
2	Bhatkal	15189	5335	0	130	230	851	21734
3	Haliyal	9853	11609	1253	7720	2532	16062	49030
4	Honnavar	36782	6403	0	0	1508	4007	48700
5	Karwar	39176	9264	0	0	1878	4097	54414
6	Kumta	19873	10697	0	0	746	4615	35931
7	Mundgod	1161	3047	171	10080	1554	16144	32156
8	Siddapur	35882	10214	0	124	3479	9615	59315
9	Sirsi	24666	44070	0	1670	2620	20133	93159
10	Supa	124118	21923	0	492	6090	10882	163504
11	Yellapura	34003	22541	0	15108	5987	35017	112656
	District Total	394645	153330	1424	35385	31223	128334	744341
	%	53.02	20.60	0.19	4.75	4.19	17.24	100.00

use analysis (Table 6) show that Supa taluk has highest forest area (1635 sq.km) and Bhatkal has lowest spatial extent of forests (217 sq.km). Evergreen to semi evergreen type of vegetation cover is about 3946 sq.km (53 %), followed by moist deciduous type (1533 sq.km). Area under monoculture plantations is about 1283 sq.km (17.24%).

Provisioning Goods and Services

Based on the consideration and inclusion of various components in ecological perspectives, total value of provisioning goods and services are presented in scenarios as follows:

- *Scenario - I:* provisional services include timber, NTFP, litter and mulching leaves, fodder, medicinal plants, fuel wood, food, inland fishing and hydrological services;
- *Scenario - II:* components in Scenario-I and wild fruits;
- *Scenario - III:* components in Scenario-II and oxygen services;

Table 7: Provisioning goods and services (different scenarios) for Uttara Kannada

Scenario	*Value of provisioning goods and services (in Rs. crores)*	*Values of provisioning goods and services (Billion Rs)*
Scenario I	9707	97.07
Scenario II	11842	118.42
Scenario III	15171	151.71

The estimated total value of provisioning goods and services for Uttara Kannada district per year for three different scenarios are presented in Table 7, which reveals the value of goods and services from forests in Uttara Kannada district ranges from INR 97.07 billion per year (scenario 1) to 151.71 billion per year (scenario 3).

Goods derived from the forests were quantified as discussed earlier and details are:

i. *Timber:* Timber accounts to Rs. 1,457 crores per year with the share of 10 percent in scenario – III of the total value of provisioning goods and services obtained from the forest.

ii. *NTFP:* NTFP being the largest contributor among all the components of provisioning goods and services is estimated at Rs. 3,601 crores per year for the district.

iii. *Litter and Mulching Leaves:* Litter and mulching leaves which is a vital component of sustainable agricultural system of the district is valued at Rs. 689 crores per year.

iv. *Fodder:* The value of total fodder productivity in the forests of the district is valued at Rs. 205 crores per year.

v. *Medicinal Plants:* The value of medicinal plants that has been estimated from the benefit transfer method and extrapolated to the different types of forest is found to be worth of Rs. 25 crores per year.

vi. *Fuel Wood:* Forest, being the important source of energy for domestic and various commercial purposes in the district supplies fuel wood of Rs. 366 crores per year.

vii. *Food:* The value of various food products extracted from forest is of worth Rs. 59 per year. Further the inland fishing in the district is valued at Rs. 22 crores per year.

viii. *Hydrological Services:* The total value of water usage for domestic purpose, industrial purpose, agricultural, water requirement for livestock, power generation and ecological water was termed as hydrological services from the forests. It was found that the forests in the district provide hydrological services of worth Rs. 2,313 crores per year.

ix. *Wild Fruits:* Wild fruits being the important component in ecological sustenance of forest ecosystem are being valued at Rs. 1,922 crores per year that is obtained from the forests of entire district.

x. *Oxygen:* The value of oxygen which is computed by benefit transfer method. The result of the study shows that the total forests in the district supplies the oxygen to the atmosphere of worth Rs. 3,000 crores per year. Further, 10 percent of the total value of provisioning services supplied from forest being considered as miscellaneous benefits that are derived from forest ecosystem is of value Rs. 1517 crores per year (for scenario – III).

In all the three scenarios, NTFP is the major contributor to the total value. The share of the value of food, inland fishing, medicinal plants, fuel wood, fodder, litter and mulching leaves varies from 14 percent in Scenario - I to 8 percent in Scenario - III. These goods have an important bearing on the livelihood of people and especially the livelihood of local people. The value of wild fruits and oxygen provision comprises to about thirty five percent share in the total value in Scenario – III. These components are often neglected in valuation of forest and policy making but they play an important role in ecosystem sustenance, protection of biodiversity and thus, in human wellbeing in the long run. Table 8 presents the taluk-wise breakup in the total provisioning goods and services. This illustrates that Supa taluk contributes the high-

Table 8: Value of various provisioning goods and services across taluks (in Rs. crores)

S. No.	*Provisioning goods and services*	*Ankola*	*Bhatkal*	*Haliyal*	*Honnavar*	*Karwar*	*Kumta*	*Mundgod*	*Siddapur*	*Sirsi*	*Supa*	*Yellapur*	*Total*
1	Timber	10.18	2.64	267.47	104.34	77.23	174.38	271.00	62.52	311.31	95.28	80.45	1456.80
2	NTFP	473.83	135.84	98.93	324.02	345.36	180.37	17.43	333.55	278.31	1095.93	317.04	3600.61
3	Litter and Mulching leaves	48.92	13.29	57.13	41.19	33.80	27.85	52.39	62.41	102.35	139.88	110.25	689.44
4	Fodder	24.18	6.70	9.92	15.11	17.14	10.38	2.96	18.00	24.27	52.09	23.80	204.55
5	Medicinal plants	2.88	0.92	1.04	1.96	2.20	1.38	0.25	2.13	3.12	6.65	2.66	25.17
6	Fuelwood	24.99	34.17	45.05	38.59	32.35	35.57	25.81	34.17	55.45	15.51	24.60	366.26
7	Food	5.65	1.91	3.98	4.81	4.42	3.12	2.57	4.81	7.26	12.08	8.43	59.04
8	Inland fishing	0.77	0.35	2.06	4.02	1.54	1.62	0.73	2.35	1.83	4.34	2.13	21.74
9	Hydrological services	172.74	140.66	341.64	279.89	118.27	185.32	127.89	218.26	319.62	223.46	184.85	2312.58
10	Wild fruits	228.20	71.96	71.62	157.08	174.01	104.36	13.51	164.75	213.22	531.33	191.87	1921.91
11	Oxygen	303.97	94.24	178.13	207.19	230.47	150.88	106.14	240.13	372.87	693.21	418.56	2995.81
12	Others	144.03	55.85	119.65	130.91	115.20	97.25	68.96	127.01	187.74	318.86	151.63	1517.09
	Total	1440.35	558.51	1196.54	1309.11	1152.00	972.47	689.60	1270.08	1877.36	3188.63	1516.25	15170.90

Table 9: Value of various regulating services across taluks (in Rs. crores)

S. No.	*Taluk*	*Ankola*	*Bhatkal*	*Haliyal*	*Honnavar*	*Karwar*	*Kumta*	*Mundgod*	*Siddapur*	*Sirsi*	*Supa*	*Yellapur*	*Total*
1	Air quality regulation	47	14	31	31	35	23	21	38	59	104	72	475
2	Climate regulation	79	23	52	52	58	38	34	63	100	175	121	797
3	Disturbance regulation, natural hazard mitigation and flood prevention	1607	474	1068	1061	1186	783	701	1292	2030	3562	2454	16217
4	Water regulation and groundwater recharging	1927	568	1281	1273	1422	939	840	1550	2435	4273	2944	19454
5	Pollination	9	3	6	6	7	4	4	7	11	20	14	89
6	Waste treatment	31	9	20	20	23	15	13	25	39	68	47	311
7	Soil erosion control and soil retention	87	26	58	57	64	42	38	70	110	192	132	875
8	Soil formation	4	1	2	2	3	2	2	3	4	8	5	36
9	Biological regulation	8	2	5	5	6	4	4	7	10	18	12	82
10	Nutrient cycling, water cycling and nutrient retention	326	96	217	216	241	159	142	263	412	724	499	3294
11	Carbon sequestration	494	153	143	301	375	209	54	307	391	1171	417	4016
	Total value of regulating services	4619	1368	2885	3025	3419	2219	1853	3625	5602	10316	6718	45647

Table 10: Talukwise value of cultural services (in Rs. crores)

S. No.	Taluk	Aesthetic services	Cultural andartistic inspiration	Recreational services	Science and education	Spiritual andhistoric information	Total
1	Ankola	11	4	1196	354	277	1841
2	Bhatkal	3	1	349	104	81	539
3	Haliyal	7	2	243	235	34	522
4	Honnavar	7	2	599	234	131	973
5	Karwar	8	3	893	261	208	1373
6	Kumta	5	2	437	172	95	713
7	Mundgod	5	2	103	154	7	271
8	Siddapura	9	3	584	285	120	1000
9	Sirsi	14	4	656	447	117	1239
10	Supa	25	8	2885	785	679	4381
11	Yellapura	17	5	824	541	150	1536
	District Total	112	36	8770	3573	1897	14388

Table 11: Talukwise value of supporting services (Rs. in crores)

S. No.	Taluk	Habitat/ refugium Services	Nursery services	Biodiversity and genetic diversity	Total
1	Ankola	539	69	295	903
2	Bhatkal	159	20	87	266
3	Haliyal	358	46	196	600
4	Honnavar	356	46	195	596
5	Karwar	398	51	218	666
6	Kumta	263	34	144	440
7	Mundgod	235	30	129	394
8	Siddapura	434	56	237	726
9	Sirsi	681	87	373	1141
10	Supa	1195	153	654	2002
11	Yellapura	824	105	451	1380
	District Total	5441	697	2977	9115

est amount of provisioning goods and services with Rs. 3,188 crores per year (21% of the district), while Bhatkal taluk contributes the least with the provisional services of Rs. 558 crores per year (4 % of the district).

Regulating Services

Regulation service quantification includes the estimated value of carbon sequestration in each taluk and other regulation services (Table 3 in methods section) multiplied by the forest area. The total value of regulating services in the district from forest ecosystems estimated at Rs. 45,657 crores per year. Table 9 shows the share of each taluks in the district's regulating services. Regulating services such as disturbance regulation, natural hazard mitigation and flood prevention, water regulation and groundwater recharging, and carbon sequestration has the major share in the regulating services provided by the forest ecosystem.

Cultural Services

The cultural services from forest can be aesthetic, recreational, spiritual, science and education. The district of Uttara Kannada is rich in places of recreational interest. There are immense number of waterfalls like Jog falls, Lalguli falls, Magod falls, Sathodi falls and Unchalli falls which adds to recreational and aesthetic values. The recreational sites also include the Anashi-Dandeli Tiger Reserve, Attiveri bird sanctuary and caves in Yana, Kavala, Uluvi, Sintheri, etc. The spiritual value of the Uttara Kannada district is also high due to the presence of many temples and pilgrimage centres like Gokarna, Murdeshwar, and Dhareshwar, Idagunji, Banavasi, etc. The cultural and heritage function is another important cultural service provided by forest. The presence of sacred groves is important for the cultural services as there are many cultural beliefs associated with the sacred groves in India. Some groves have valuable timber in

Table 12: Total economic value goods and services from forest ecosystem in Uttara Kannada district (in Rs. crores)

Scenario	*Provisioning services*	*Regulating services*	*Cultural services*	*Supporting services*	*Total economic value*
Scenario - I	9,707	45,647	14,388	9,115	78,857
Scenario - II	11,842				80,993
Scenario - III	15,171				84,321

them but are not harvested for timber due to sacred beliefs. The taluks of Siddapur and Sirsi in Uttara Kannada district have higher cultural values as the region is rich in sacred grooves. The presence of wild life sanctuaries and grooves in turn increases the educational value of the forest ecosystem. The unit value of different components of cultural services was as per Table 4, considering the conditions and type of forests in Uttara Kannada. The total cultural value of the district was estimated at Rs. 14,388 crores. Talukwise value of each component of cultural services and total value of cultural services is presented in Table 10.

Supporting Services

Table 11 lists taluk wise values of supporting services. The components of supporting services as per Table 5 were considered with the types and spatial extent of forest. The total value of supporting services obtained from forest ecosystem is estimated at Rs. 9,115 crores per year.

Total Economic Value of Forest Ecosystem in Uttara Kannada District

Total economic value (TEV) is calculated by aggregating provisioning services, regulating services, cultural services and supporting services. Total economic value (TEV) for all three scenarios and are presented in Table 12. The TEV of forest ecosystem in Uttara Kannada district is Rs. 78,857 crores, Rs. 80,993 crores and Rs. 84,321 crores for Scenario -I, II and III respectively.

Table 13 presents the share of different categories of services from forest ecosystem for scenario – III. Regulating services underpin the delivery of other service categories (Kumar et al. 2010), contributes to half of the share (54%) of the total economic value of forest ecosystem in the district. Provisioning services (18 %), cultural services (17 %) and supporting service (11 %) contributes to the other half of total economic value. Table 13 also shows that the total value of services per hectare of forest per year in the district. Value of provisioning services provided by the forest ecosystem is about Rs. 2,03,818 per hectare per year and the total value is about Rs. 11,32,832 per hectare per year which is implicit in the subsistence, income and local employment.

Supa taluks with Rs. 19,887 crores per year is the largest contributor (with 24 percent share) to the TEV of forest ecosystem in the district (Table 14) and Bhatkal taluk with the contribution of Rs. 2,732 crores per year is the least contributor (with 3% share) to the TEV of forest ecosystem of the district.

Total Economic Value of Forest Ecosystem and GDDP

Sector-wise district's Gross District Domestic Product (GDDP) is given in Table 15. GDDP of Uttara Kannada is about Rs. 5,978 crores and the contribution of forests' goods is about Rs.

Table 13: Total value of goods and services from forest ecosystem in Uttara Kannada

Services from forest ecosystem	*District value per year (in Rs. crores)*	*Value of services per hectare per year (in Rs.)*	*Percent share*
Provisioning services	15,171	2,03,818	18
Regulating services	45,647	6,13,254	54
Cultural services	14,388	1,93,296	17
Supporting services	9,115	1,22,464	11
Total Value	84,321	11,32,832	100

Table 14: Taluk wise total economic value goods and services from forest ecosystem

S. No.	Taluk	TEV of forest ecosystem (in Rs. crores per year)
1	Ankola	8803
2	Bhatkal	2732
3	Haliyal	5204
4	Honnavar	5904
5	Karwar	6610
6	Kumta	4344
7	Mundgod	3207
8	Siddapur	6622
9	Sirsi	9859
10	Supa	19887
11	Yellapur	11150
	District Total	84321

180 crores (3% of GDDP), in contrast to the estimated valuation of provisioning services (ranges from 9707 to 15171 crores per year). *This highlights the undervaluation of forest resources in the regional accounting system.* TEV of forest ecosystem of Uttara Kannada district is about Rs. 84,321 crores.

Table 15: GDDP of Uttara Kannada with sectors

Sector	Sectoral contribution (in Rs. crores)	Sectoral share (in percent)
Primary Sector (Agriculture, Forestry, Fishing, Mining)	1060	18
Forestry and Logging Sector	180	3
GDDP of Uttara Kannada	5978	100

Source: Directorate of Economics and Statistics, Government of Karnataka

The forest products included in the national income account framework includes: (a) Industrial wood (timber, match and pulpwood) and fuel wood and (b) minor forest products (Haripriya 2001). It includes only the recorded values by forest department and thus, all other benefits from forests are unaccounted in the national income. This necessitates relook at the current approach of computations of Gross Domestic District Product (GDDP), State Domestic Product (SDP) and Gross Domestic Product (GDP). Gross underestimation and non-accounting of natural resources and forest resources in particular is responsible for unsustainable utilization of natural resources. Under valuation of ecosystem goods and services is evident from GDDP of Rs. 5,978 crores in 2009-10 (at current prices), which accounts as the sectoral share of forests of Rs. 180 crores, contrary to the estimated valuation of provisioning services (ranges from 9707 to 15171 crores per year). TEV of forest ecosystem accounts to Rs. 84,321 crores per year.

CONCLUSION

Forest resources in the Uttara Kannada district has undergone tremendous change and degradation because the value of it is being poorly understood and not considered in the policy making process. However, valuation of regulating services, cultural services and supporting services are more difficult to estimate and thus pose serious challenges to planners and practitioners. As a consequence the values of these services are often overlooked. Hence, valuation of these services in income accounting of a region/nation is essential to make the plans and policies more sustainable.

Goods and services that forest ecosystems provide are grossly undervalued, evident from GDDP of Uttara Kannada, about Rs. 5,978 crores, which accounts goods of forests as Rs. 180 crores (3% of GDDP), in contrast to TEV of Rs. 84,321 crores from forest ecosystems of Uttara Kannada district. The comprehensive valuation has the potential to provide effective options for management of ecosystem. If the total economic value of forests ecosystem in particular and ecosystem in general are not considered in decision and policy making, the policies thus adopted would lead to detrimental effect on human and societal welfare in the long run. Policies therefore, have an important role in ensuring that benefits from forest ecosystem are accounted in decision making to avoid underestimation of the values of forest, value of conservation and sustainable use of forest resources. Incorporating the values of ecosystem services plays an important role in making the economy resource efficient

RECOMMENDATIONS

Forest resources in the Uttara Kannada district have undergone tremendous change and degradation because the value of it is being poorly understood and not considered in the policy making process. However, valuation of regulating services, cultural services and supporting services are more difficult to estimate and thus pose serious challenges to planners and practitioners. As a consequence the values of these services are often overlooked. Hence, valuation of these services in income accounting of a region/ nation is essential to make the plans and policies more sustainable.

Major threats are habitat fragmentation, negligence, conflict of interest and ineffective restoration/improvement strategies. Poor understanding of the complex ecological processes and proper estimation of the ecosystem benefits have often lead to the destruction of fragile ecosystems. To improve the scenario, thorough understandings of the complex ecosystem dynamics as well as its socio-religious association with community life both are important from conservation and management point of view.

Conservation activities are mostly implemented by Government agencies, NGOs and sometimes by communities. However community participation is often activated by extra mural support which has serious problem in long term sustainability due to financial limitation. The problem could be mitigated to some extent by awareness generation so to raise the interest among people to safeguard its future for their own benefit. The premium should be on conservation of the remaining fragile ecosystems, which are vital for the water security (perenniality of streams), food security (sustenance of biodiversity) and uplift the livelihoods of local population due to carbon credits.

ACKNOWLEDGEMENTS

We are grateful to (i) the NRDMS division, The Ministry of Science and Technology, Government of India, (ii) ENVIS division, the Ministry of Environment, Forests and Climate Change, GoI and (iii) Indian Institute of Science for the financial and infrastructure support. We thank Dr. Prakash Mesta for the assistance in compiling information from government agencies.

REFERENCES

Anderson T, Bojo J 1992. The economic value of forests. In: Anil Agarwal (Ed.): *The Price of Forests.* New Delhi: Centre for Science and Environment, pp. 14-26.

Anitha V, Muraleedharan PK 2006. Economic Valuation of Ecotourism Development of a Recreational Site in the Natural Forests of Southern Western Ghats. *KFRI Research Report,* Kerala Forest Research Institute, Peechi.

Arnold JEM, Pérez MR 2001. Can non-timber forest products match tropical forest conservation and development objectives? *Ecol Econ,* 39(3): 437-447.

Atkinson G, Gundimeda H 2006. Accounting for India's forest wealth. *Ecol Econ,* 59(4): 462-476.

Bhat DM, Murali KS, Ravindranath NH 2003. Carbon stock dynamics in tropical rain forest of Uttara Kannada district, Western Ghats, India. *Int J Environ Pollut,* 19(2): 139-149.

CBD 2001. Secretariat of the Convention on Biological Diversity, The Value of Forest Ecosystems. *CBD Technical Series* No. 4, Montreal.

Champion HG, Seth SK 1968. *A Revised Survey of the Forest Types of India*. New Delhi: Govt. of India Publication.

Chandran MDS 1993. *Vegetational Changes in the Evergreen Forest Belt of the Uttara Kannada District of Karnataka State*. PhD Thesis submitted to Karnataka University, Dharwad, India: Karnataka University.

Chandran MDS, Rao GR, Gururaja KV, Ramachandra TV 2010. Ecology of the swampy relic forests of Kathalekan from Central Western Ghats, India. *Biorem Biodiv Bioavail* (Special Issue), 4(1): 54-68.

Costanza R, d'Arge R, de Groot R, Farberk S, Grasso M, Hannon B, Limburg K, Naeem S, O'Neill RV, Paruelo J, Raskin R G Sutton P, van den Belt M 1997. The value of the world's ecosystem services and natural capital. *Nature*, 387: 253-260.

Daily GC, Matson PA 2008. Ecosystem services: From theory to implementation. *Proc Natl Acad Sci,* 105(28): 9455–9456.

Daniels RJR 1989. *A Conservation Strategy for the Birds of Uttara Kannada District.* PhD Thesis. Bangalore, India: Centre for Ecological Science, Indian Institute of Science.

Database of Medicinal Plants 2015. Database of Medicinal Plants. From <http://www.medicinalplants-kr.org/ECONOMIC_ VALUE_OF_ MEDICINAL.HTM> (Retrieved on 17 April 2016).

de Groot RS, Wilson MA, Boumans RMJ 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. *Ecol Econ,* 41(3): 393–408.

DEFRA 2007. An Introductory Guide to Valuing Ecosystem Services. London: Department for Environment, Food and Rural Affairs, pp. 66. From <https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69192/pb12852-eco-valuing-071205.pdf> (Retrieved on 3 April 2016; 9 July 2017).

Djafar F 2006. Cultural Services of Forests: A Case Study in Garhwal Hills, Uttaranchal, India. NET-FOP Report 07. Alterra, Wageningen UR. From <http://edepot.wur.nl/385797> (Retrieved on 28 April 2016).

EEC 2012. European Energy Exchange. From <https://www.eex.com> (Retrieved on 17 April 2016).

Falconer J, Koppell CRS 1990. The Major Significance of 'Minor' Forest Products: The Local Use and Value of Forest in the West African Humid Forest Zone. *Community Forestry Note* 6, Rome: FAO.

FAO 2010. Global Forest Resources Assessment-2010. *FAO Forestry Paper* 163. Rome: FAO.

Gera M, Yadav AKR, Bisht NS, Mohan G 2008. Valuation of recreational benefits from the valley of flowers National Park. *Indian For,* 134(1): 26-35.

Gonzalez P, Hassan R, Lakyda P, McCallum I, Nilsson S, Pulhin J, Rosenburg B, Scholes B 2005. Forest and woodland systems. In: R Hassan, R Scholes, N Ash (Eds.): *Ecosystems and Human Wellbeing: Volume 1: Current State and Trends*. Washington: Island Press, pp 68-77.

Gunderson LH, Cosens B, Garmestani AS 2016. Adaptive governance of riverine and wetland ecosystem goods and services. *Journal of Environmental Management*, 183(2): 353-360. doi.org/10.1016/j.jenvman. 2016. 05.024.

Haripriya GS 2001. Integrated environmental and economic accounting: An application to the forest resources in India. *Environ Resour Econ*, 19(1): 73-95.

Haripriya GS 2002. Biomass carbon of truncated diameter classes in Indian forests. *Forest Ecol Manage,* 168(1-3): 1-13.

Harsha VH, Shripathi V, Hegde GR 2005. Ethno veterinary practices in Uttara Kannada district of Karnataka. *Indian J Tradit Know,* 4(30): 253-258.

Hebbar SS, Hegde G, Hegde GR 2010. Less known wild edible fruits and seeds of Uttara Kannada district. *Indian For,* 136(9): 1218-1222.

Hegde HV, Hegde GR, Kholkute SD 2007. Herbal care for reproductive health: Ethnomedicobotany from Uttara Kannada district, Karnataka, India. *Complement Ther Clin Pract,* 13(1): 38-45.

Kamath SU 1985. *Uttara Kannada District. Karnataka State Gazetteer.* Bangalore: Government of Karnataka.

KFD 2015. Karwar Division, Karnataka Forest Department. From <http://www.aranya.gov.in/Static%20Pages/Karwar.aspx> (Retrieved on 12 January 2015, 18 June 2017; 9 July 2017).

KPCL 2016. Karnataka Power Corporation Limited. From <http://www.karnatakapower.com > (Retrieved on 17 April 2016).

Kramer RA, Sharma N, Munasinghe M 1995. Valuing Tropical Forests: Methodology and Case Study of Madagascar. *World Bank Environment Paper* No. 13, Washington D.C.

Kumar P, Verma M, Wood MD, Negandhi D 2010. *Guidance Manual for the Valuation of Regulating Services*. UNEP, Nairobi, 2010.

Lal M, Singh R 2000. Carbon sequestration potential of Indian forests. *Environ Monit Assess*, 60(3): 315-327.

Mace GM 2005. Biodiversity: An index of intactness. *Nature,* 434(7029): 32-33.

Manoharan TR 1996. *Economics of Protected Areas: A Case Study of Periyar Tiger Reserve*. PhD Thesis. Dehra Dun: Forest Research Institute.

Maudgal S, Kakkar M 1992. Evaluation of forests for impact assessment of development project. In: A Agarwal (Ed.): *The Price of Forests*. New Delhi: CSE, pp. 53-60.

MEA (Millennium Ecosystem Assessment) 2003. *Ecosystems and Human Well-being: A Framework for Assessment*. Washington, DC: Island Press.

Mohandas TV, Remadevi OK 2011. A study on tourist visitations in protected areas of central Western Ghats in Karnataka. *Indian For,* 137(4): 403-410.

Murthy IK, Bhat PR, Ravindranath NH, Sukumar R, 2005. Financial valuation of non-timber forest product flows in Uttara Kannada district, Western Ghats, Karnataka. *Curr Sci India*, 88(10): 1573-1579.

Myers N 1984. *The Primary Source: Tropical Forests and Our Future*. New York: W. W. Norton.

NABARD (National Bank for Agricultural and Rural Development) 2015. From <http://www.nabard.org/modelbankprojects> (Retrieved on 12 January 2015, 18 June 2017).

Nasi R, Wunder S, Campos AJJ 2002. *Forest Ecosystem Services: Can They Pay Our Way Out of Deforestation?* Bogor, Indonesia: CIFOR for the Global Environmental Facility (GEF).

Newcome J, Provins A, Johns H, Ozdemiroglu E, Ghazoul J, Burgess D, Turner K 2005. *The Economic, Social and Ecological Value of Ecosystem Services: A Literature Review*. London: Economics for the Environment Consultancy.

NPCIL (Nuclear Power Corporation of India Limited) 2016. From <http://www.npcil.nic.in/main/ProjectOperationDisplay.aspx?ReactorID=76&Page> (Retrieved on 21 February 2016).

Panchamukhi PR, Trivedi P, Debi S, Kulkarni AK, Sharma P 2008. *Natural Resource Accounting In Karnataka: A Study on Land and Forestry Sector (Excluding Mining)*. Centre for Multi-Disciplinary Development Research, Dharwad, p. 242. From <http://docplayer.net/45191657-Natural-resource-accounting-in-karnataka-a-study-of-the-land-forestry-sector-excluding-mining.html> (Retrieved on 28 September 2016; 9 July 2017).

Pearce DW, Moran D, Biller D 2002. *Handbook of Biodiversity Valuation: A Guide for Policy Makers*. Paris and Washington, D.C.: OECD, p. 40. From <http://portals.wi.wur.nl/files/docs/File/nfp%20for%20all/FinancingMech/OECD Handbook on Biodiversity Valuation.pdf> (Retrieved on 28 September 2016).

Peters CM, Gentry AH, Mendelsohn RO 1989. Valuation of an Amazonian rainforest. *Nature*, 339: 655-656.

Pittini M 2011. Monetary Valuation for Ecosystem Accounting. Issue Paper Prepared for the UN/World Bank/EEA Expert Meeting on Ecosystem Accounts, London., p. 30. From <https://unstats.un.org/unsd/envaccounting/seeaLES/egm/Issue10_UK.pdf> (Retrieved on 28 September 2016; 9 July 2017).

Prasad SN, Hegde M, Hedge MS 1987b. Fuel Consumption and Conservation Method in Urban Centres of Uttara Kannada. *CES Technical Report* 25. CES, IISc, Bangalore.

Prasad SN, Hegde HG, Bhat DM, Hegde M 1987a. Estimates of Standing Biomass and Productivity of Tropical Moist Forest of Uttara Kannada District, Karnataka, India. *CES Technical Report No.* 19, CES, IISc, Bangalore.

PSP 2016. Parrys Sugar Factory. From <http://www.parrysugar.in/html/locations-Haliyal > (Retrieved on 28 September 2016; 9 July 2017).

Raghunath HM 2006. *Hydrology: Principles, Analysis and Design*. New Delhi: Wiley Eastern Limited.

Ramachandra TV, Nagarathna AV 2001. Energetics in paddy cultivation in Uttara Kannada District. *Energ Convers and Manage*, 42(2): 132-155.

Ramachandra TV 1998. Energy utilisation in rural industries in Karnataka. *Int J Ambient Energy*, 19(2): 75-92.

Ramachandra TV, Subramanian DK, Joshi NV 1999. Hydroelectric resource assessment in Uttara Kannada District, Karnataka State, India. *J Clean Prod*, 7(3): 195-211.

Ramachandra TV, Joshi NV, Subramanian DK 2000. Present and prospective role of bioenergy in regional energy system. *Renew Sust Energ Rev,* 4(4): 375-430.

Ramachandra TV, Kamakshi G, Shruthi BV 2004. Bioresource status in Karnataka. *Renew Sust Energ Rev*, 8(1): 1-47.

Ramachandra TV, Ganapathy S 2007. Vegetation Analysis in Uttara Kannada District Using GIS and Remote Sensing Techniques. *ENVIS Technical Report No*. 24, Environmental Information System, CES, IISc, Bangalore.

Ramachandra TV, Chandran MDS, Gururaja KV, Sreekantha 2007. *Cumulative Environmental Impact Assessment*. New York: Nova Science Publishers.

Ramachandra TV, Alakananda B, Ali Rani, Khan MA 2011. Ecological and socio-economic assessment of Varthur wetland, Bengaluru, India. *J Environ Sci Eng,* 53(1): 101-108.

Ramachandra TV, Chandran MDS, Joshi NV, Balachandran C 2012. Beekeeping: Sustainable Livelihood Option in Uttara Kannada, Central Western Ghats. *ENVIS Technical Report No*. 19, Environmental Information System, CES, IISc, Bangalore.

Ramachandra TV, Subramanian DK, Joshi NV, Gunaga SV, Harikanta RB 2000. Domestic energy consumption patterns in Uttara Kannada district, Karnataka state, India. *Energ Convers Manage,* 41(8): 775-831.

Ramachandra TV, Chandran MDS, Joshi NV, Karthick B, Mukri VD 2015. *Ecohydrology of Lotic Systems in Uttara Kannada, Central Western Ghats, India*. Springer: Environmental Management of River Basin Ecosystems, Springer Earth System Sciences.

Ramachandra TV, Bharath Setturu, Rajan KS, Chandran MDS 2016a. Stimulus of Developmental Projects to Landscape Dynamics in Uttara Kannada, Central Western Ghats. The Egyptian Journal of Remote Sensing and Space Sciences. From <http://dx.doi.org/10.1016/j.ejrs.2016.09.001>, pp.1-19.

Ramachandra, TV, Vinay S, Aithal BH 2016b. Environmental flow assessment in a lotic ecosystem of Central Western Ghats, India. *Hydrol Curr Res,* 7: 1-14.

Ramana P, Patil SK 2008. Marketing of value added products from Artocarpus species in Uttara Kannada district of Karnataka. *My Forest,* 44(1): 49-53.

Rao GR, Mesta D, Chandran MDS, Ramachandra TV 2008. Wetland flora of Uttara Kannada. In: TV Ramachandra (Ed.): *Environmental Education for Ecosystem Conservation*. New Delhi: Capital Publishing Company, pp 140-152.

Ray R, Chandran MDS, Ramachandra TV 2011. Sacred Groves in Siddapur Taluk, Uttara Kannada, Karnataka: Threats and Management Aspects. *ENVIS Technical Report* 38, Environmental Information System, CES, IISc, Bangalore.

Ray R, Ramachandra TV 2011. Small sacred groves in local landscape: Are they really worth for conservation? *Curr Sci India,* 98(9): 1178-1180.

Ray R, Chandran MDS, Ramachandra TV 2015. Hydrological importance of sacred forest fragments in Central Western Ghats of India. *Trop Ecol,* 56: 87-99.

Schaafsma M, Morse-Jones S, Posen P, Swetnam R.D, Balmford A, Bateman IJ, Burgess ND, Chamshama SAO., Fisher B, Freeman T, Geofrey V, Green RE, Hepelwa AS, Turner RK 2014. The importance of local forest benefits: Economic valuation of Non-Timber Forest Products in the Eastern Arc Mountains in Tanzania. *Global Environmental Change,* 24(2014): 295-305.

SCIL 2015. Solaris Chemtech Industries Limited, Binaga, Karwar. From <http://www. solarischemtech. com/infra-falt.asp?links=falt> (Retrieved on 17 June 2015).

Seema D, Ramachandra TV 2010. Carbon Sequestration Potential of Ecosystems in Uttara Kannada District, Western Ghats of Karnataka, India, In: TV Ramachandra (Ed.): Proceedings of Lake 2010: Conference on Wetlands, Biodiversity and Climate Change, 22-24 Dec. 2010, Bangalore, pp. 162-178. From <http://wgbis.ces.iisc.ernet.in/energy/lake 2010/Theme%201/seema_day.pdf>.

Simpson RD, Sedjo RA, Reid JW 1996. Valuing biodiversity for use in pharmaceutical research. *The J of Polit Econ*, 104(1): 163-185.

TEEB 2010. The Economics of Ecosystems and Biodiversity Ecological and Economic Foundations. Pushpam Kumar (Ed.). London and Washington: Earthscan, pp 31-224. From <http://www.teebweb.org/our-publications/teeb-study-reports/ecological-and-economic-foundations>. (Retrieved on 21 February 2016)

Tewari DD, Campbell JY 1996. Increased Development of Non-Timber Forest Products in India: Some Issues and Concern. Unasylva, 47(187): 26-31. From <http://www.fao.org/docrep/w2149e/w2149 e06.htm#increased development of non timber forest products in India: some issues and co> (Retrieved on 17 January 2015).

Verma M, Joshi S, Godbole G, Singh A 2007. Valuation of Ecosystem Services and Forest Governance: A Scoping Study from Uttarakhand, Leadership in Environment and Development (LEAD-India), New Delhi. Pp 125. From <http://www. leadindia. org> (Retrieved on 21 February 2016)

Villegas-Palacio C, Berrouet L, Connie L, Ruiz A, Upegui A 2016. Lessons from the integrated valuation of ecosystem services in a developing country: Three case studies on ecological, socio-cultural and economic valuation. *Ecosystem Services,* 22(2016): 297-308. http://dx.doi.org/10.1016/j.ecoser.2016. 10.017

WCPM 2016. West Cosast Paper Mill, Dandeli. From <http:// westcoastpaper.com/index.php?q=node/23> (Retrieved on 22 October 2016).

Paper received for publication on February 2017
Paper accepted for publication on July 2017

रजिस्ट्री सं० डी० एल०-33004/99 REGD. NO. D. L.-33004/99

भारत का राजपत्र
The Gazette of India

असाधारण
EXTRAORDINARY
भाग II—खण्ड 3—उप-खण्ड (ii)
PART II—Section 3—Sub-section (ii)
प्राधिकार से प्रकाशित
PUBLISHED BY AUTHORITY

सं. 2617] नई दिल्ली, बृहस्पतिवार, नवम्बर 3, 2016/कार्तिक 12, 1938
No. 2617] NEW DELHI, THURSDAY, NOVEMBER 3, 2016/KARTIKA 12, 1938

पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय

अधिसूचना

नई दिल्ली, 2 नवम्बर, 2016

का.आ. 3369(अ).—निम्नलिखित अधिसूचना का प्रारुप, जिसे केन्द्रीय सरकार, पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3 की उपधारा (2) के खंड (v) और खंड (xiv) तथा उपधारा (3) के साथ पठित उपधारा (1) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, जारी करने का प्रस्ताव करती है, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उपनियम (3) की अपेक्षानुसार, जनसाधारण की जानकारी के लिए प्रकाशित की जाती है; जिनके उससे प्रभावित होने की संभावना है; और यह सूचना दी जाती है कि उक्त प्रारूप अधिसूचना पर, उस तारीख से, जिसको इस अधिसूचना वाले भारत के राजपत्र की प्रतियां जनसाधारण को उपलब्ध करा दी जाती हैं, साठ दिन की अवधि की समाप्ति पर या उसके पश्चात् विचार किया जाएगा ;

ऐसा कोई व्यक्ति, जो प्रारूप अधिसूचना में अंतर्विष्ट प्रस्तावों के संबंध में कोई आक्षेप या सुझाव देने में हितबद्ध है, इस प्रकार विनिर्दिष्ट अवधि के भीतर, केन्द्रीय सरकार द्वारा विचार किए जाने के लिए, आक्षेप या सुझाव सचिव, पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय, इंदिरा पर्यावरण भवन, जोर बाग रोड, अलीगंज, नई दिल्ली-110003 या ई-मेल पते: esz-mef@nic.in पर लिखित रूप में भेज सकेगा ।

प्रारूप अधिसूचना

डंडेली वन्यजीव अभयारण्य और अंशी राष्ट्रीय उद्यान कर्नाटक राज्य में उत्तरा कन्नड़ जिले के हलियाल, जायडा और करवार ताल्लुक में स्थित है;

और, डंडेली वन्यजीव अभयारण्य (475.018 वर्ग किलोमीटर) और अंशी राष्ट्रीय उद्यान (339.866 वर्ग किलोमीटर) एक दूसरे के संसक्त हैं और जैवीय रूप से संवेदनशील पश्चिमी घाटों में अवस्थित संरक्षित क्षेत्र का एकल भू भाग है;

और, संपूर्ण डंडेली अंशी बाघ आरक्षिती (डीएटीआर) जिसमें 814.884 वर्ग किलोमीटर का क्षेत्र है, वन्यजीव (संरक्षण) अधिनियम, 1972 (1972 का 53) की धारा 38फ के उपबंधों के लिए आदेश संख्या एफईई299एफडब्ल्यूएल 2007, तारीख 20 दिसंबर, 2007 द्वारा राज्य सरकार क्रोड/संकटपूर्ण बाघ प्राकृतिक वास घोषित किया गया था;

और, इन दोनों संरक्षित क्षेत्रों को वर्ष, 2007 में शासन आदेश संख्या एफईई 254 एफडब्ल्यूएल 2006, तारीख 4 जनवरी, 2007 द्वारा डंडेली अंशी बाघ आरक्षिती (डीएटीआर) के अधीन प्रशासनिक रूप से एकीकृत किया गया है;

और, डंडेली अंशी बाघ आरक्षिती संरक्षित क्षेत्रों और आरक्षित वनों के बाघ संरक्षण स्थलाकृति का 8,800 वर्ग किलोमीटर के निकट का भाग है और डंडेली वन्यजीव अभयारण्य उत्तर में भीमगढ़ वन्यजीव अभयारण्य से सटा हुआ है जो आगे महाराष्ट्र में राधा नगरी तथा कोयना वन्यजीव अभयारण्यों से जुड़ा हुआ है। पश्चिम की ओर गोवा के समीप डंडेली अंशी बाघ आरक्षिती में पांच संरक्षित क्षेत्र हैं;

और, डंडेली अंशी बाघ आरक्षिती दुर्लभ स्थानिक वनस्पति और प्राणिजात के लिए गृह है और पाई गई वनस्पति का मुख्य भाग विशिष्ट दक्षिण भारतीय किस्म के मांसाहारी भांति का है और महत्वपूर्ण वनस्पति के अंतर्गत बाघ, तेंदुआ, ढोले, सियार, हाथी, गौर, संबर मृग, धारीदार मृग, मुंजक, पिसूरी, रीछ, हनुमान लंगूर, लघु पुच्छ वानर, भारतीय विशाल गिलहरी, उड़न गिलहरी, साल आदि हैं;

और, डंडेली अंशी बाघ आरक्षिती में कम से कम 272 पक्षी प्रजातियों का पर्यावास है जो 45 परिवारों से संबंधित है जिसमें 19 प्रजातियां स्थानिक हैं और यहां बृहत् भारतीय तितली-दक्षिणी पक्षीपंख के स्थानिक मालाबार वृक्ष निम्फ़ अच्छी जनसंख्या में पाये जाते हैं और चर्चित पक्षियों में सामान्य ग्रे धनेश, मालाबार ग्रे धनेश, मालाबार पाइड धनेश, ग्रे भारतीय पाइड धनेश और साइलॉन फ्रोगमाउथ सम्मिलित है;

और, अंशी राष्ट्रीय उद्यान के अंतर्गत मुख्यत वनों के प्रकारों में उष्णकटिबंधीय सदाहरित और अर्ध सदाहरित है और यह छोटे स्तनधारियों, सरीसृपों, उभयचरों, तितलियों, आर्किडों, पक्षियों, औषधी जड़ी-बूटियों और कीड़े-मकोडों के लिए पर्यावास है और इसमें किंग कोबरा, अजगर, कोबरा, रैट सांप, वाइपर (बाँस पिट वाइपर, हम्प नोस्ड पिट वाइपर, मालाबार पिट वाइपर आदि), ऑरनेट फ्लाइंग सांप, वूल्फ सांप और करैत सांपों के साथ-साथ और अन्य जैसे ड्राको सम्मिलित है;

और, राज्य सरकार ने वन्यजीव (संरक्षण) अधिनियम, 1972 (1972 का 53) की धारा 26क के अधीन अपने आदेश संख्या एफईई-16-एफडब्ल्यूएल-2008, तारीख 21 अगस्त, 2009 और अधिसूचना संख्या एफईई 123 एफडब्ल्यूएल 009, तारीख 1 सितंबर, 2010 द्वारा डंडेली अंशी बाघ आरक्षिती के 282.63 वर्ग किलोमीटर के क्षेत्र को मध्यवर्ती जोन के रूप में अधिसूचित किया है;

अतः, अब, केन्द्रीय सरकार, पर्यावरण (संरक्षण) नियम, 1986 के नियम 5 के उपनियम (3) के साथ पठित पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) की धारा 3 की उपधारा (1), उपधारा (2) के खंड (v) और खंड (xiv) और उप धारा (3) द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए, कर्नाटक राज्य के डंडेली अंशी बाघ आरक्षिती की सीमा के चारों ओर 7 किलोमीटर तक के विस्तार वाले क्षेत्र को डंडेली अंशी बाघ आरक्षिती, पारिस्थितिक संवेदी जोन (जिसे इसमें इसके पश्चात् पारिस्थितिक संवेदी जोन कहा गया है) के रूप में अधिसूचित करती है, जिसका ब्यौरे निम्नानुसार है, अर्थात् :--

1. **पारिस्थितिक संवेदी जोन का विस्तार और उसकी सीमाएं.**—(1) पारिस्थितिक संवेदी जोन पूर्वी और दक्षिणी भागों में 7 किलोमीटर तक के विस्तार सहित 1201.94 वर्ग किलोमीटर के क्षेत्र पर फैला हुआ है और डंडेली अंशी बाघ आरक्षिती उत्तर अक्षांश 14°52'29.40" और 15°31'27.94" तथा पूर्व देशांतर 74°14'53.10" और 74°43'53.30" के बीच स्थित है और गोवा के साथ अंतर्राज्यीय सीमा के कारण पश्चिमी भाग में कोई पारिस्थितिक संवेदी जोन प्रस्तावित नहीं है और भीमगढ़ वन्यजीव अभयारण्य के कारण उत्तरी भाग में भी कोई पारिस्थितिक संवेदी जोन प्रस्तावित नहीं है तथा ऐसे जोन की सीमा के वर्णन **उपाबंध I** में दिया गया है ।

(2) अक्षांश और देशांतर के साथ पारिस्थितिक संवेदी जोन की सीमा के ब्यौरे मानचित्र सहित **उपाबंध II** के रूप में संलग्न है।

(3) प्रमुख बिंदुओं के निर्देशांकों के साथ पारिस्थितिक संवेदी जोन के भीतर आने वाले ग्रामों की सूची **उपाबंध III** में दी गई है।

(4) पारिस्थितिक संवेदी जोन की सीमा पर और साथ ही अभायरण्य पर मुख्य अवस्थित (बिंदु) **उपाबंध IV** में दिए गए हैं।

2. **पारिस्थितिक संवेदी जोन के लिए आंचलिक महायोजना** —(1) राज्य सरकार, पारिस्थितिक संवेदी जोन के प्रयोजनों के लिए राजपत्र में इस अधिसूचना के अंतिम प्रकाशन की तारीख से दो वर्ष की अवधि के भीतर, स्थानीय व्यक्तियों के परामर्श से, और इस अधिसूचना में दिए गए अनुबंधों का पालन करते हुए आंचलिक महायोजना तैयार करेगी ।

(2) आचंलिक महायोजना का अनुमोदन राज्य सरकार में सक्षम प्राधिकारी द्वारा किया जाएगा ।

(3) पारिस्थितिक संवेदी जोन के लिए आंचलिक महायोजना राज्य सरकार द्वारा ऐसी रीति जैसा इस अधिसूचना में विनिर्दिष्ट है और सुसंगत केन्द्रीय और राज्य विधियों तथा केन्द्रीय सरकार द्वारा जारी मार्गदर्शक सिद्धांतों, यदि कोई हो, के अनुरूप भी तैयार की जाएगी ।

(4) आंचलिक महायोजना सभी संबद्ध राज्य विभागों के साथ परामर्श से पर्यावरणीय और पारिस्थितिक विचारणों को उसमें एकीकृत करने के लिए तैयार की जाएगी, अर्थात्:—

(i) पर्यावरण ;
(ii) वन ;
(iii) शहरी विकास ;
(iv) पर्यटन ;
(v) नगरपालिका ;
(vi) राजस्व ;
(vii) कृषि ;
(viii) कर्नाटक राज्य प्रदूषण नियंत्रण बोर्ड;
(ix) सिंचाई; और
(x) लोक निर्माण विभाग।

(5) आंचलिक महायोजना अनुमोदित विद्यमान भू-उपयोग, अवसंरचना और क्रियाकलापों पर कोई निर्बंधन अधिरोपित नहीं करेगी जब तक कि इस अधिसूचना में विनिर्दिष्ट न हो और आचंलिक महायोजना सभी अवसंरचना और क्रियाकलापों में दक्षता और पारिस्थितिक अनुकूलता का सुधार करेगी ।

(6) आंचलिक महायोजना में अनाच्छादित क्षेत्रों के जीर्णोद्धार, विद्यमान जल निकायों के संरक्षण, आवाह क्षेत्रों के प्रबंधन, जल-संभरों के प्रबंधन, भूतल जल के प्रबंधन, मृदा और नमी संरक्षण, स्थानीय समुदायों की आवश्यकताओं तथा पारिस्थितिक और पर्यावरण से संबंधित ऐसे अन्य पहलूओं, जिन पर ध्यान देना आवश्यक है, के लिए उपबंध होंगे।

(7) आंचलिक महायोजना सभी विद्यमान पूजा स्थलों, ग्रामों और नगरीय बंदोबस्तों, वनों के प्रकार और किस्मों, कृषि क्षेत्रों, ऊपजाऊ भूमि, हरित क्षेत्र जैसे उद्यान और उसी प्रकार के स्थान, उद्यान कृषि क्षेत्र, फलोधान, झीलों और अन्य जल निकायों का अभ्यकंन करेगी।

(8) आंचलिक महायोजना पारिस्थितिक संवेदी जोन में विकास का विनियमन करेगी ताकि स्थानीय समुदायों के पारिस्थितिक अनुकूल विकास का उनके जीवकोपार्जन को संरक्षित करने के लिए सुनिश्चित किया जा सके।

3. **राज्य सरकार द्वारा किए जाने वाले उपाय** —राज्य सरकार इस अधिसूचना के उपबंधों को प्रभावी करने के लिए निम्नलिखित उपाय करेगी, अर्थात् :—

(1) **भू-उपयोग** —पारिस्थितिक संवेदी जोन में वनों, उद्यान-कृषि क्षेत्रों, कृषि क्षेत्रों, आमोद-प्रमोद के प्रयोजन के लिए चिन्हित किए गए पार्कों और खुले स्थानों का वाणिज्यिक और औद्योगिक संबद्ध विकास क्रियाकलापों के लिए उपयोग या संपरिवर्तन नहीं होगा:

परंतु पारिस्थितिक संवेदी जोन के भीतर कृषि भूमि का संपरिवर्तन, मानीटरी समिति की सिफारिश पर और राज्य सरकार के पूर्व अनुमोदन से, स्थानीय निवासियों की आवासीय जरूरतों को पूरा करने के लिए और पैरा 4 की सारणी के स्तंभ (2) के अधीन मद सं. 12, 18, 24, 33 और 36 के क्रियाकलापों को पूरा करने के लिए अनुज्ञात होंगे, अर्थात् :-

(i) पारिस्थितिक अनुकूल पर्यटन क्रियाकलापों के लिए पर्यटकों के अस्थायी आवासन के लिए पारिस्थितिक अनुकूल आरामगाह जैसे टेंट, लकड़ी के मकान आदि;
(ii) विद्यमान सड़कों को चौड़ा और सुदृढ़ करना;
(iii) प्रदूषण उत्पन्न न करने वाले लघु उद्योग;
(iv) वर्षा जल संचय; और
(v) कुटीर उद्योग, जिसके अंतर्गत ग्रामीण उद्योग, सुविधा भंडार और स्थानीय सुविधाएं सम्मिलित हैं।

परंतु यह और कि जनजातीय भूमि का उपयोग राज्य सरकार के पूर्व अनुमोदन और संविधान के अनुच्छेद 244 या तत्समय प्रवृत्त विधि के उपबंधों के अनुपालन के बिना, जिसके अंतर्गत अनुसूचित जनजाति और अन्य परंपरागत वन निवासी (वन अधिकारों की मान्यता) अधिनियम, 2006 (2007 का 2) भी है, वाणिज्यिक या उद्योग विकास क्रियाकलापों के लिए अनुज्ञात नहीं होगा :—

परंतु यह और भी कि पारिस्थितिक संवेदी जोन के भीतर भू-अभिलेखों में उपसंजात कोई त्रुटि, मानीटरी समिति के विचार प्राप्त करने के पश्चात् राज्य सरकार द्वारा प्रत्येक मामले में एक बार संशोधित होगी और उक्त त्रुटि के संशोधन की सूचना केंद्रीय सरकार के पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय को देनी होगी।

परंतु यह और भी कि उपर्युक्त त्रुटि का संशोधन में इस उप पैरा के अधीन यथा उपबंधित के सिवाय किसी भी दशा में भू-उपयोग का परिवर्तन सम्मिलित नहीं होगा।

परंतु यह और भी कि जिससे हरित क्षेत्र में जैसे वन क्षेत्र, कृषि क्षेत्र आदि में कोई पारिणामिक कटौती नहीं होगी और अनप्रयुक्त या अनुत्पादक कृषि क्षेत्रों में पुन: वनीकरण करने के प्रयास किए जाएंगे।

(2) **प्राकृतिक जल स्रोतों.**—आचंलिक महायोजना में सभी प्राकृतिक जल स्रोतों की पहचान की जाएगी और उनके संरक्षण और पुनरुद्‌भूतकरण के लिए योजना सम्मिलित होगी और राज्य सरकार द्वारा ऐसे क्षेत्रों पर या उनके निकट विकास क्रियाकलाप प्रतिषिद्ध करने के लिए ऐसी रीति से मार्गनिर्देश तैयार किए जाएंगे ।

(3) **पर्यटन.**—(क) पारिस्थितिक संवेदी जोन के भीतर पर्यटन संबंधी क्रियाकलाप पर्यटन महायोजना के अनुसार होंगे जो कि आंचलिक महायोजना के भाग रूप में होगी ।

(ख) पर्यटन महायोजना पर्यटन विभाग, राज्य सरकार के वन और पर्यावरण विभाग के परामर्श से तैयार की जाएगी।

(ग) पर्यटन संबंधी क्रियाकलाप निम्नलिखित के अधीन विनियमित होंगे, अर्थात् :-

(i) पारिस्थितिक संवेदी जोन के भीतर सभी नए पर्यटन क्रियाकलापों या विद्यमान पर्यटन क्रियाकलापों का विस्तार केंद्र सरकार के पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय के मार्गदर्शक सिद्धांतों के द्वारा तथा राष्ट्रीय व्याघ्र संरक्षण प्राधिकरण, द्वारा जारी पारिस्थितिक पर्यटन (समय-समय पर यथा संशोधित) मार्गदर्शक सिद्धांतों के अनुसार, पारिस्थितिक पर्यटन, पारिस्थितिक शिक्षा और पारिस्थितिक विकास को महत्व देते हुए पारिस्थितिक संवेदी जोन की वहन क्षमता के अध्ययन पर आधारित होगा;

(ii) पारिस्थितिक अनुकूल पर्यटक क्रियाकलापों के संबंध में अस्थायी अधिभोग के लिए वास सुविधा के सिवाय डंडेली अंशी बाघ आरक्षिती की सीमा से एक किलोमीटर के भीतर होटल और रिसोर्टों का नया संनिर्माण अनुज्ञात नहीं होगा;

परंतु संरक्षित क्षेत्र की सीमा से एक किलोमीटर की दूरी से परे पारिस्थितिक संवेदी जोन की सीमा तक नए होटल और रिसोर्ट की स्थापना पर्यटन महायोजना के अनुसार पारिस्थितिक पर्यटन सुविधा के लिए पूर्व परिभाषित और विनिर्दिष्ट स्थान में ही अनुज्ञात किया जाएगा ।

(iii) आंचलिक महायोजना का अनुमोदन किए जाने तक, पर्यटन के लिए विकास और विद्यमान पर्यटन क्रियाकलापों के विस्तार को वास्तविक स्थल विनिर्दिष्ट संवीक्षा तथा मानीटरी समिति की सिफारिश पर आधारित संबंधित विनियामक प्राधिकरणों द्वारा अनुज्ञात किया होगा ।

(4) **नैसर्गिक विरासत** —पारिस्थितिक संवेदी जोन में महत्वपूर्ण नैसर्गिक विरासत के सभी स्थलों जैसे सभी जीन कोश आरक्षित क्षेत्र, शैल विरचनाएं, जल प्रपातों, झरनों, घाटी मार्गों, उपवनों, गुफाएं, स्थलों, भ्रमण, अश्वरोहण, प्रपातो आदि की पहचान की जाएगी और उन्हें संरक्षित किया जाएगा तथा उनकी सुरक्षा और संरक्षा के लिए इस अधिसूचना के अंतिम प्रकाशन की तारीख से छह मास के भीतर, उपयुक्त योजना बनाएगी और ऐसी योजना आंचलिक महायोजना का भाग होगा ।

(5) **मानव निर्मित विरासत स्थल** —पारिस्थितिक संवेदी जोन में भवनों, संरचनाओं, शिल्प-तथ्य, ऐतिहासिक, कलात्मक और सांस्कृतिक महत्व के क्षेत्रों की पहचान करनी होगी और इस अधिसूचना के अंतिम प्रकाशन की तारीख से छह माह के भीतर उनके संरक्षण की योजनाएं तैयार करनी होगी तथा आंचलिक महायोजना में सम्मिलित की जाएगी ।

(6) **ध्वनि प्रदूषण** —पारिस्थितिक संवेदी जोन में ध्वनि प्रदूषण के नियंत्रण के लिए राज्य सरकार का पर्यावरण विभाग, वायु (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1981 (1981 का 14) और उसके अधीन बनाए गए नियमों के उपबंधों के अनुसरण में मार्गदर्शक सिद्धांत और विनियम तैयार करेगा ।

(7) **वायु प्रदूषण.**—पारिस्थितिक संवेदी जोन में, वायु प्रदूषण के नियंत्रण के लिए राज्य सरकार का पर्यावरण विभाग, वायु (प्रदूषण निवारण और नियंत्रण) अधिनियम, 1981 (1981 का 14) और उसके अधीन बनाए गए नियमों के उपबंधों के अनुसरण में मार्गदर्शक सिद्धांत और विनियम तैयार करेगा ।

(8) **बहिस्राव का निस्सारण.**—पारिस्थितिक संवेदी जोन में उपचारित बहिस्राव का निस्सारण, जल (प्रदूषण निवारण तथा नियंत्रण) अधिनियम, 1974 (1974 का 6) और उसके अधीन बनाए गए नियमों के उपबंधों के अनुसार होगा ।

(9) **ठोस अपशिष्ट.**—ठोस अपशिष्टों का निपटान निम्नलिखित रूप में होगा :—

(i) पारिस्थितिक संवेदी जोन में ठोस अपशिष्टों का निपटान भारत सरकार के तत्कालीन पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय की समय-समय पर यथा संशोधित अधिसूचना सं.का.आ. 1357(अ), तारीख 8 अप्रैल, 2016 नगरपालिक ठोस अपशिष्ट प्रबंध नियम, 2016 के उपबंधों के अनुसार किया जाएगा ;

(ii) स्थानीय प्राधिकरण जैव निम्नीकरणीय और अजैव निम्नीकरणीय संघटकों में ठोस अपशिष्टों के संपृथक्कन के लिए योजनाएं तैयार करेंगे ;

(iii) जैव निम्नीकरणीय सामग्री को अधिमानतः खाद बनाकर या कृमि खेती के माध्यम से पुनःचक्रित किया जाएगा ;

(iv) अकार्बनिक सामग्री का निपटान पारिस्थितिक संवेदी जोन के बाहर पहचान किए गए स्थल पर किसी पर्यावरणीय स्वीकृत रीति में होगा और पारिस्थितिक संवेदी जोन में ठोस अपशिष्टों को जलाना या भष्मीकरण अनुज्ञात नहीं होगा ।

(10) **जैव चिकित्सीय अपशिष्ट.**—पारिस्थितिक संवेदी जोन में जैव चिकित्सीय अपशिष्टों का निपटान भारत सरकार के पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय की समय-समय पर यथासंशोधित अधिसूचना सा.का.नि. 343(अ), तारीख 28 मार्च 2016 द्वारा प्रकाशित जैव चिकित्सीय अपशिष्ट प्रबंध नियम, 2016 के उपबंधों के अनुसार किया जाएगा ।

(11) **यानीय परिवहन.**— परिवहन की यानीय गतिविधियां आवास के अनुकूल विनियमित होंगी और इस संबंध में आंचलिक महायोजना में विशेष उपबंध अधिकथित किए जाएंगे और आंचलिक महायोजना के तैयार होने और राज्य सरकार के सक्षम प्राधिकारी के द्वारा अनुमोदित होने तक, मानीटरी समिति प्रवृत्त नियमों और विनियमों के अनुसार यानीय गतिविधियों के अनुपालन को मानीटर करेगी ।

(12) **औद्योगिक इकाईयां.**—(क) प्रस्तावित पारिस्थितिक संवेदी जोन में विधि के अनुसार स्थापित विद्यमान काष्ठ आधारित उद्योगों के सिवाए नए काष्ठ आधारित उद्योगों की स्थापना को अनुज्ञात नहीं किया जाएगा ।

(ख) जल, वायु, मृदा, ध्वनि प्रदूषण कारित करने वाले किसी नए उद्योग की प्रस्तावित पारिस्थितिक संवेदी जोन में स्थापना को अनुज्ञात नहीं किया जाएगा ।

4. पारिस्थितिक संवेदी जोन में प्रतिषिद्ध और विनियमित क्रियाकलापों की सूची.—पारिस्थितिक संवेदी जोन में सभी क्रियाकलाप पर्यावरण (संरक्षण) अधिनियम, 1986 (1986 का 29) के उपबंधों और तद्धीन बनाए गए नियमों द्वारा शासित होंगे और नीचे दी गई तालिका में विनिर्दिष्ट रीति में विनियमित होंगे, अर्थात् :—

सारणी

क्रम सं.	क्रियाकलाप	टीका-टिप्पणी
(1)	(2)	(3)
		प्रतिषिद्ध क्रियाकलाप
1.	वाणिज्यिक खनन, पत्थर की खदान और उनको तोड़ने की इकाइयां।	(क) सभी प्रकार के नए और विद्यमान खनन (लघु और वृहत खनिज), पत्थर उत्खनन और उनको तोड़ने की इकाइयां प्रतिषिद्ध हैं, सिवाय निवासियों की वास्तविक घरेलू आवश्यकताओं के नहीं होंगी, जिसके अंतर्गत गृहों के संनिर्माण या मरम्मत के लिए मिट्टी की खुदाई और व्यक्तिक उपभोग के लिए गृहों के निर्माण के लिए देशी टाइलों या ईंटों का संनिर्माण भी है। (ख) खनन संक्रियाएं, माननीय उच्चतम न्यायालय की रिट याचिका (सिविल) सं. 1995 का 202 टी.एन. गौडाबर्मन थिरुमूलपाद बनाम भारत संघ के मामले में आदेश तारीख 4 अगस्त, 2006 और रिट याचिका (सी) सं. 2012 का 435 गोवा फाउंडेशन बनाम भारत संघ के मामले में तारीख 21 अप्रैल, 2014 के अंतरिम आदेश के अनुसरण में सर्वदा प्रचालन होगा।
2.	आरा मीलों की स्थापना।	पारिस्थितिक संवेदी जोन के भीतर नई और विद्यमान आरा मीलों का विस्तार अनुज्ञात नहीं होगा।
3.	जल या वायु या मृदा या ध्वनि प्रदूषण कारित करने वाले उद्योगों की स्थापना।	पारिस्थितिक संवेदी जोन के भीतर नए और विद्यमान प्रदूषण कारित करने वाले का विस्तार अनुज्ञात नहीं होगा।
4.	जलावन लकड़ी का वाणिज्यिक उपयोग।	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।
5.	नई मुख्य जल विद्युत और सिंचाई परियोजनाओं की स्थापना।	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।
6.	किसी परिसंकटमय पदार्थ जिसके अंतर्गत नाशक जीवमार और कीटनाशी भी है का उपयोग या उत्पादन।	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।
7.	प्राकृतिक जल निकायों या सतही क्षेत्र में अनुपचारित बहिस्राव और ठोस अपशिष्टों का	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।

क्रम सं.	क्रियाकलाप	टीका-टिप्पणी
	निस्सारण।	
8.	ठोस अपशिष्टों का निपटान।	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।
9.	नए काष्ठ आधारित उद्योग।	पारिस्थितिक संवेदी जोन की सीमाओं के भीतर नए काष्ठ आधारित उद्योग की कोई स्थापना अनुज्ञात नहीं की जाएगी : परंतु विद्यमान काष्ठ आधारित उद्योग विधि के अनुसार बना रहेगा: परंतु यह भी कि विद्यमान आरा मीलों की अनुज्ञप्तियों का नवीकरण उनकी समाप्ति अवधि पर नहीं किया जाएगा।
10.	पवन चक्कियों और मोबाइल टावरों का परिनिर्माण।	लागू विधियों के अनुसार प्रतिषिद्ध (अन्यथा उपबंधित के सिवाय)।
	विनियमित क्रियाकलाप	
11.	प्लास्टिक के कैरी बैग, लैमिनेटों और टेट्रापैकों का उपयोग।	लागू विधियों के अनुसार विनियमित होंगे।
12.	होटलों और रिसोर्टों की वाणिज्यिक स्थापना।	पारिस्थितिक पर्यटन क्रियाकलाप से संबंधित पर्यटकों के अस्थायी व्यवसाय के लिए आवास के संबंध में संरक्षित क्षेत्र की सीमा के एक किलोमीटर या पारिस्थितिक संवेदी जोन की सीमा तक, जो भी निकट हो, के भीतर ही नए वाणिज्यिक होटलों और रिसोर्टों को अनुज्ञात किया जाएगा अन्यथा नहीं : परन्तु वन्यजीव अभयारण्य की सीमा से एक किलोमीटर से परे और पारिस्थितिक संवेदी जोन के विस्तार तक सभी नए पर्यटन क्रियाकलापों या विद्यमान क्रियाकलापों का विस्तार पर्यटन महायोजना के अनुरूप होगा।
13.	सन्निर्माण क्रियाकलाप।	संरक्षित क्षेत्र की एक किलोमीटर की सीमा के भीतर किसी भी प्रकार के नए वाणिज्यिक संनिर्माण को अनुज्ञात नहीं किया जाएगा: परंतु स्थानीय लोगों को पैरा 3 के उप पैरा (1) में सूचीबद्ध क्रियाकलापों सहित उनके आवासीय उपयोग के लिए उनकी भूमि में संनिर्माण करने की अनुमति दी जाएगी: ऐसे लघु उद्योगों जो प्रदूषण उत्पन्न नहीं करते हैं, से संबंधित संनिर्माण क्रियाकलाप विनियमित किए जाएंगे और लागू नियमों और विनियमों, यदि कोई हों, के अनुसार सक्षम प्राधिकारी की पूर्व अनुमति से ही न्यूनतम पर रखे जाएंगे। एक किलोमीटर से आगे और पारिस्थितिक संवेदी जोन की सीमा तक वास्तविक स्थानीय आवश्यकताओं के लिए संनिर्माण की अनुज्ञा दी जाएगी और अन्य वाणिज्यिक संनिर्माण क्रियाकलाप आंचलिक महायोजना के अनुरूप होंगे।
14.	वृक्षों की कटाई।	(क) राज्य सरकार में सक्षम प्राधिकारी की पूर्व अनुमति के बिना वन, सरकारी या राजस्व या निजी भूमि पर या वनों में किंही वृक्षों की कटाई नहीं होगी।

क्रम सं.	क्रियाकलाप	टीका-टिप्पणी
		(ख) वृक्षों की कटाई संबंधित केंद्रीय या राज्य अधिनियम या उसके अधीन बनाए गए नियमों के उपबंध के अनुसार विनियमित होगी । (ग) आरक्षित वनों और संरक्षित वनों की दशा कार्ययोजना में दिए गए विवरण का अनुसरण किया जाएगा।
15.	वाणिज्यिक जल संसाधन जिसके अंतर्गत भू-जल संचयन भी है ।	(क) भूमि के अधिभोगी के वास्तविक कृषि और घरेलू खपत के लिए जल का निष्कर्षण (सतही और भूमिगत जल) अनुज्ञात होगा । (ख) औद्योगिक, वाणिज्यिक उपयोग के लिए सतही और भूमिगत जल का निष्कर्षण के लिए संबंधित विनियामक प्राधिकरण पूर्व लिखित अनुज्ञा अपेक्षित होगी जिसके अंतर्गत कितने परिणाम में वह निष्कर्षण करेगा, भी है । (ग) सतही या भूजल का विक्रय अनुज्ञात नहीं होगा। (घ) जल के संदूषण या प्रदूषण, जिसके अंतर्गत कृषि भी है, को रोकने के लिए सभी उपाय किए जाएंगे ।
16.	विद्युत केबलों, पारेषण लाइनों और दूरसंचार टावरों का परिनिर्माण।	(i) भूमिगत केबल बिछाने को प्रोत्साहन दिया जाएगा। (ii) 11 केवी तक घरेलू प्रयोजन के लिए विद्युत लाइनों को भविष्य में भूमिगत बिछाया जाएगा । (iii) 11 केवी से अधिक किसी पारेषण लाइन के लिए टावरों के बीच "अवतलन"बिंदु भूमि से सुरक्षित दूरी पर होना चाहिए ।
17.	होटलों और लॉज के विद्यमान परिसरों में बाड़ लगाना ।	लागू विधियों के अधीन विनियमित होंगे ।
18.	नई सड़कों का संनिर्माण विद्यमान सड़कों को चौड़ा करना और उन्हें सुदृढ़ करना।	उचित पर्यावरण समाघात निर्धारण और न्यूनीकरण उपाय यथा लागू अनुसार होंगे ।
19.	रात्रि में यानिक यातायात का संचलन ।	लागू विधियों के अधीन वाणिज्यिक प्रयोजन के लिए विनियमित होंगे ।
20.	विदेशी प्रजातियों को लाना ।	लागू विधियों के अधीन विनियमित होंगे ।
21.	पहाड़ी ढालों और नदी तटों का संरक्षण ।	लागू विधियों के अधीन विनियमित होंगे ।
22.	प्राकृतिक जल निकायों या भू–क्षेत्र में उपचारित बहिर्स्रावों का निस्सारण और ठोस अपशिष्ट का निपटान।	उपचारित बहिस्त्रावों का पुनःचक्रण को प्रोत्साहन दिया जाएगा और गाद या ठोस अपशिष्टों के निपटान के लिए विद्यमान विनियमों का पालन किया जाएगा ।
23.	वाणिज्यिक साइन बोर्ड और होर्डिंग ।	लागू विधियों के अधीन विनियमित होंगे ।

क्रम सं.	क्रियाकलाप	टीका-टिप्पणी
24.	प्रदूषण उत्पन्न न करने वाले लघु उद्योग।	पारिस्थितिक संवेदी जोन से गैर प्रदूषण, गैर परिसंकटमय, लघु और सेवा उद्योग, कृषि, पुष्प कृषि, उद्यान कृषि या कृषि आधारित देशीय माल से औद्योगिक उत्पादों का उत्पादन उद्योग और जो पर्यावरण पर कोई विपरीत प्रभाव नहीं डालते हैं, को अनुज्ञात किया जाएगा।
25.	वन उत्पादों और गैर काष्ठ वन उत्पादों का संग्रहण।	लागू विधियों के अधीन विनियमित होंगे।
26.	वायु और यानीय प्रदूषण।	लागू विधियों के अधीन विनियमित होंगे।
27.	कृषि प्रणाली में आमूल परिवर्तन।	लागू विधियों के अधीन विनियमित होंगे।
28.	पर्यटन से संबंधित क्रियाकलाप जैसे गर्म वायु गुब्बारों आदि द्वारा राष्ट्रीय उद्यान क्षेत्र के ऊपर से उड़ना जैसे क्रियाकलाप करना।	लागू विधियों के अधीन विनियमित होंगे।
29.	मछली पकड़ना।	लागू विधियों के अधीन विनियमित होंगे।
30.	ठोस अपशिष्ट प्रबंधन।	लागू विधियों के अधीन विनियमित होंगे।
31.	पारिस्थितिक-पर्यटन।	लागू विधियों के अधीन विनियमित होंगे।
	संवर्धित क्रियाकलाप	
32.	स्थानीय समुदायों द्वारा चल रही कृषि और बागवानी व्यवसायों के साथ पशुपालन, पशुपालन कृषि, जल कृषि और मछली पालन।	लागू विधियों के अधीन अनुज्ञात होंगे।
33.	वर्षा जल संचयन।	सक्रिय रूप से बढावा दिया जाएगा।
34.	जैविक खेती।	सक्रिय रूप से बढावा दिया जाएगा ।
35.	सभी गतिविधियों के लिए हरित प्रौद्योगिकी को ग्रहण करना।	सक्रिय रूप से बढावा दिया जाएगा ।
36.	कुटीर उद्योगों जिसके अंतर्गत ग्रामीण कारीगर और अन्य कुटीर उद्योग आदि भी हैं।	सक्रिय रूप से बढावा दिया जाएगा ।
37.	नवीकरणीय ऊर्जा स्रोत का उपयोग।	बायो गैस, सौर लाइट, आदि का संवर्धन किया जाएगा।
38.	कृषि वानिकी।	सक्रिय रूप से बढावा दिया जाएगा ।
39.	कौशल विकास।	सक्रिय रूप से बढावा दिया जाएगा ।
40.	पर्यावरणीय जागरुकता।	सक्रिय रूप से बढावा दिया जाएगा ।

5. मानीटरी समिति.—(1) केंद्रीय सरकार, पर्यावरण संरक्षण अधिनियम, 1986 (1986 का 29) की धारा 3 द्वारा प्रदत्त शक्तियों का प्रयोग करते हुए इस अधिसूचना के अनुपालन को मानीटर करने के लिए एक समिति का गठन करेगी जिसका नाम डंडेली अंशी बाघ आरक्षिती पारिस्थितिक संवेदी जोन मानीटरी समिति होगा, अर्थात् :-

(2) ऊपर पैरा (1) में निर्दिष्ट मानीटरी समिति निम्नलिखित सदस्यों से मिलकर बनेगी :-

(i) क्षेत्रीय आयुक्त, बेलगाम	– अध्यक्ष;
(ii) विधानसभा सदस्य, जायडा, निर्वाचन क्षेत्र	- सदस्य;
(iii) विधानसभा सदस्य, करवार, निर्वाचन क्षेत्र	- सदस्य;
(iv) विधानसभा सदस्य, येलापुर, निर्वाचन क्षेत्र	- सदस्य;
(v) विधानसभा सदस्य, हलियाल, निर्वाचन क्षेत्र	- सदस्य;
(vi) पर्यावरण विभाग का प्रतिनिधि, कर्नाटक सरकार	- सदस्य;
(vii) शहरी विकास विभाग, कर्नाटक सरकार का प्रतिनिधि	- सदस्य;
(viii) पर्यावरण के क्षेत्र में कार्य करने वाले गैर सरकारी संगठनों (जिसके अंतर्गत विरासत संरक्षण भी है) का प्रत्येक मामले में कर्नाटक राज्य सरकार द्वारा नामनिर्दिष्ट एक प्रतिनिधि	- सदस्य;
(ix) क्षेत्रीय अधिकारी, कर्नाटक राज्य प्रदूषण नियंत्रण बोर्ड, करवार	- सदस्य;
(x) पारिस्थितिक और पर्यावरण के क्षेत्र से कर्नाटक सरकार द्वारा नामर्निदिष्ट किया जाने वाला एक विशेषज्ञ	- सदस्य;
(xi) उपायुक्त या उसका प्रतिनिधि, करवार	- सदस्य;
(xii) राज्य जैव विविधता बोर्ड का सदस्य	- सदस्य;
(xiii) वन संरक्षक और निदेशक, डंडेली अंशी बाघ आरक्षिती, डंडेली	- सदस्य-सचिव।

6. निर्देश निबंधन :

(1) मानीटरी समिति का कार्यकाल तीन वर्ष के लिए होगा।

(2) मानीटरी समिति इस अधिसूचना के उपबंधों के अनुपालन को मानीटर करेगी।

(3) पारिस्थितिक संवेदी जोन में भारत सरकार के तत्कालीन पर्यावरण और वन मंत्रालय की अधिसूचना सं. का.आ. 1533(अ) तारीख 14 सितंबर, 2006 की अनुसूची में के अधीन सम्मिलित क्रियाकलापों और इस अधिसूचना के पैरा 4 के अधीन प्रतिषिद्ध गतिविधियों के सिवाय आने वाले ऐसे क्रियाकलापों की दशा में वास्तविक विनिर्दिष्ट स्थलीय दशाओं पर आधारित मानीटरी समिति द्वारा संवीक्षा की जाएगी और उक्त अधिसूचना के उपबंधों के अधीन पूर्व पर्यावरण निकासी के लिए केन्द्रीय सरकार के पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय को निर्दिष्ट की जाएगी।

(4) इस अधिसूचना के पैरा 4 के अधीन यथा विनिर्दिष्ट प्रतिषिद्ध क्रियाकलापों के सिवाय, भारत सरकार के पर्यावरण और वन मंत्रालय की अधिसूचना संख्यांक का.आ. 1533(अ) तारीख 14 सितंबर, 2006 की अधिसूचना के अनुसूची के अधीन ऐसे क्रियाकलापों, जिन्हें सम्मिलित नहीं किया गया है, परंतु पारिस्थितिक संवेदी जोन में आते हैं, ऐसे क्रियाकलापों की वास्तविक विनिर्दिष्ट स्थलीय दशाओं पर आधारित मानीटरी समिति द्वारा संवीक्षा की जाएगी और उसे संबद्ध विनियामक प्राधिकरणों को निर्दिष्ट किया जाएगा ।

(5) मानीटरी समिति का सदस्य-सचिव या संबद्ध उपायुक्त, ऐसे व्यक्ति के विरूद्ध, जो इस अधिसूचना के किसी उपबंध का उल्लंघन करता है, पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 19 के अधीन परिवाद फाइल करने के लिए सक्षम होगा ।

(6) मानीटरी समिति मुद्दा दर मुद्दा के आधार पर अपेक्षाओं पर निर्भर रहते हुए संबद्ध विभागों के प्रतिनिधियों या विशेषज्ञों, औद्योगिक संगमों या संबद्ध पणधारियों के प्रतिनिधियों को अपने विचार-विमर्श में सहायता के लिए आमंत्रित कर सकेगी ।

(7) मानीटरी समिति प्रत्येक वर्ष की 31 मार्च तक की राज्य के मुख्य वन्यजीव वार्डन को अपनी वार्षिक कार्रवाई रिपोर्ट **उपाबंध V** पर उपाबद्ध रूप विधान के अनुसार उक्त वर्ष के 30 जून तक प्रस्तुत करेगी ।

(8) केन्द्रीय सरकार का पर्यावरण, वन और जलवायु परिवर्तन मंत्रालय मानीटरी समिति को अपने कृत्यों के प्रभावी निर्वहन के लिए समय-समय पर ऐसे निदेश दे सकेगा, जो वह ठीक समझे ।

7. इस अधिसूचना के उपबंधों को प्रभाव देने के लिए केंद्रीय सरकार और राज्य सरकार अतिरिक्त उपाय, यदि कोई हों, विनिर्दिष्ट कर सकेंगे ।

8. इस अधिसूचना के उपबंध, भारत के माननीय उच्चतम न्यायालय या उच्च न्यायालय या राष्ट्रीय हरित प्राधिकरण द्वारा पारित कोई आदेश या पारित होने वाले किसी आदेश, यदि कोई हों, के अधीन होंगे ।

[एफ. सं. 25/29/2016-ईएसजेड-आरई]

डा. टी. चांदनी, वैज्ञानिक 'जी'

उपाबंध I

पारिस्थितिक संवेदी जोन की सीमा का वर्णन

उत्तर-पूर्व: पारिस्थितिक संवेदी जोन की सीमा कैस्टलरॉक वन्यजीव श्रेणी सीमा के उत्तर-पूर्व भूभाग से आरंभ होकर जहाँ यह देवल्ली (टीनाईघाट) ग्राम की उत्तर पश्चिम सीमा को छूती है और इसके बाद यह देवल्ली ग्राम की सीमा के साथ यह कामरा ग्राम सीमा को छूती है । सीमा इसके बाद कामरा ग्राम सीमा के साथ उत्तर पूर्व दिशा की ओर मुड़कर और कामरा ग्राम की पूर्वी सीमा के साथ मुड़कर, यह सूपा अप्रवाही जल को छूती है । इसके बाद यह सूपा जलाशय के अप्रवाही जल के साथ जाती है फिर यह करनजायडा ग्राम की उत्तरी सीमा को छूती है । इस बिंदु से यह करनजायडा ग्राम की पश्चिमी सीमा के साथ दक्षिण दिशा की ओर जाती है, फिर यह

देरिया ग्राम पहुँचती है। देरिया ग्राम सीमा से यह देवली (जायडा), कतेल, थिन्नाईखांड ग्रामों की सीमा के साथ पूर्वी भाग की ओर जाती है, फिर यह हुदसा ग्राम की पश्चिमी सीमा को छूती है। सीमा इसके बाद हुदसा, सनगवे, गवेगली ग्रामों की उत्तरी सीमा के साथ जाती है, फिर यह बादाकंशिरदा ग्राम के निकट हार्नबिल संरक्षण रिज़र्व सीमा को छूती है। इसके बाद यह बादाकंदशिरदा, हरनोदा ग्रामों के साथ दक्षिण पूर्व दिशा की ओर मुड़कर फिर यह बदाशिरगुर ग्राम की उत्तर पूर्व सीमा को छूती है। इसके बाद यह बोम्मानाहल्ली जलाशय की उत्तर पश्चिम सीमा को छूती है और बोम्मानाहल्ली जलाशय की सीमा के साथ जाती है और फिर यह अदिगेरा ग्राम पहुँचती है।

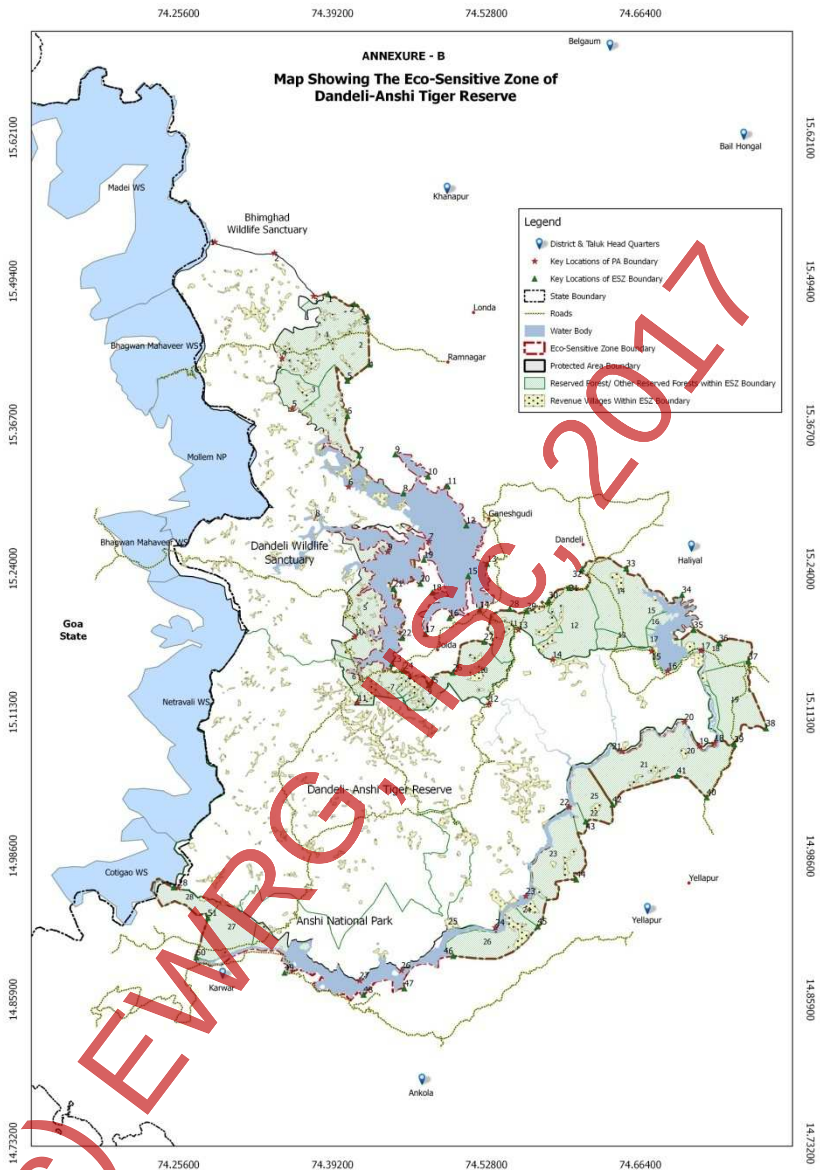
पूर्व: बोम्मानाहल्ली जलाशय के ऊपर बिंदु से जहाँ यह अदिगेरा ग्राम की उत्तर सीमा को छूकर यह बोम्मानाहल्ली जलाशय की सीमा के साथ पूर्वी दिशा की ओर जाती है, फिर यह अदिगेरा ग्राम के उत्तर पूर्व भूभाग पहुँचती है। इसके बाद यह अदिगेरा ग्राम की सीमा के साथ दक्षिण दिशा की ओर जाकर, और यह लालगूली ग्राम सीमा पहुँचती है।

दक्षिण-पूर्व: लागूली ग्राम से सीमा दक्षिण पश्चिम भाग की ओर जाती है फिर यह घोतगुली ग्राम और नगरखान ग्राम पहुँचती है। इस बिंदु से पुन: यह दक्षिण की ओर मुड़कर फिर यह कोदसली अप्रवाही जल की दक्षिणी सीमा के बरबल्ली ग्राम सीमा से और कट्टिगे ग्राम, बरबल्ली ग्राम पहुँचती है। कोदसली अप्रवाही जल बिंदु से जहाँ यह देवकर ग्राम की उत्तर पूर्व सीमा को छूकर यह देवकर ग्राम की सीमा के साथ दक्षिणी दिशा की ओर जाकर और देवकर ग्राम की दक्षिणी सीमा के साथ पश्चिमी दिशा की ओर मुड़ती है, फिर यह कदरा अप्रवाही जल को छूती है।

दक्षिण: देवकर ग्राम और कदरा अप्रवाही जल की दक्षिणी सीमा से यह कदरा अप्रवाही जल की सीमा के साथ पश्चिमी दिशा की ओर जाती है फिर यह कदरा ग्राम सीमा पहुँचती है। कदरा ग्राम से यह कदरा ग्राम की सीमा के साथ पश्चिमी दिशा की ओर जाकर, फिर यह गोयर ग्राम सीमा को छूती है। गोयर ग्राम से यह गोयर ग्राम की सीमा के साथ पश्चिमी दिशा की ओर मुड़कर, फिर यह डंडेली अंशी बाघ आरक्षिती के पश्चिमी भाग की ओर गोवा राज्य सीमा पहुँचती है।

उपाबंध II

अक्षांश और देशांतर और जीपीएस निर्देशांकों के साथ डंडेली अंशी बाघ आरक्षिती के पारिस्थितिक संवेदी जोन का मानचित्र



उपाबंध III

पारिस्थितिक संवेदी जोन के अंतर्गत आने वाले ग्रामों की सूची

क्र. सं.	तालुका	ग्राम के नाम	विस्तार (हेक्टेयर में)	अक्षांश	देशांतर	टिप्पणी
1	जायडा	पयासवाड़ी	1262.00	15.44325	74.38557	सम्पूर्ण ग्राम
2	जायडा	देवाल्ली	312.40	15.43378	74.41532	सम्पूर्ण ग्राम
3	जायडा	कामरे	191.74	15.39456	74.37339	सम्पूर्ण ग्राम
4	जायडा	लियेधाबे	197.81	15.36750	74.39199	सम्पूर्ण ग्राम
5	जायडा	करन जायडा	3401.32	15.20181	74.41904	सम्पूर्ण ग्राम
6	जायडा	कतेल	550.00	15.14060	74.40924	सम्पूर्ण ग्राम
7	जायडा	चपोली (के)	1510.75	15.13147	74.44305	सम्पूर्ण ग्राम
8	जायडा	देवली	19.97	15.14432	74.45861	सम्पूर्ण ग्राम
9	जायडा	अम्बरदा	267.00	15.12741	74.47619	सम्पूर्ण ग्राम
10	जायडा	हुदसा	94.22	15.14635	74.52218	सम्पूर्ण ग्राम
11	जायडा	पोटोलीसंगवे	124.27	15.18794	74.54856	सम्पूर्ण ग्राम
12	जायडा	वीरनोली	1951.00	15.18592	74.60232	आंशिक ग्राम
13	हलियाल	बदकंसिरदा	1524.00	15.17746	74.64425	आंशिक ग्राम
14	हलियाल	होसा-कुम्बरकोप	0.00	15.21635	74.64324	सम्पूर्ण ग्राम
15	हलियाल	हरनोदा	73.77	15.19910	74.67029	सम्पूर्ण ग्राम
16	हलियाल	मलवाड़	187.23	15.18930	74.67367	सम्पूर्ण ग्राम
17	हलियाल	कलभवी	12.26	15.17374	74.67266	सम्पूर्ण ग्राम
18	हलियाल	बोम्मनाहल्ली	119.36	15.16935	74.72710	सम्पूर्ण ग्राम
19	हलियाल	अदिगेरा	107.96	15.12031	74.74401	आंशिक ग्राम
20	येल्लापुर	लालगुली	214.14	15.07500	74.70512	सम्पूर्ण ग्राम
21	येल्लापुर	घोतागुली	7.19	15.06283	74.66387	सम्पूर्ण ग्राम
22	येल्लापुर	नगरखान	47.02	15.02766	74.61957	सम्पूर्ण ग्राम
23	येल्लापुर	हिरीयाली	603.00	14.98404	74.59049	आंशिक ग्राम
24	येल्लापुर	कतगी	190.69	14.93433	74.56715	आंशिक ग्राम
25	येल्लापुर	बारबल्ली	594.84	15.03510	74.61991	आंशिक ग्राम
26	येल्लापुर	कोदासल्ली	232.77	14.90626	74.52522	आंशिक ग्राम
	कुल क्षेत्र हेक्टेयर में	13796.71				

उपाबंध IV

क. डंडेली अंशी बाघ आरक्षिती के जीपीएस मुख्य अवस्थान (डंडेली वन्यजीव अभयारण्य एवं अंशी राष्ट्रीय उद्यान सम्मिलित है)

मानचित्र आई डी	अक्षांश	देशांतर
1	15.5253	74.2846
2	15.5145	74.3441
3	15.4809	74.3753
4	15.4258	74.3475
5	15.3814	74.3564
6	15.3123	74.4062
7	15.2641	74.4772
8	15.2845	74.3769
9	15.2548	74.4409
10	15.1796	74.4116
11	15.1213	74.4143
12	15.1205	74.5305
13	15.1857	74.5563
14	15.1595	74.5864
15	15.1668	74.6740
16	15.1495	74.6883
17	15.1672	74.7176
18	15.0858	74.7296
19	15.0831	74.7161
20	15.1043	74.7030
21	15.0785	74.6474
22	15.0291	74.6011
23	14.9504	74.5629
24	14.9241	74.5336
25	14.9195	74.4969
26	14.8825	74.4533
27	14.8736	74.4186
28	14.9581	74.2557

ख. पारिस्थितिक संवेदी जोन पर मुख्य अवस्थान (भूमण्डलीय स्थिति प्रणाली बिंदु)

मानचित्र आई डी	अक्षांश	देशांतर
1	15.4835	74.3882
2	15.4707	74.4181
3	15.4039	74.4383
4	15.3748	74.4447
5	15.3489	74.41707
6	15.3067	74.45452
7	15.3411	74.44743
8	15.3215	74.47645
9	15.3131	74.49365
10	15.2783	74.51019
11	15.2443	74.52874
12	15.2038	74.522
13	15.2335	74.51187
14	15.1964	74.49534
15	15.1822	74.47409
16	15.2190	74.48016
17	15.2480	74.47274
18	15.2267	74.4697
19	15.2223	74.44608
20	15.1788	74.45351
21	15.1559	74.44473
22	15.1498	74.45519
23	15.1370	74.47712
24	15.1481	74.49838
25	15.1754	74.52604
26	15.2045	74.54865
27	15.2274	74.55708
28	15.2122	74.58306
29	15.2230	74.60128
30	15.2399	74.61242
31	15.2402	74.65155
32	15.2169	74.70081
33	15.1859	74.71127
34	15.1741	74.73354
35	15.1579	74.75952
36	15.0989	74.77504
37	15.0847	74.74703
38	15.0378	74.72274

मानचित्र आई डी	अक्षांश	देशांतर
39	15.0570	74.69643
40	15.0314	74.63941
41	15.0165	74.61579
42	14.9652	74.60736
43	14.9237	74.57328
44	14.8822	74.51761
45	14.8448	74.48826
46	14.8657	74.37793
47	14.8595	74.40863
48	14.8963	74.27165
49	14.9313	74.28177
50	14.9583	74.25175

उपाबंध V

पारिस्थितिक संवेदी जोन मानीटरी समिति.— की गई कार्रवाई की रिपोर्ट का रूप विधान

1. बैठकों की संख्या और तारीख।
2. बैठकों का कार्यवृत : कृपया मुख्य उल्लेखनीय बिंदुओं का वर्णन करें। बैठक के कार्यवृत्त को एक पृथक अनुबंध में उपाबद्ध करें।
3. आंचलिक महायोजना की तैयारी की प्रास्थिति जिसके अंतर्गत पर्यटन महायोजना भी है।
4. भू-अभिलेख में सदृश्य त्रुटियों के सुधार के लिए ब्यौहार किए गए मामलों का सारांश।
5. पर्यावरण प्रभाव निर्धारण अधिसूचना, 2006 के अधीन आने वाली गतिविधियों की संविक्षा के मामलों का सारांश। ब्यौरे एक पृथक् उपाबंध के रूप में उपाबद्ध किए जा सकते हैं।
6. पर्यावरण प्रभाव निर्धारण अधिसूचना, 2006 के अधीन न आने वाली गतिविधियों की संविक्षा के मामलों का सारांश। ब्यौरे एक पृथक् उपाबंध के रूप में उपाबद्ध किए जा सकते हैं।
7. पर्यावरण (संरक्षण) अधिनियम, 1986 की धारा 19 के अधीन दर्ज की गई शिकायतों का सारांश।
8. कोई अन्य महत्वपूर्ण विषय।

MINISTRY OF ENVIRONMENT, FOREST AND CLIMATE CHANGE

NOTIFICATION

New Delhi, 2nd November, 2016

S.O.3369(E).—The following draft of the notification, which the Central Government proposes to issue in exercise of the powers conferred by sub-section (1), read with clause (v) and clause (xiv) of sub-section (2) and sub-section (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986) is hereby published, as required under sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, for the information of the public likely to be affected thereby; and notice is hereby given that the said draft notification shall be taken into consideration on or after the expiry of a period of sixty days from the date on which copies of the Gazette containing this notification are made available to the public;

Any person interested in making any objections or suggestions on the proposals contained in the draft notification may forward the same in writing, for consideration of the Central Government within the period so specified to the Secretary, Ministry of Environment, Forest and Climate Change, Indira Paryavaran Bhawan, Jorbagh Road, Aliganj, New Delhi-110003, or send it to the e-mail address of the Ministry at: - esz-mef@nic.in

Draft Notification

WHEREAS, Dandeli Wildlife Sanctuary and Anshi National Park are situated in Haliyal, Joida, and Karwar taluk's of Uttara Kannada district in the State Karnataka state;

AND WHEREAS, Dandeli Wildlife Sanctuary (475.018 square kilometre) and Anshi National Park (339.866 square kilometre) are contiguous to each other and form a single tract of protected area located in biologically sensitive Western Ghats;

AND WHEREAS, the entire Dandeli-Anshi Tiger Reserve (DATR) with an area of 814.884 square kilometre was notified as Core/Critical Tiger Habitat by the State Government vide Order No. FEE 299 FWL 2007 dated 20-12-2007 under the provisions of the Section 38V of the Wildlife (Protection) Act 1972, (53 of 1972);

AND WHEREAS, these two protected areas are administratively unified under Dandeli-Anshi Tiger Reserve (DATR) in the year 2007 vide G.O No. FEE 254 FWL 2006 dated 04-01-2007;

AND WHEREAS, Dandeli-Anshi Tiger Reserve is part of nearby 8,800 square kilometre of tiger conservation landscape of protected areas and reserved forests and the Dandeli Wildlife Sanctuary abuts Bhimghad Wildlife Sanctuary in the north, which is further connected to Radhanagari and Koyna Wildlife Sanctuaries in Maharashtra. To the west five protected areas in Goa adjoin Dandeli-Anshi Tiger Reserve;

AND WHEREAS, Dandeli-Anshi Tiger Reserve is home to rare endemic flora and fauna and the major part of the fauna found is of typical South Indian type carnivores and the important fauna includes Tiger, Leopard, Dhole, Jackal, Elephant, Gaur, Sambar Deer, Spotted Deer, Barking deer, Mouse Deer, Sloth Bear, Hanuman Langur, Bonnet Macaque, Indian Giant Squirrel, Flying Squirrel, Pangolin, etc.;

AND WHEREAS, Dandeli-Anshi Tiger Reserve provides a habitat for at least 272 bird species belonging to 45 families of which 19 species are endemic and the largest Indian butterfly-Southern Birdwing to the endemic Malabar Tree Nymph are found in good population and the interesting birds include Common Grey Hornbill, Malabar Grey Hornbill, Malabar Pied Hornbill, Great Indian Pied Hornbill and Ceylon Frogmouth;

AND WHEREAS, Anshi National Park comprises of mostly tropical evergreen and semi-evergreen types of forests and is a habitat for small mammals, reptiles, amphibians, butterflies, orchids, birds, ferns, medicinal herbs and insects and these include the King Cobra, Python, Cobra, Rat Snake, Vipers (Bamboo Pit Viper, Hump-nosed Pit Viper, Malabar Pit Viper, etc.), Ornate flying snake, Wolf snake and Kraits amongst the snakes that and other such as Draco;

AND WHEREAS, The State Government under section 26A of the Wildlife (Protection) Act, 1972 53 of 1972) vide its order no. FEE-16-FWL-2008 dated: 21-8-2009 and Notification No. FEE 123 FWL 009 dated: 1-9-2010, notified an area of 282.63 square kilometre as Buffer zone of the Dandeli-Anshi Tiger Reserve;

NOW THEREFORE, in exercise of the powers 3 conferred by sub-section (1) and clauses (v) and (xiv) of sub-section (2) and sub-section (3) of section 3 of the Environment (Protection) Act 1986 (29 of 1986) read with sub-rule (3) of rule 5 of the Environment (Protection) Rules, 1986, the Central Government hereby notifies the area to an extent upto seven kilometers around the boundary of the Dandeli-Anshi Tiger Reserve in the State of Karnataka as the Dandeli-Anshi Tiger Reserve Eco-sensitive Zone (hereinafter referred to as the Eco-sensitive Zone) details of which are as under, namely:-

1. Extent and boundaries of Eco-sensitive Zone.—(1) The Eco-sensitive Zone is spread over an area of 1201.94 square kilometers with an extent up to seven kilometers on the Eastern and Southern sides and the Dandeli-Anshi Tiger Reserve lies between the North Latitudes 14°52'29.40" and 15°31'27.94" and between the East Longitudes 74°14'53.10" and 74°43'53.30" and there is no Eco-sensitive Zone proposed on the western side due to interstate boundary with Goa, and also no Eco-sensitive Zone proposed on the northern side due to Bhimgadh Wildlife Sanctuary and the boundary description of such Zone is given in **Annexure-I**.

(3) The map of the Eco-sensitive Zone along with boundary details and latitudes and longitudes is given in Annexure **- II.**

(3) The list of villages falling within Eco-sensitive Zone along with co-ordinates of prominent points is given in **Annexure-III.**

(4) Key locations (points) on the Eco-sensitive Zone boundary as well as on the sanctuary are given in **Annexure-IV.**

2. Zonal Master Plan for the Eco-sensitive Zone.—(1) The State Government shall, for the purpose of the Eco-sensitive Zone prepare, a Zonal Master Plan, within a period of two years from the date of publication of final notification in the Official Gazette, in consultation with local people and adhering to the stipulations given in this notification.

(2) The said Plan shall be approved by the competent authority in the State Government.

(3) The Zonal Master Plan for the Eco-sensitive Zone shall be prepared by the State Government in such a manner as is specified in this notification and also in consonance with the relevant Central and State laws and the guidelines issued by the Central Government, if any.

(4) The Zonal Master Plan shall be prepared in consultation with all concerned State Departments, namely:-

(i) Environment;

(ii) Forest;

(iii) Urban Development;

(iv) Tourism;

(v) Municipal;

(vi) Revenue;

(vii) Agriculture;

(viii) Karnataka State Pollution Control Board;

(ix) Irrigation; and

(x) Public Works Department,

for integrating environmental and ecological considerations into it.

(5) The Master Plan shall not impose any restriction on the approved existing land use, infrastructure and activities, unless so specified in this notification and the Zonal Master Plan shall factor in improvement of all infrastructure and activities to be more efficient and eco-friendly.

(6) The Zonal Master Plan shall provide for restoration of denuded areas, conservation of existing water bodies, management of catchment areas, watershed management, groundwater management, soil and moisture conservation, need of local community and such other aspects of the ecology and environment that needs attention.

(7) The Zonal Master Plan shall demarcate all the existing worshipping places, village and urban settlements, types and kinds of forests, tribal areas, agricultural areas, fertile lands, green area, such as, parks and like places, horticultural areas, orchards, lakes and other water bodies.

(8) The Zonal Master Plan shall regulate development in the Eco-sensitive Zone so as to ensure eco-friendly development for livelihood security of local communities.

3. **Measures to be taken by State Government.—**The State Government shall take the following measures for giving effect to the provisions of this notification, namely:—

(1) **Land use.—**Forests, horticulture areas, agricultural areas, parks and open spaces earmarked for recreational purposes in the Eco-sensitive Zone shall not be used or converted into areas for commercial or industrial related development activities:

Provided that the conversion of agricultural lands within the Eco-sensitive Zone may be permitted on the recommendation of the Monitoring Committee, and with the prior approval of the State Government, to meet the residential needs of local residents, and for the activities listed against serial numbers 12, 18, 24, 33 and 36 in column (2) of the Table in paragraph 4, namely:—

(i) Eco-friendly cottages for temporary occupation of tourists, such as tents, wooden houses, etc. for eco-friendly tourism activities;
(ii) widening and strengthening of existing roads and construction of new roads;
(iii) small scale industries not causing pollution;
(iv) rainwater harvesting; and
(v) cottage industries including village industries, convenience stores and local amenities:

Provided further that no use of tribal land shall be permitted for commercial and industrial development activities without the prior approval of the State Government and without compliance of the provisions of article 244 of the Constitution or the law for the time being in force, including the Scheduled Tribes and other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (2 of 2007):

Provided also that any error appearing in the land records within the Eco-sensitive Zone shall be corrected by the State Government, after obtaining the views of Monitoring Committee, once in each case and the correction of said error shall be intimated to the Central Government in the Ministry of Environment, Forest and Climate Change:

Provided also that the above correction of error shall not include change of land use in any case except as provided under this sub-paragraph:

Provided also that there shall be no consequential reduction in green area, such as forest area and agricultural area and efforts shall be made to reforest the unused or unproductive agricultural areas.

(2) **Natural springs.—**The catchment areas of all natural springs shall be identified and plans for their conservation and rejuvenation shall be incorporated in the Zonal Master Plan and the guidelines shall be drawn up by the State Government in such a manner as to prohibit development activities at or near these areas which are detrimental to such areas.

(3) **Tourism.—**(a) The activity relating to tourism within the Eco-sensitive Zone shall be as per Tourism Master Plan, which shall form part of the Zonal Master Plan.

(b) The Tourism Master Plan shall be prepared by the Department of Tourism, in consultation with Department of Forests and Environment of the State Government of Karnataka.

(c) The activity of tourism shall be regulated as under, namely:—

(i) all new tourism activities or expansion of existing tourism activities within the Eco-sensitive Zone shall be in accordance with the guidelines issued by the Central Government in the Ministry of Environment, Forest and Climate Change and the eco-tourism guidelines issued by the National Tiger Conservation Authority, (as amended from time to time) with emphasis on eco-tourism, eco-education and eco-development and based on carrying capacity study of the Eco-sensitive Zone;

(ii) new construction of hotels and resorts shall not be permitted within one kilometer from the boundary of the Dandeli-Anshi Tiger Reserve Sanctuary except for accommodation for temporary occupation of tourists related to Eco-friendly tourism activities:

Provided that beyond the distance of one kilometer from the boundary of protected areas till the extent of the Eco-sensitive Zone, the establishment of new hotels and resorts shall be permitted only in pre-define and designated areas for Eco-tourism facilities as per Tourism Master Plan;

(iii) till the Zonal Master Plan is approved, development for tourism and expansion of existing tourism activities shall be permitted by the concerned regulatory authorities based on the actual site specific scrutiny and recommendation of the Monitoring Committee.

(4) **Natural heritage.—**All sites of valuable natural heritage in the Eco-sensitive Zone, such as the gene pool reserve areas, rock formations, waterfalls, springs, gorges, groves, caves, points, walks, rides, cliffs, etc. shall be identified and preserved and plan shall be drawn up for their protection and conservation, within six months from the date of publication of this notification and such plan shall form part of the Zonal Master Plan.

(5) **Man-made heritage sites.—**Buildings, structures, artefacts, areas and precincts of historical, architectural, aesthetic and cultural significance shall be indentified in the Eco-sensitive Zone and plans for their conservation shall be prepared within six months from the date of publication of this notification and incorporated in the Zonal Master Plan.

(6) **Noise pollution.—**The Environment Department of the State Government or Karnataka State Pollution Control Board shall draw up guidelines and regulations for the control of noise pollution in the Eco-sensitive Zone in accordance with the provisions of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and the rules made thereunder.

(7) **Air pollution.—**The Environment Department of the State Government or Karnataka State Pollution Control Board shall draw up guidelines and regulations for the control of air pollution in the Eco-sensitive Zone in accordance with the provisions of the Air (Prevention and Control of Pollution) Act, 1981 (14 of 1981) and the rules made thereunder.

(8) **Discharge of effluents.—**The discharge of treated effluent in Eco-sensitive Zone shall be in accordance with the provisions of the Water (Prevention and Control of Pollution) Act, 1974 (6 of 1974) and the rules made thereunder.

(9) **Solid wastes.—** Disposal of solid wastes shall be as under:-

(i) the solid waste disposal in the Eco-sensitive Zone shall be carried out as per the provisions of the Solid Waste Management Rules, 2016 published by the Government of India in the erstwhile Ministry of Environment and Forest vide notification number S.O. 1357(E), dated the 8th April, 2016 as amended from time to time;

(ii) the local authorities shall draw up plans for the segregation of solid wastes into biodegradable and non-biodegradable components;

(iii) the biodegradable material shall be recycled preferably through composting or vermiculture;

(iv) the inorganic material may be disposed in an environmentally acceptable manner at site(s) identified outside the Eco-sensitive Zone and no burning or incineration of solid wastes shall be permitted in the Eco-sensitive Zone.

(10) **Bio-medical waste.—**The bio-medical waste disposal in the Eco-sensitive Zone shall be carried out as per the provisions of the Bio-Medical Waste (Management and Handling) Rules, 2016 published by the Government of India in the Ministry of Environment, Forest and Climate Change *vide* notification number G.S.R. 343(E), dated the 28th March, 2016 as amended from time to time.

(11) **Vehicular traffic**.—The vehicular movement of traffic shall be regulated in a habitat friendly manner and specific provisions in this regard shall be incorporated in the Zonal Master Plan and till such time as the Zonal Master Plan is prepared and approved by the Competent Authority in the State Government, Monitoring Committee shall monitor compliance of vehicular movement under the relevant Acts and the rules and regulations made thereunder.

(12) **Industrial units**..—(a) No establishment of new wood based industries within the proposed Eco-sensitive Zone shall be permitted except the existing wood based industries set up as per the law.

(b) No establishment of any new industry causing water, air, soil and noise pollution within the proposed Eco-sensitive Zone shall be permitted.

4. **List of activities prohibited or to be regulated within the Eco-sensitive Zone.—**All activities in the Eco-sensitive Zone shall be governed by the provisions of the Environment (Protection) Act, 1986 (29 of 1986) and the rules made thereunder, and be regulated in the manner specified in the Table below, namely:—

TABLE

S. No.	Activity	Remarks
(1)	(2)	(3)
Prohibited Activities		
1.	Commercial mining, stone quarrying and crushing units.	(a) All new and existing mining (minor and major minerals), stone quarrying and crushing units shall be prohibited except for the domestic needs of *bona fide* local residents with reference to digging of earth for construction or repair of houses and for manufacture of country tiles or bricks for housing for personal use. (b) The mining operations shall strictly be in accordance with the interim orders of the Hon'ble Supreme Court dated, 4th August, 2006 in the matter of T.N. Godavarman Thirumulpad Vs. Union of India in Writ Petition (Civil) No. 202 of 1995 and order of the Hon'ble Supreme Court dated 21st April, 2014 in the matter of Goa Foundation Vs. Union of India in Writ Petition(Civil) No. 435 of 2012.
2.	Setting up of saw mills.	No new or expansion of existing saw mills shall be permitted within the Eco-sensitive Zone.
3.	Setting up of industries causing water or air or soil or noise pollution.	No new or expansion of polluting industries in the Eco-sensitive Zone shall be permitted.
4.	Commercial use of firewood.	Prohibited (except as otherwise provided) as per applicable laws.
5.	Establishment of new major hydroelectric projects and irrigation projects.	Prohibited (except as otherwise provided) as per applicable laws.
6.	Use or production of any hazardous substances including pesticides and insecticides.	Prohibited (except as otherwise provided) as per applicable laws.
7.	Discharge of untreated effluents and solid waste in natural water bodies or land area.	Prohibited (except as otherwise provided) as per applicable laws.
8.	Disposal of solid wastes.	Prohibited (except as otherwise provided) as per applicable laws.
9	New wood based industry.	No establishment of new wood based industry shall be permitted within the limits of Eco-sensitive Zone: Provided that the existing wood-based industry may continue as per law:

		Provided further that renewal of licenses of existing saw mills shall not be done on their expiry period.
10.	Erection of wind mills and mobile towers.	Prohibited (except as otherwise provided) as per applicable laws.
	Regulated Activities	
11.	Uses of plastic carry bags, laminates and tetra packs.	Regulated under applicable laws. Disposal of plastic articles laminates and tetra packs shall be strictly regulated and monitored.
12.	Establishment of hotels and resorts.	No new commercial hotels and resorts shall be permitted within one kilometer of the boundary of the Protected Area except for accommodation for temporary occupation of tourists related to Eco-friendly tourism activities. However, beyond one kilometre and upto the extent of the Eco-sensitive Zone, all new tourism activities or expansion of existing activities would in conformity with the Tourism Master Plan.
13.	Construction activities.	No new commercial construction of any kind shall be permitted within one kilometer from the boundary of the Protected Area: Provided that the local people shall be permitted to undertake construction in their land for residential use including the activities listed in sub-paragraph (1) of paragraph 3: Provided further that the construction activity related to small scale industries not causing pollution shall be regulated and kept at the minimum with the prior permission from the competent authority as per applicable rules and regulations, if any: Provided also that beyond one kilometer upto the extent of Eco-sensitive Zone construction for bona fide local needs shall be permitted and other construction activities shall be regulated as per Zonal Master Plan.
14.	Felling of trees.	(a) There shall be no felling of trees in the forest or Government or revenue or private lands without prior permission of the competent authority in the State Government; (b) The felling of trees shall be regulated in accordance with the provisions of the concerned Central or State Acts and the rules made thereunder.

		(c) In case of Reserve Forests and Protected Forests, the Working Plan prescriptions shall be followed.
15.	Commercial water resources including ground water harvesting.	(a) The extraction of surface water and ground water shall be permitted only for *bona fide* agricultural use and domestic consumption of the occupier of the land; (b) Extraction of surface water and ground water for industrial or commercial use including the amount that can be extracted, shall require prior written permission from the concerned Regulatory Authority; (c) No sale of surface water or ground water shall be permitted; (d) steps shall be taken to prevent contamination or pollution of water from any sources including agriculture.
16.	Erection of electrical cables, transmission lines and telecommunication towers.	(i) Promote underground cabling. (ii) For any future laying of electric lines for the domestic purpose up to 11KV has to be done underground. (iii) For any transmission line more than 11KV the "sag" point between the two towers should be at safe distance from the ground.
17.	Fencing of existing premises of hotels and lodges.	Regulated under applicable laws.
18.	Widening and strengthening of existing roads and construction of new roads.	Shall be done with proper Environment Impact Assessment and mitigation measures, as applicable.
19.	Movement of vehicular traffic at night.	Regulated for commercial purpose, under applicable laws.
20.	Introduction of exotic species.	Regulated under applicable laws.
21.	Protection of hill slopes and river banks.	Regulated under applicable laws.
22.	Discharge of treated effluents in natural water bodies or land area and disposal of solid waste.	Recycling of treated effluent shall be encouraged and for disposal of sludge or solid wastes, the existing regulations shall be followed.
23.	Commercial sign boards and hoardings.	Regulated under applicable laws.
24.	Small scale industries not causing pollution.	Non polluting, non-hazardous, small-scale and service industry, agriculture, floriculture, horticulture or agro-based industry producing products from indigenous goods from the Eco-sensitive Zone, and which do not cause any adverse impact on environment shall be permitted.
25.	Collection of Forest Produce or Non-Timber Forest Produce (NTFP).	Regulated under applicable laws.
26.	Air and vehicular pollution.	Regulated under applicable laws.

27.	Drastic change of agriculture systems.	Regulated under applicable laws.
28.	Undertaking activities related to tourism like over-flying the national park area by aircraft, hot-air balloons.	Regulated under applicable laws.
29.	Fishing.	Regulated under applicable laws.
30	Solid Waste Management.	Regulated under applicable laws.
31	Eco Tourism.	Regulated under applicable laws.
	Promoted Activities	
32.	Ongoing agriculture and horticulture practices by local communities along with dairies, dairy farming, aquaculture and fisheries.	Permitted under applicable laws.
33.	Rain water harvesting.	Shall be actively promoted.
34.	Organic farming.	Shall be actively promoted.
35.	Adoption of green technology for all activities.	Shall be actively promoted.
36.	Cottage industries including village artisans etc.	Shall be actively promoted.
37.	Use of renewable energy sources.	Bio gas, solar light etc to be promoted.
38.	Agro-Forestry.	Shall be actively promoted.
39.	Skill Development.	Shall be actively promoted.
40.	Environment Awareness .	Shall be actively promoted.

5. Monitoring Committee:-

1. In exercise of the powers conferred by sub-section (3) of section 3 of the Environment (Protection) Act, 1986 (29 of 1986), the Central Government hereby constitutes a committee to be called as the Dandeli-Anshi Tiger Reserve Eco-sensitive Zone Monitoring Committee to monitor the compliance of this notification.
2. The Monitoring Committee referred to in sub-paragraph (1) above shall consist of the following members, namely:

(i) Regional Commissioner, Belgaum – Chairman

(ii) Member of Legislative Assembly, Joida Constituency – Member;

(iii) Member of Legislative Assembly, Karwar Constituency – Member;

(iv) Member of Legislative Assembly, Yellapur Constituency – Member;

(v) Member of Legislative Assembly, Haliyal Constituency – Member;

(vi) Representative of the Department of Environment, Government of Karnataka – Member;

(vii) Representative of the Department of Urban Development, Government of Karnataka; –Member;

(viii) Representative of Non-governmental Organisations working in the field of natural conservation (including heritage conservation) to be nominated by the State Government -Member; -Member;

(ix) The Regional Officer, Karnataka State Pollution Control Board, Karwar; -Member;

(x) One expert in Ecology from reputed Institution or University of the State of Karnataka to be nominated by the Ministry of Environment and Forest, Government of India - Member;

(xi) Deputy Commissioner or his representative, Karwar –Member;

(xii) Member State Biodiversity Board - Member;

(xiii) The Conservator of Forests and Director, Dandeli- Anshi Tiger Reserve, Dandeli - Member Secretary.

6. Terms of Reference:

(1) The tenure of the Monitoring Committee is for three (3) years.

(2) The Monitoring Committee shall monitor the compliance of the provisions of this notification.

(3) The activities that are covered in the Schedule to the notification of the Government of India in the erstwhile Ministry of Environment and Forests number S.O. 1533(E), dated the 14th September, 2006, and are falling in the Eco-sensitive Zone, except for the prohibited activities as specified in the Table under paragraph 4 thereof, shall be scrutinised by the Monitoring Committee based on the actual site-specific conditions and referred to the Central Government in the Ministry of Environment, Forest and Climate Change for prior environmental clearances under the provisions of the said notification.

(4) The activities that are not covered in the Schedule to the notification of the Government of India in the erstwhile Ministry of Environment and Forests number S.O. 1533 (E), dated the 14th September, 2006 and are falling in the Eco-sensitive Zone, except for the prohibited activities as specified in the Table under paragraph 4 thereof, shall be scrutinised by the Monitoring Committee based on the actual site-specific conditions and referred to the concerned Regulatory Authorities.

(5) The Member-Secretary of the Monitoring Committee or the concerned Collector(s) or the concerned Park Deputy Conservator of Forests shall be competent to file complaints under section 19 of the Environment (Protection) Act, 1986 against any person who contravenes the provisions of this notification.

(6) The Monitoring Committee may invite representatives or experts from concerned Departments, representatives from industry associations or concerned stakeholders to assist in its deliberations depending on the requirements on issue to issue basis.

(7) The Monitoring Committee shall submit the annual action taken report of its activities as on 31st March of every year by 30th June of that year to the Chief Wildlife Warden of the State as per pro-forma appended at **Annexure-V**.

(8) The Central Government in the Ministry of Environment, Forest and Climate Change may give such directions, as it deems fit, to the Monitoring Committee for effective discharge of its functions.

7. The Central Government and State Government may specify additional measures, if any, for giving effect to provisions of this notification.

8. The provisions of this notification shall be subject to the orders, if any, passed, or to be passed, by the Hon'ble Supreme Court of India or the High Court or National Green Tribunal .

[F. No. 25/29/2016-ESZ-RE]

Dr. T. CHANDINI, Scientist 'G'

ANNEXURE-I

BOUNDARY DESCRIPTION OF THE ECO-SENSITIVE ZONE:

North-East: The Eco-sensitive Zone boundary starts at the North East Corner of the Castlerock Wildlife Range boundary where it touches the North West boundary of the Devalli (Tinaighat) village and then it runs all along the boundary of the Devalli village until it touches the Kamra village boundary. The boundary then turns towards the North East direction along the Kamra village boundary and moves all along the Eastern boundary of Kamra village, until it touches the Supa Backwaters. Then it runs all along the backwater of Supa reservoir till it touches the Northern boundary of Karanjoida village. From that point it runs towards south direction all along the western boundary of the Karanjoida village, until it reaches the Deriya village. From Deriya village boundary it runs towards the eastern side all along the boundary of Devali (Joida), Katel, Thinnaikhand villages, until it touches the western boundary of Hudsa village. The boundary then runs all along the Northern boundary of the Hudsa, Sangave, Gavegali villages, until it touches the Hornbill Conservation Reserve boundary near Badakanshirda village. Then it moves towards the South east direction all along the Badakanshirda, Harnoda villages until it touches the Badashirgur village North East boundary. Then it touches the North West boundary of Bommanahalli reservoir and runs all along the boundary of Bommanahalli reservoir and until it reaches the Addigera village.

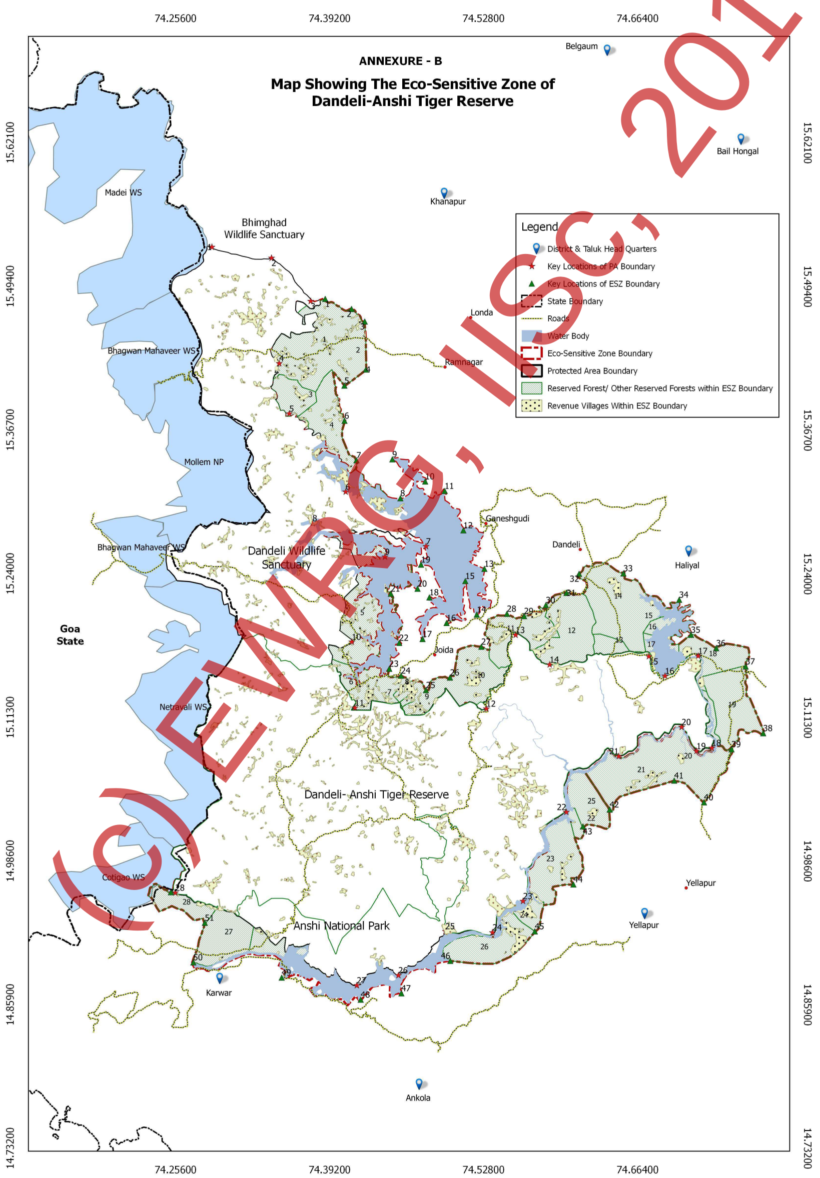
East: From the above point of Bommanahalli reservoir where it touches the North boundary of Addigera village it runs towards the Eastern direction all along the boundary of Bommanahalli reservoir, until it reaches the North East corner of the Addigera village. Then it runs towards South direction all along the boundary of Addigera village, and it reaches the Lalguli village boundary.

South-East: From Laguli village the boundary runs towards the South west side until it reaches the Ghotguli village and Nagarkhan village. From that point again it turns towards South until it reaches Kattige village, Barballi village and from Barballi village boundary to Southern boundary of Kodsalli backwater. From the point of Kodsalli Backwater where it touches the North East boundary of Devkar village it runs towards southern direction all along the boundary of Devkar village and moves towards the western direction all along the southern boundary of Devkar village,until it touches the Kadra backwater.

South: From Devkar village and the Southern boundary of Kadra backwater it runs towards the Western direction all along the boundary of Kadra Backwater until it reaches the Kadra village boundary. From the Kadra village it runs towards the western direction all along the boundary of Kadra village, until it touches the Goyar village boundary. From Goyar village it moves towards the Western direction all along the boundary of Goyar village, until it reaches the Goa state boundary towards the western side of the Dandeli-Anshi Tiger Reserve.

ANNEXURE-II

MAP OF ECO-SENSITIVE ZONE OF DANDELI-ANSHI TIGER RESERVE WITH LATITUDES AND LONGITUDES AND GPS COORDINATES



ANNEXURE-III

LIST OF VILLAGES FALLING UNDER THE ECO-SENSITIVE ZONE

Sl. No.	Taluka	Village Name	Extent (Ha)	Latitude	Longitude	Remarks
1	Joida	Payasvadi	1262.00	15.44325	74.38557	Entire Village
2	Joida	Devalli	312.40	15.43378	74.41532	Entire Village
3	Joida	Kamare	191.74	15.39456	74.37339	Entire Village
4	Joida	IliyeDhabe	197.81	15.36750	74.39199	Entire Village
5	Joida	Karanjoida	3401.32	15.20181	74.41904	Entire Village
6	Joida	Katel	550.00	15.14060	74.40924	Entire Village
7	Joida	Chapoli(K)	1510.75	15.13147	74.44305	Entire Village
8	Joida	Devali	19.97	15.14432	74.45861	Entire Village
9	Joida	Ambarda	267.00	15.12741	74.47619	Entire Village
10	Joida	Hudsa	94.22	15.14635	74.52218	Entire Village
11	Joida	Potolisangve	124.27	15.18794	74.54856	Entire Village
12	Joida	Virnoli	1951.00	15.18592	74.60232	Partial Village
13	Haliyal	Badakansirda	1524.00	15.17746	74.64425	Partial Village
14	Haliyal	Hosa-Kumbarkop	0.00	15.21635	74.64324	Entire Village
15	Haliyal	Harnoda	73.77	15.19910	74.67029	Entire Village
16	Haliyal	Malwad	187.23	15.18930	74.67367	Entire Village
17	Haliyal	Kalbhavi	12.26	15.17374	74.67266	Entire Village
18	Haliyal	Bommanahalli	119.36	15.16935	74.72710	Entire Village
19	Haliyal	Addigera	107.96	15.12031	74.74401	Partial Village
20	Yellapur	Lalaguli	214.14	15.07500	74.70512	Entire Village
21	Yellapur	Ghotaguli	7.19	15.06283	74.66387	Entire Village
22	Yellapur	Nagarkan	47.02	15.02766	74.61957	Entire Village
23	Yellapur	Hiriyal	603.00	14.98404	74.59049	Partial Village
24	Yellapur	Katagi	190.69	14.93433	74.56715	Partial Village
25	Yellapur	Barballi.	594.84	15.03510	74.61991	Partial Village
26	Yellapur	kodasalli	232.77	14.90626	74.52522	Partial Village
	TOTAL AREA in Ha.		**13796.71**			

ANNEXURE-IV

A. GPS KEY LOCATIONS OF DANDELI- ANSHI TIGER RESERVE (INCLUDING DANDELI WILDLIFE SANCTUARY & ANSHI NATIONAL PARK)

Map Id	Latitude	Longitude
1	15.5253	74.2846
2	15.5145	74.3441
3	15.4809	74.3753
4	15.4258	74.3475
5	15.3814	74.3564
6	15.3123	74.4062
7	15.2641	74.4772
8	15.2845	74.3769
9	15.2548	74.4409
10	15.1796	74.4116
11	15.1213	74.4143
12	15.1205	74.5305
13	15.1857	74.5563
14	15.1595	74.5864
15	15.1668	74.6740
16	15.1495	74.6883
17	15.1672	74.7176
18	15.0858	74.7296
19	15.0831	74.7161
20	15.1043	74.7030
21	15.0785	74.6474
22	15.0291	74.6011
23	14.9504	74.5629
24	14.9241	74.5336
25	14.9195	74.4969
26	14.8825	74.4533
27	14.8736	74.4186
28	14.9581	74.2557

B. Key locations (Global Positioning System Points) on the Eco-sensitive Zone

Map ID	Latitude	Longitude
1	15.4835	74.3882
2	15.4707	74.4181
3	15.4039	74.4383
4	15.3748	74.4447
5	15.3489	74.41707
6	15.3067	74.45452
7	15.3411	74.44743

Map ID	Latitude	Longitude
8	15.3215	74.47645
9	15.3131	74.49365
10	15.2783	74.51019
11	15.2443	74.52874
12	15.2038	74.522
13	15.2335	74.51187
14	15.1964	74.49534
15	15.1822	74.47409
16	15.2190	74.48016
17	15.2480	74.47274
18	15.2267	74.4697
19	15.2223	74.44608
20	15.1788	74.45351
21	15.1559	74.44473
22	15.1498	74.45519
23	15.1370	74.47712
24	15.1481	74.49838
25	15.1754	74.52604
26	15.2045	74.54865
27	15.2274	74.55708
28	15.2122	74.58306
29	15.2230	74.60128
30	15.2399	74.61242
31	15.2402	74.65155
32	15.2169	74.70081
33	15.1859	74.71127
34	15.1741	74.73354
35	15.1579	74.75952
36	15.0989	74.77504
37	15.0847	74.74703
38	15.0378	74.72274
39	15.0570	74.69643
40	15.0314	74.63941
41	15.0165	74.61579
42	14.9652	74.60736
43	14.9237	74.57328
44	14.8822	74.51761
45	14.8448	74.48826
46	14.8657	74.37793
47	14.8595	74.40863

Map ID	Latitude	Longitude
48	14.8963	74.27165
49	14.9313	74.28177
50	14.9583	74.25175

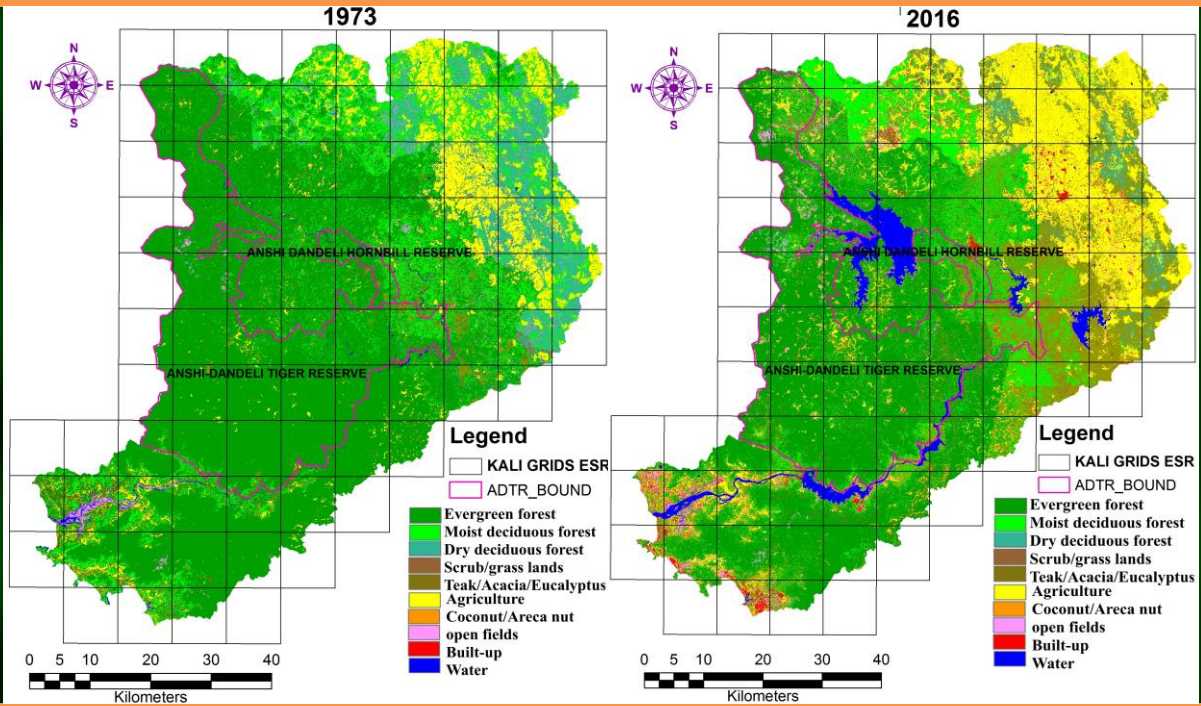
Annexure -V

Performa of Action Taken Report:

1. Number and date of meetings:
2. Minutes of the meetings: Mention main noteworthy points. Attach Minutes of the meeting as separate Annexure.
3. Status of preparation of Zonal Master Plan including Tourism master Plan:
4. Summary of cases dealt for rectification of error apparent on face of land record (Eco-sensitive Zone wise): Details may be attached as Annexure.
5. Summary of cases scrutinised for activities covered under the Environment Impact Assessment Notification, 2006: Details may be attached as separate Annexure.
6. Summary of cases scrutinised for activities not covered under the Environment Impact Assessment Notification, 2006: Details may be attached as separate Annexure.
7. Summary of complaints lodged under section 19 of the Environment (Protection) Act, 1986:
8. Any other matter of importance:

Uploaded by Dte. of Printing at Government of India Press, Ring Road, Mayapuri, New Delhi-110064
and Published by the Controller of Publications, Delhi-110054.

Sahyadri Conservation Series: 68, ETR 125



ENERGY AND WETLANDS RESEARCH GROUP
CENTRE FOR ECOLOGICAL SCIENCES
NEW BIOSCIENCE BUILDING, III FLOOR, E-WING, LAB: TE15
Indian Institute of Science, Telephone: 91-80-22933099/22933503(Ext:107)/23600985
Fax: 91-80-23601428/23600085/23600683[CES-TVR]
Email: tvr@iisc.ac.in, energy.ces@ iisc.ac.in
Web: http://ces.iisc.ernet.in/energy, http://ces.iisc.ernet.in/biodiversity
Open Source GIS: http://ces.iisc.ernet.in/grass