

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, Pompadour 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 ecologically fragile 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 involving 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

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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 CO₂ 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 (Ramachandra 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 temperature 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 3 of 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 km² 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 km² to 312.52 km². 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 km² 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 km², (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 km² (93.53% of the total forest area). The forest area under revenue and other departments are 536 km². 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 malabratrum*, *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 km². 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 km² (on 10th May 1956). In 1975, it was declared as a wildlife sanctuary with an expanded area of 5,729 km² 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 km² 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 km² through a final notification issued on 09th March 1998. Then realizing sensitiveness of region, ADTR has formed (1427.35 km²) by merging undisturbed reserve forests in Anshi, Dandeli of Supa, Haliyal taunks 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 km² 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.

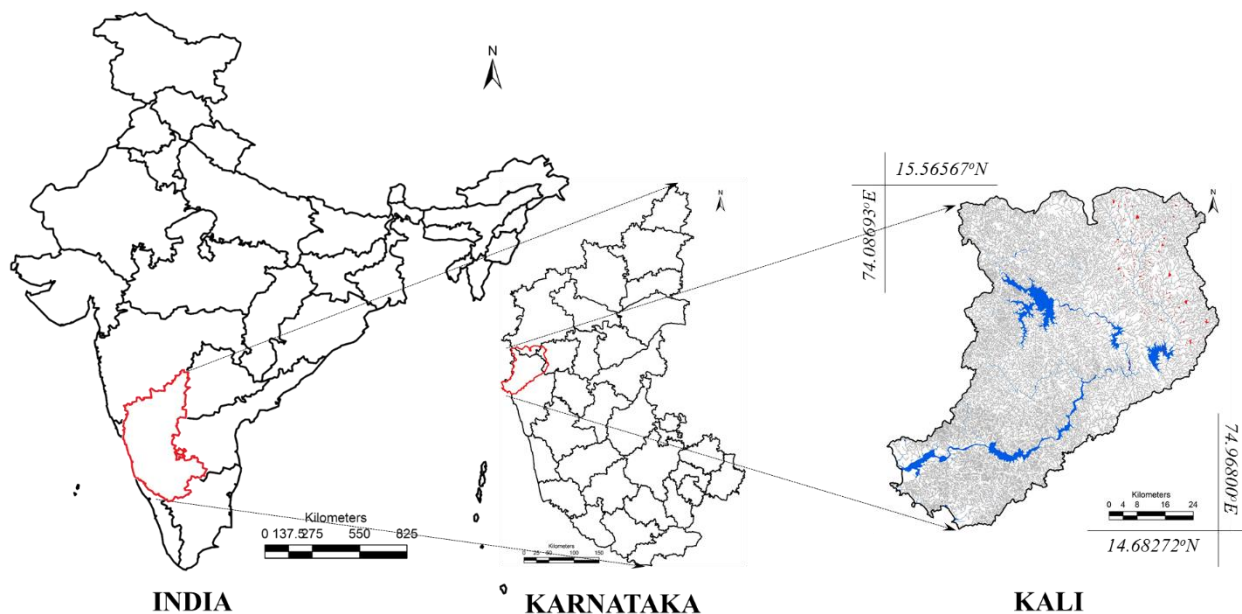


Figure 1 (a): Study area-Kali river basin.

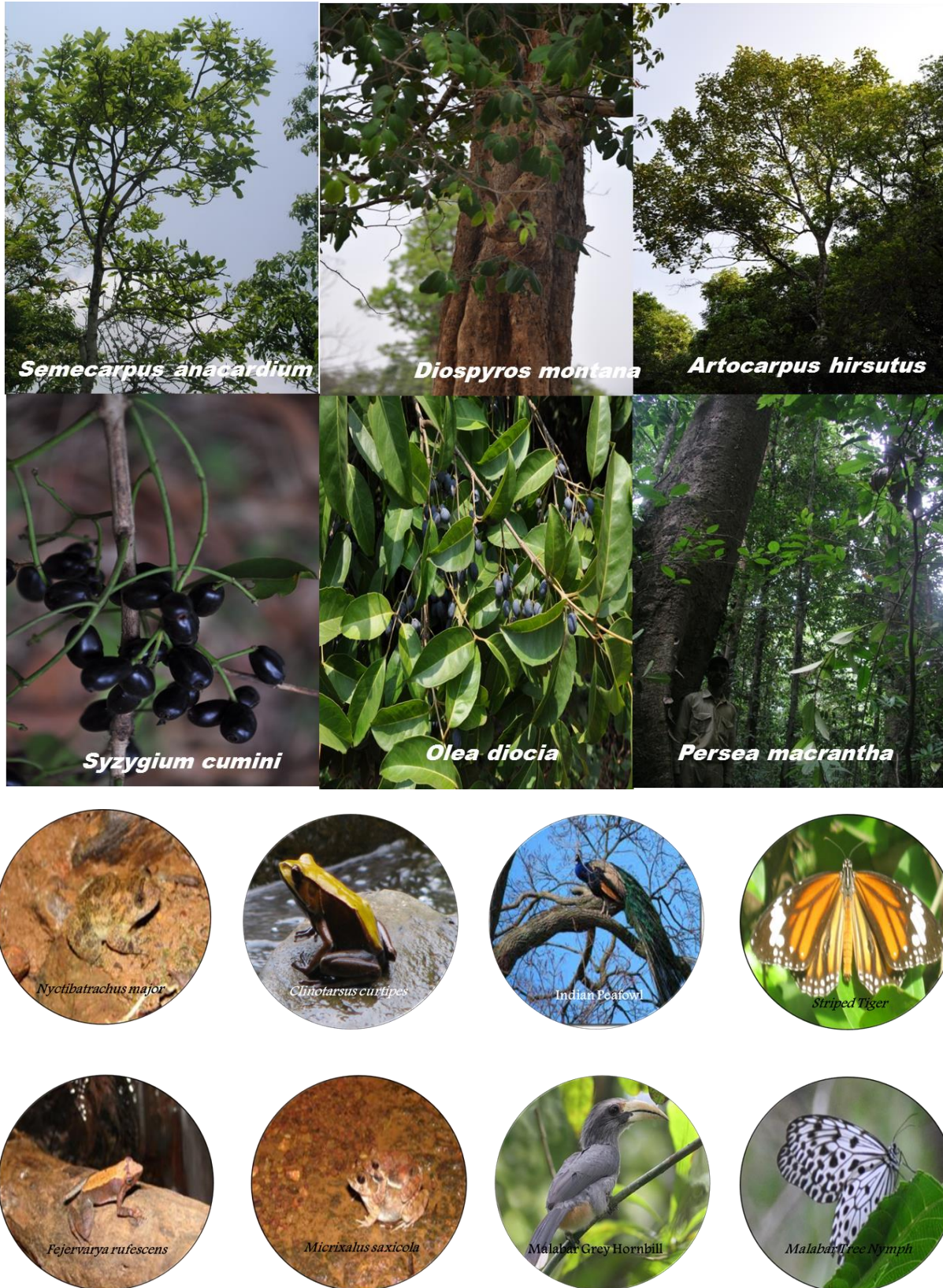


Figure 1 (b, c): Flora and Faunal diversity of Kali River Basin.

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 $5' \times 5'$ 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 Beinart, 1997 for weighting 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.

$$Weightage = \sum_{i=1}^n W_i V_i \dots(1)$$

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.

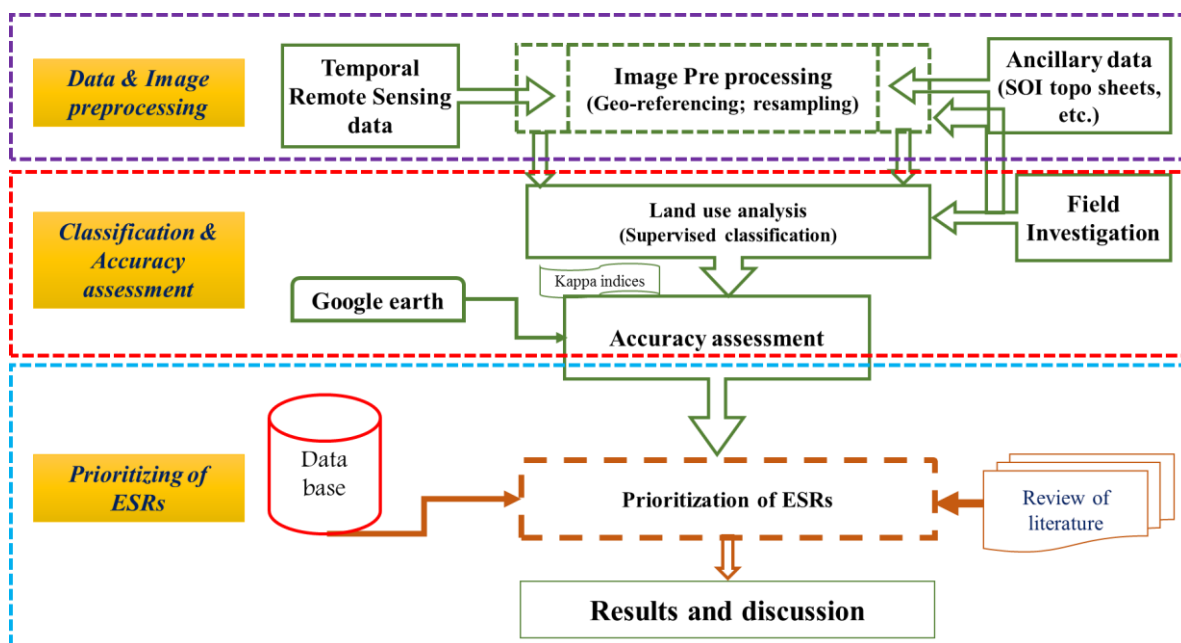


Figure 2: Method followed for land use analysis

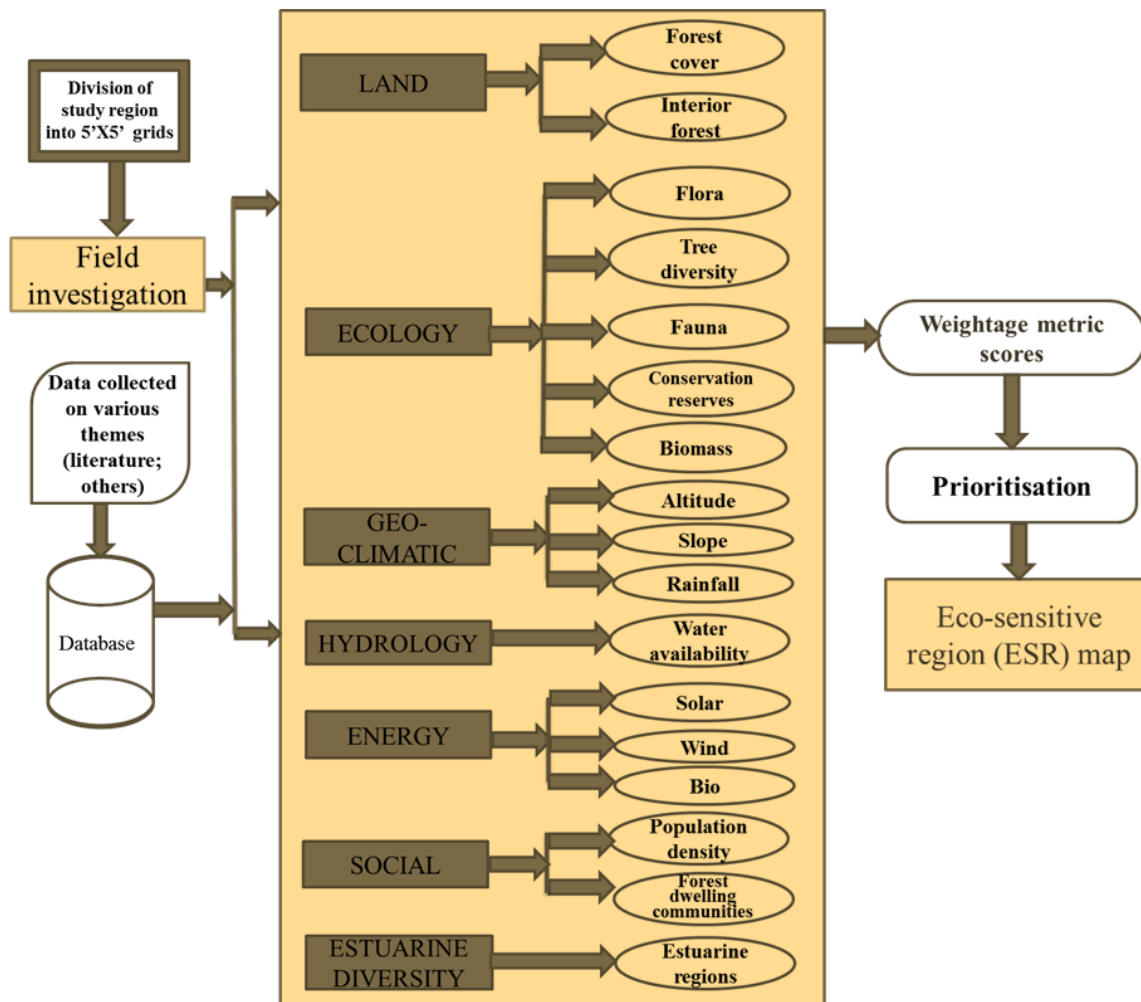


Figure 3: Computation of ecologically sensitive regions.

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	
		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.

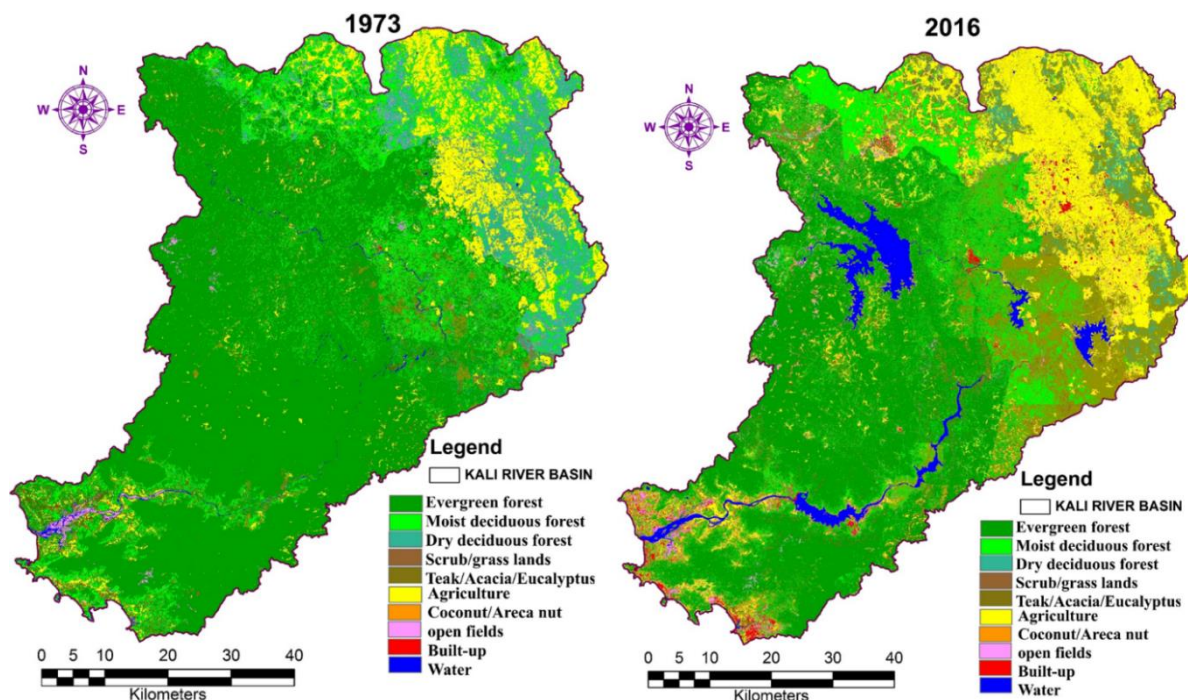


Figure 4: Land use dynamics in the Kali river basin.

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.

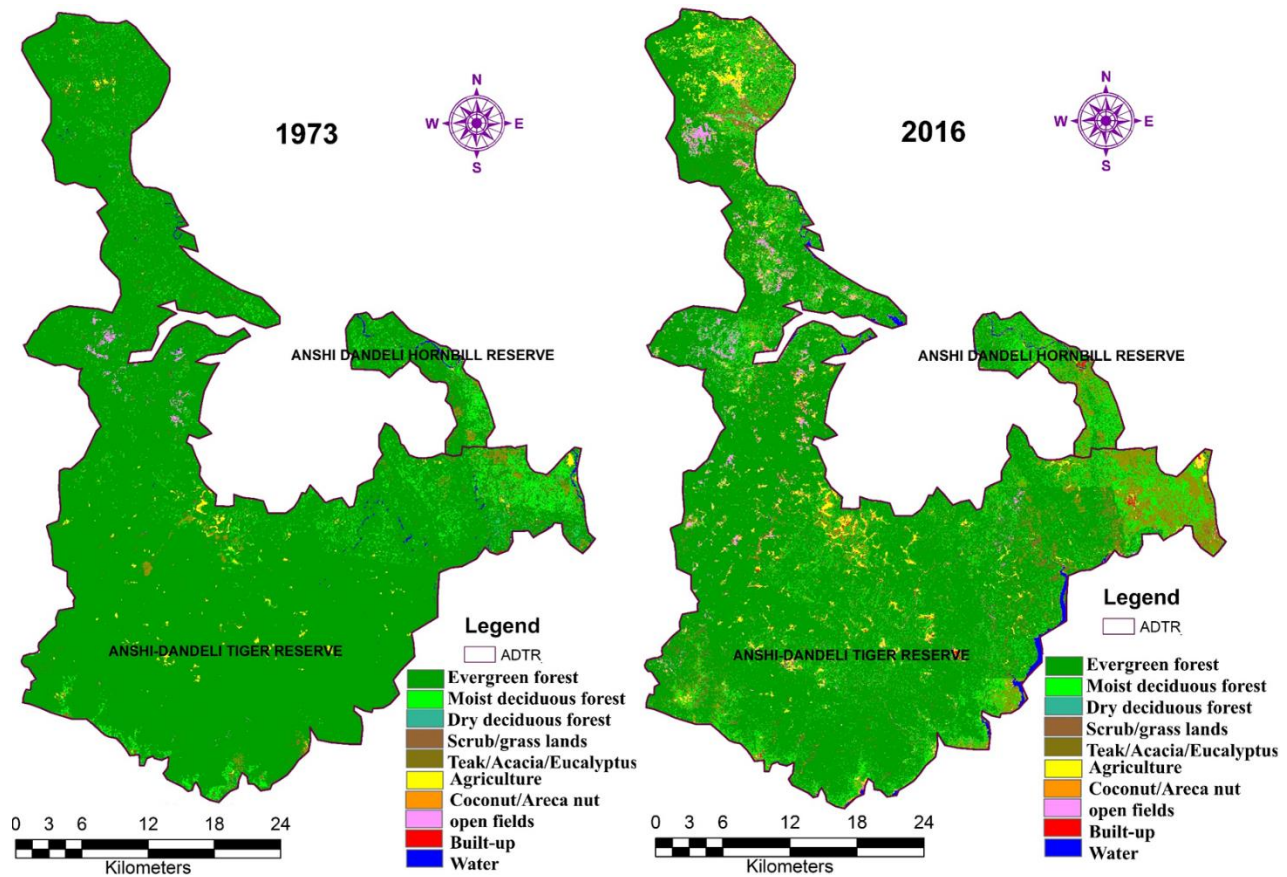


Figure 5: Land use analysis of ADTR (KTR).

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/m²/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)	x	x	x	x
	(G) Hydro power (Micro)	x	x	x	✓
	(H) Nuclear power	x	x	x	x
2	FORESTS				
	(A) Land use change (Forest to non-forest usages)	x	x	x	x
	(B) Monoculture plantations	x	x	x	x
	(C) Extraction of medicinal plants (with strict regulations)	x	x	✓	✓
	(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	x	x	x	x
	(D) Genetically modified crops	x	x	x	x
	(E) Animal Husbandry	✓	✓	✓	✓
4	HORTICULTURE	✓	✓	✓	✓
	(A) Organic farming	✓	✓	✓	✓
	(B) Nitrogen and Phosphorus (N&P) fertilizers	x	x	x	✓ Dosage as prescribed by Agriculture department
	(C) Endosulfan	x	x	x	x
	(D) Pesticide	x	x	x	✓
	(E) Watermelon & Muskmelon farming	x	✓	✓	✓
5	INDUSTRIES (Larger scale)	✓	✓	✓	✓
	(A) Agro processing industries	✓	✓	✓	✓
	(B) Information Technology industries (IT)	x	x	✓	✓
	(C) Red category (Polluting) industries	x	x	x	x
	(D) Garment industries	x	x	✓	✓
	(E) New establishment of Industries	x	x	x	✓ (Allowed only after critical review by local stake holders and experts)
	(F) Nonpolluting (Green) Industries	x	x	✓	✓

6	INDUSTRIES (Small scale)	x	✓	✓	✓
	(A) Garment industries				
	(B) <u>Domestic (Home based) industries</u>				
	a. Papad	✓	✓	✓	✓
	b. Mango processing	✓	✓	✓	✓
	c. Areca nut processing & Coir industries	x	✓	✓	✓
	d. Milk products and processing	✓	✓	✓	✓
	e. Dry fruits & Spices	✓	✓	✓	✓
	f. Fruit processing (Ex: Kokum Juice (<i>Garcinia indica</i>))	✓	✓	✓	✓
	g. Fish products processing	✓	✓	✓	✓
	h. Bee keeping and bee nurseries	✓	✓	✓	✓
	i. Pongamia plantations for biofuel (in private lands)	x	✓	✓	✓
	j. Bio pesticides manufacturing	x	✓	✓	✓
	k. Poultry farms and powdered eggs	x	✓	✓	✓
	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	x	✓	✓	✓	
7	TOURISM INDUSTRY				
	(A) Ecotourism	x	✓	✓	✓
	(B) Organic village and home stay	✓	✓	✓	✓
	(C) VFC managed tourism	✓	✓	✓	✓
	(D) VFC managed home stay tourism in higher forest cover regions and protected areas	x	✓	✓	✓
	(E) Arts and handicrafts museum and trade center	✓	✓	✓	✓
8	MINING AND MINERAL EXTRACTION				
	(A) Iron ore	x	x	x	x
	(B) Manganese	x	x	x	x

	(C) Bauxite	x	x	x	x
	(D) Limestone	x	x	x	✓
	(E) Quartz	x	x	x	✓
	(F) Sand extraction (on sustainable basis by Ban on exporting)	x	x	✓	✓
9	WASTE DISPOSAL				
	(A) Hazardous waste processing units	x	x	x	x
	(B) Solid waste disposal	x	x	x	✓ (For composting and manure preparation)
	(C) Liquid waste discharge	x	x	x	✓ (Treatment plants (STP) for processing)
	(D) Recycling and waste processing and units	x	x	x	✓ (compliant with PCB)
10	TRANSPORTATION				
	(A) Roads and express ways	x	x	x	✓ (Allowed only after strict EIA)
	(B) Rail and freight corridors	Subject to EIA; Strict regulation and social audit			
	(C) Up gradation of existing infrastructure	x	x	✓ (Subject to EIAs, strict regulation and social audit)	✓
Remarks					
<ul style="list-style-type: none"> • 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. As per 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

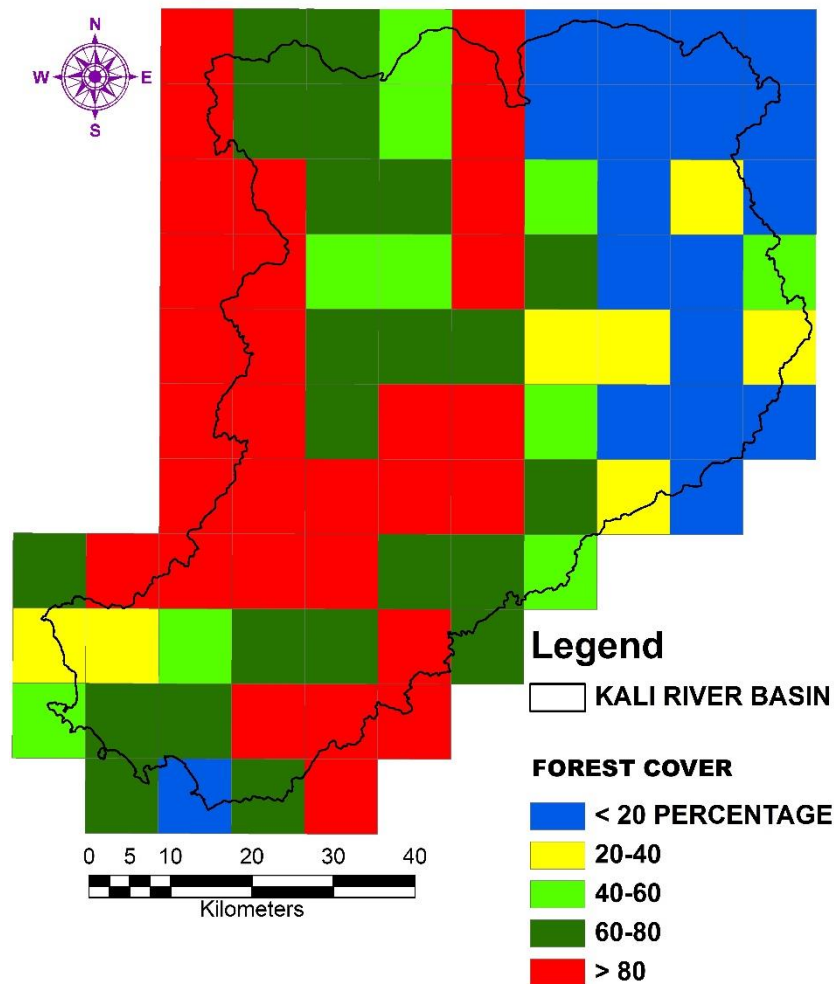


Figure 6b: Forest cover weightage map

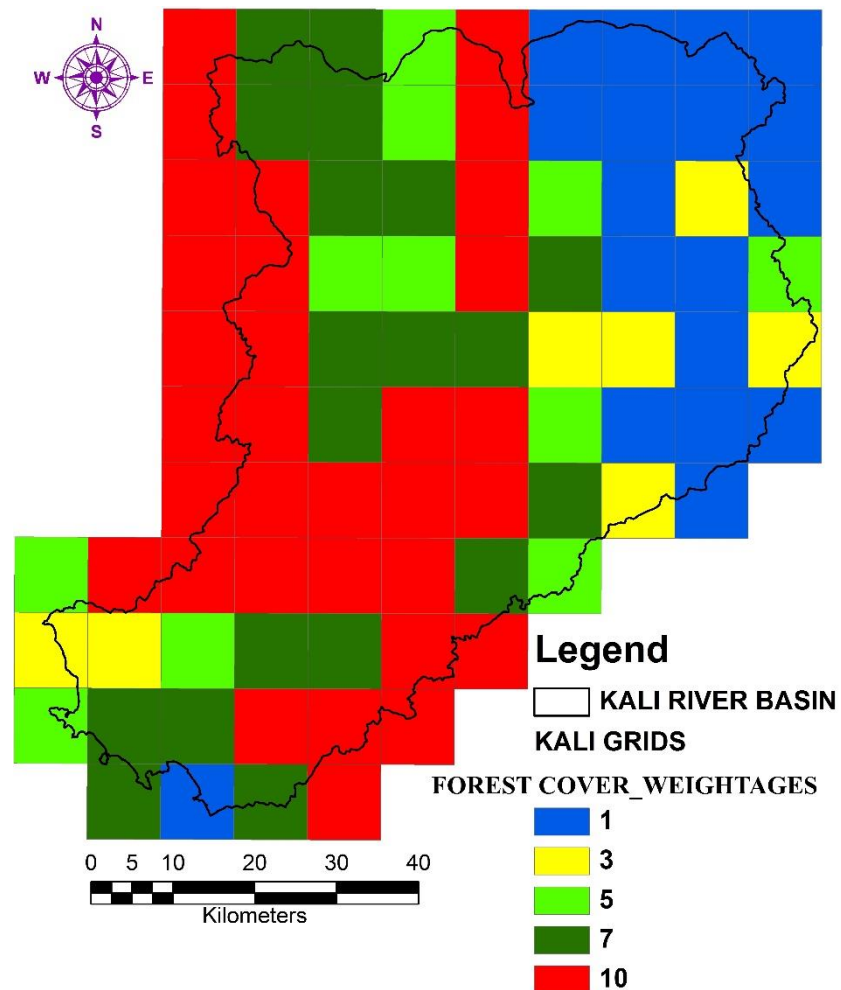


Figure 7a: Interior forest coverage of Kali basin

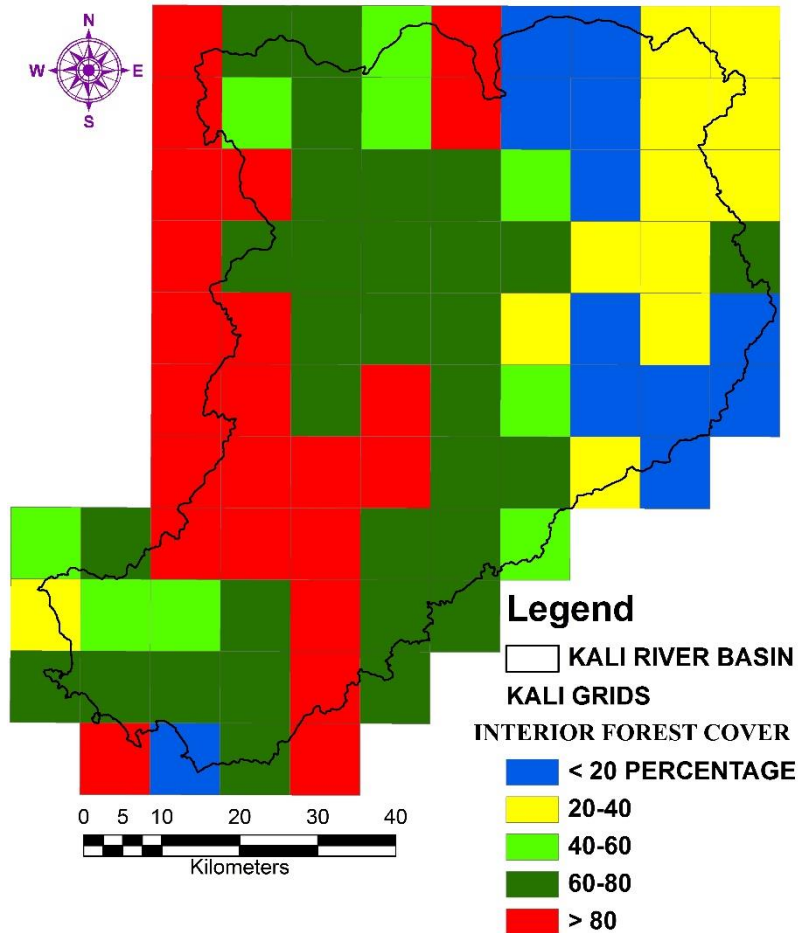
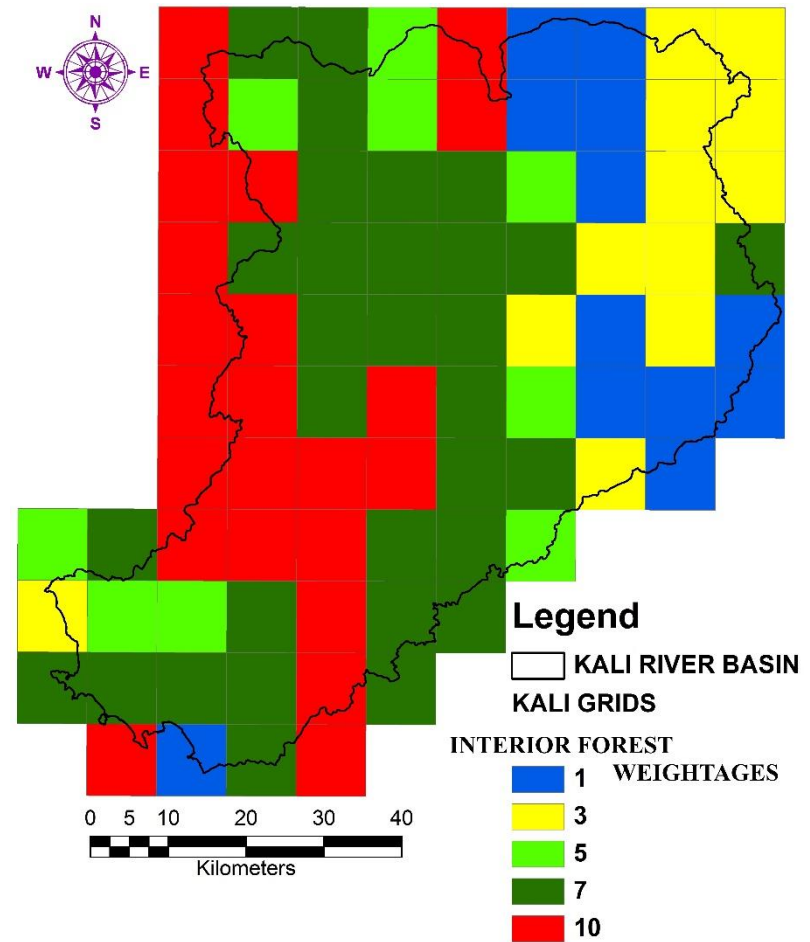


Figure 7b: Interior forest weightage map



Ecology

Figure 8a: Floral diversity of Uttara Kannada

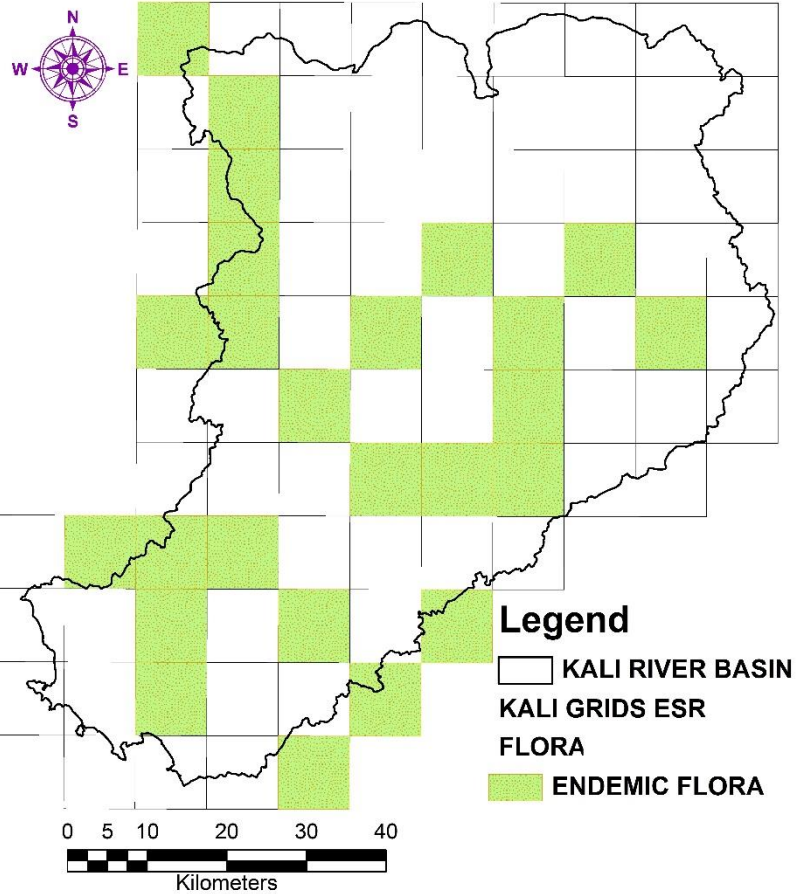


Figure 8b: Weightages of flora

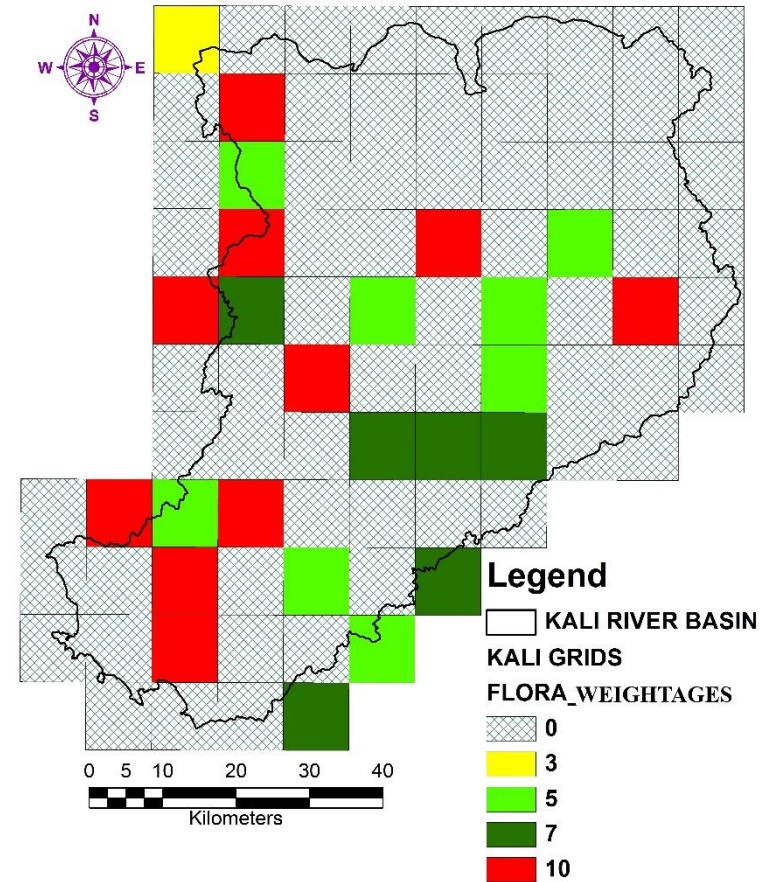


Figure 9a: Faunal diversity

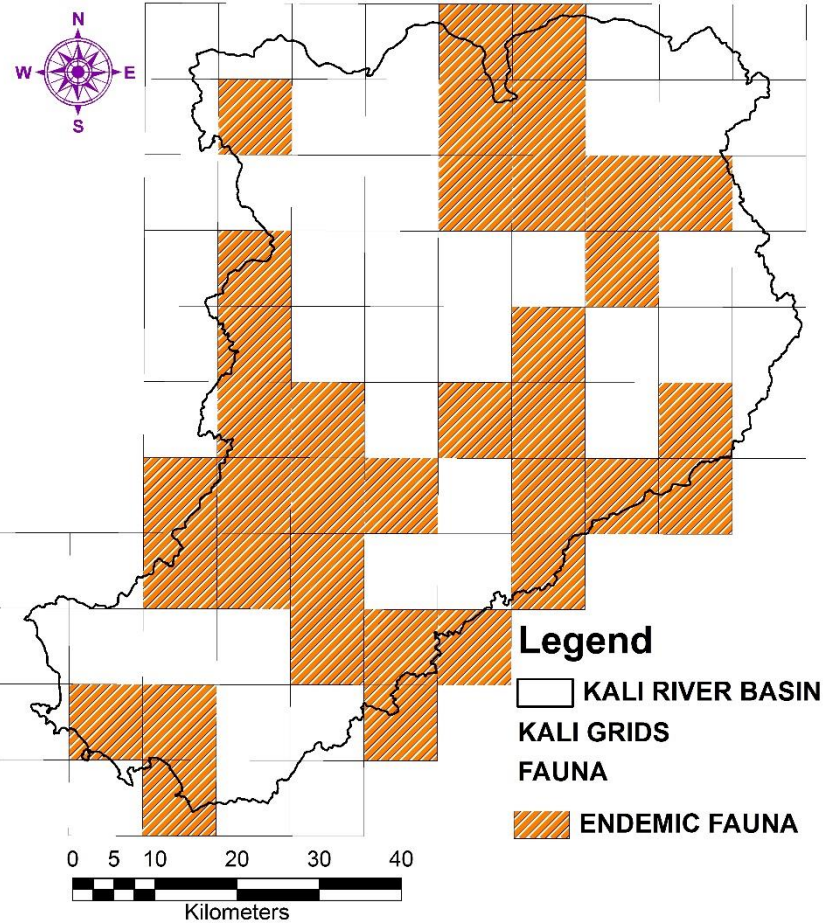
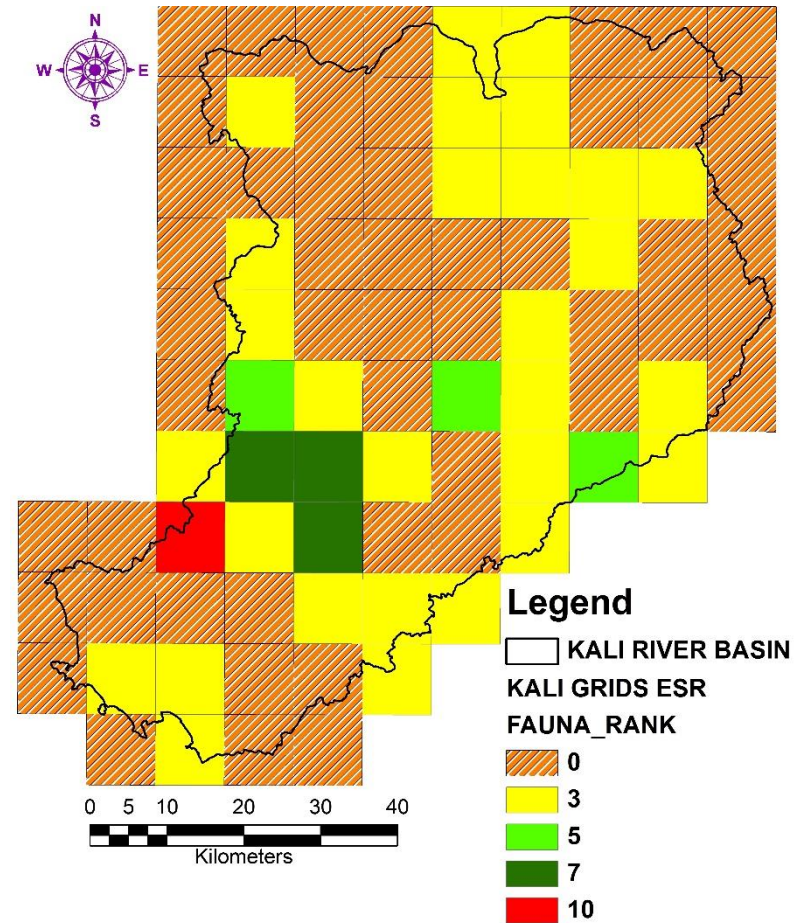
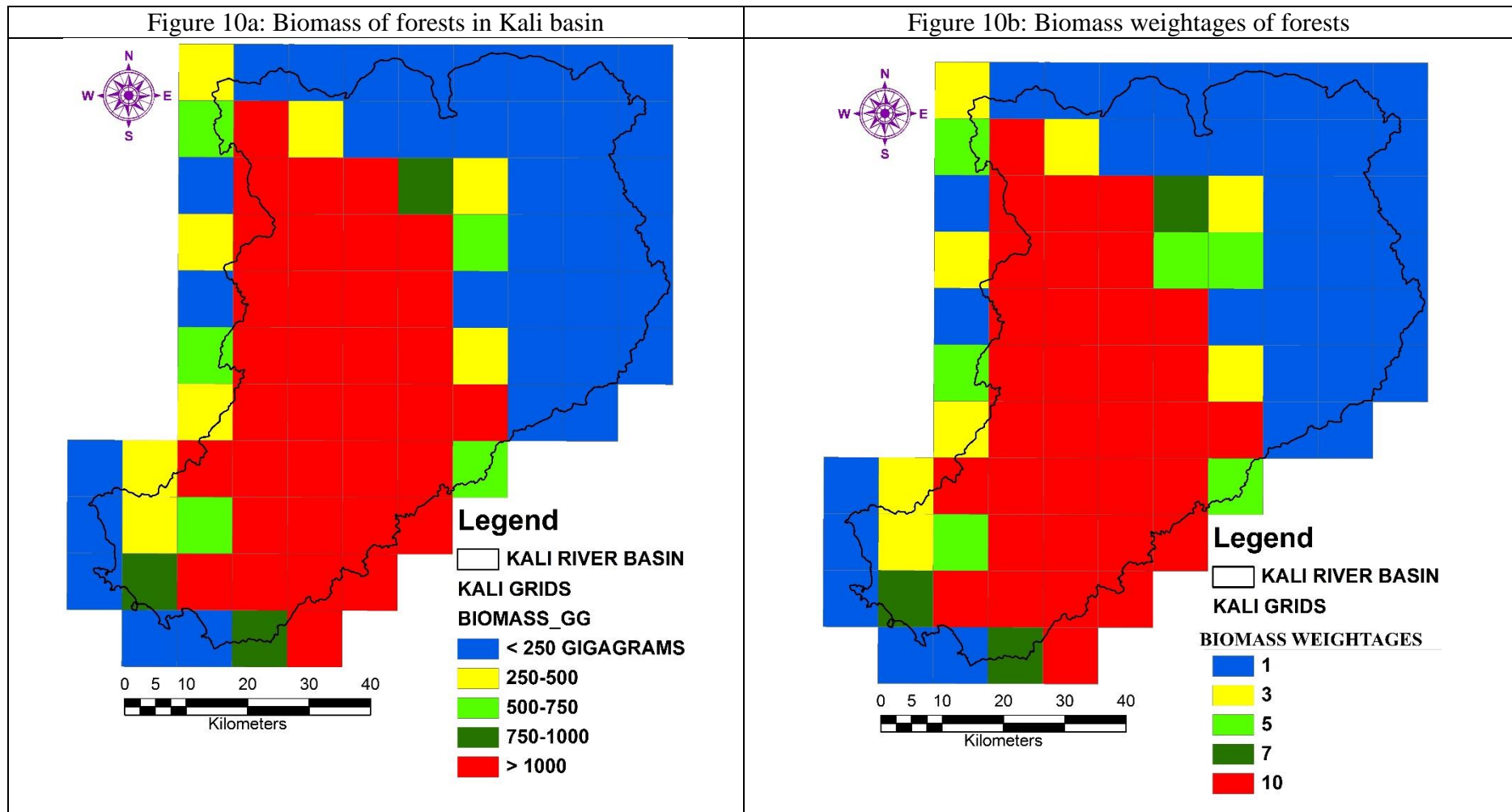


Figure 9b: Weightages of fauna





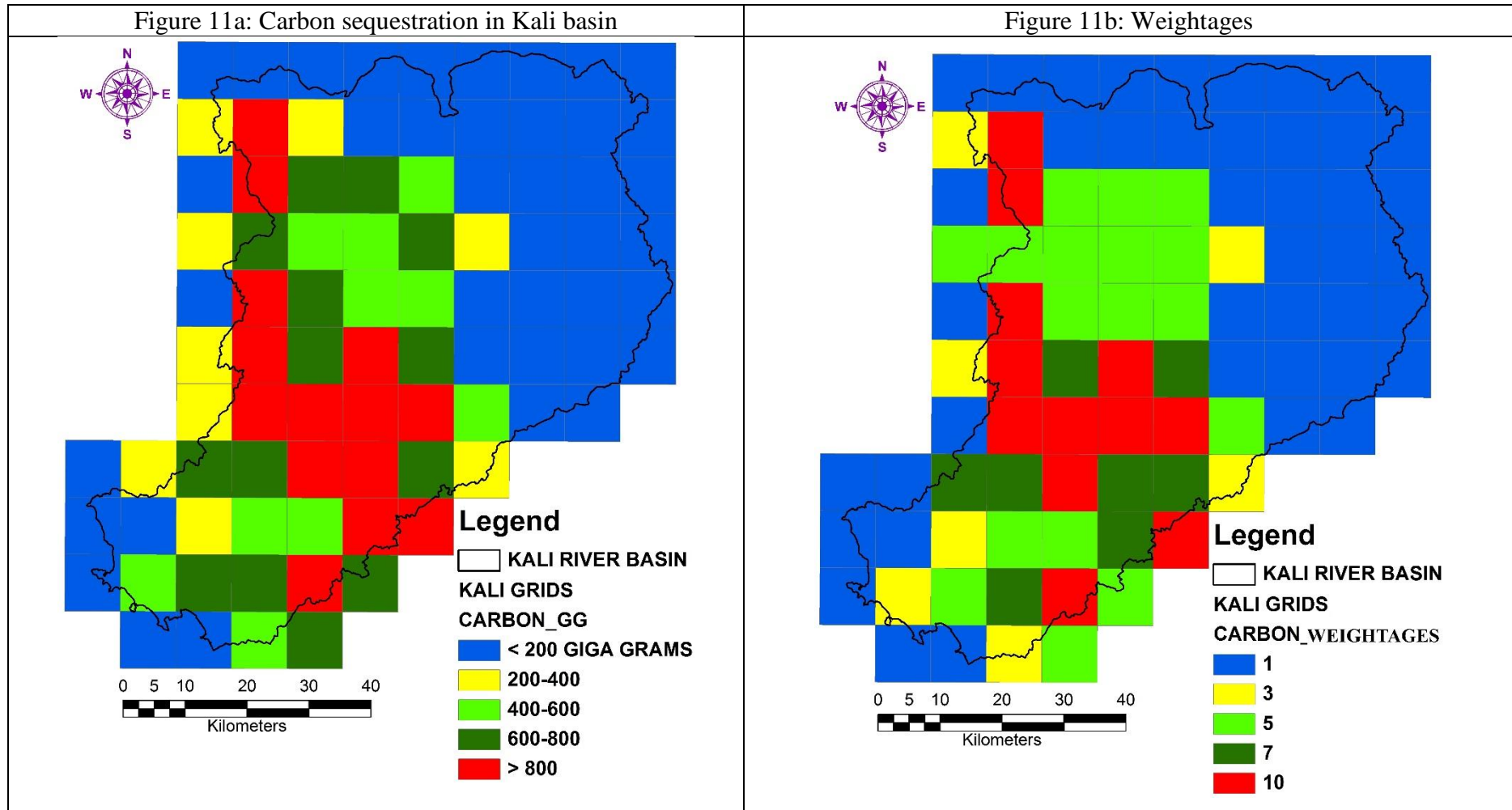


Figure 12a: Conservation reserves of Kali basin

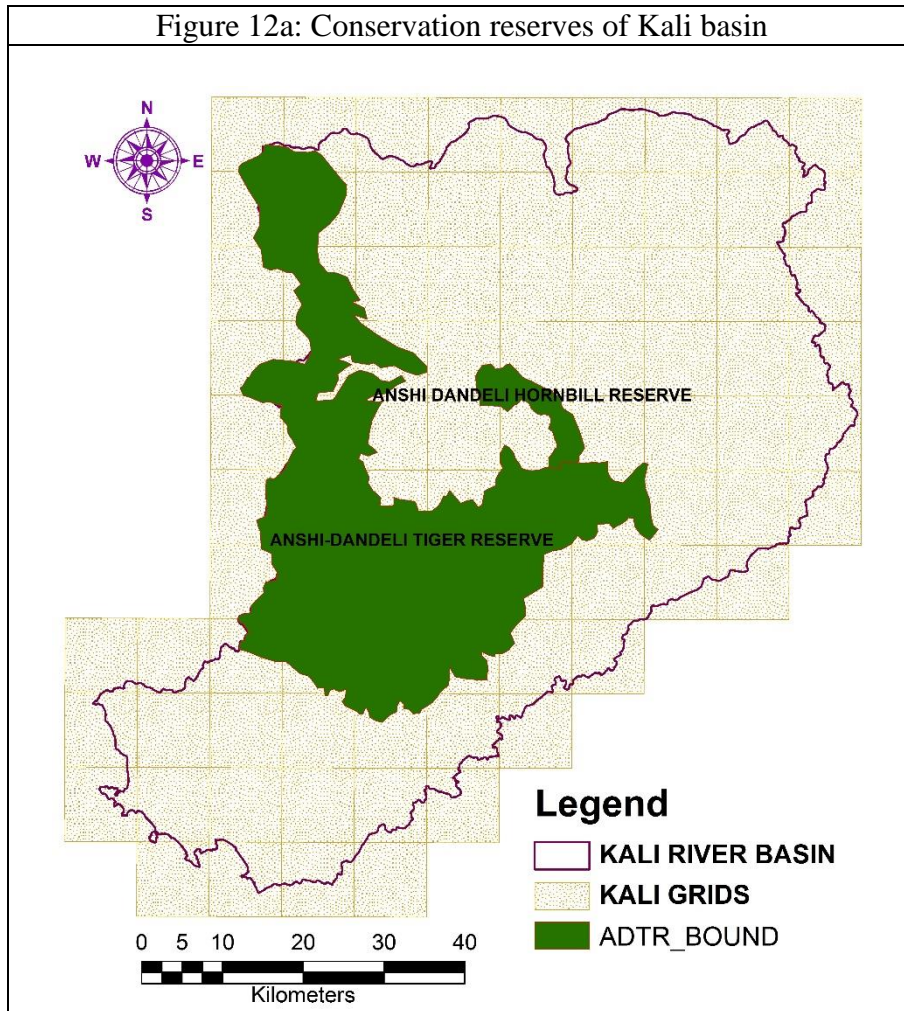
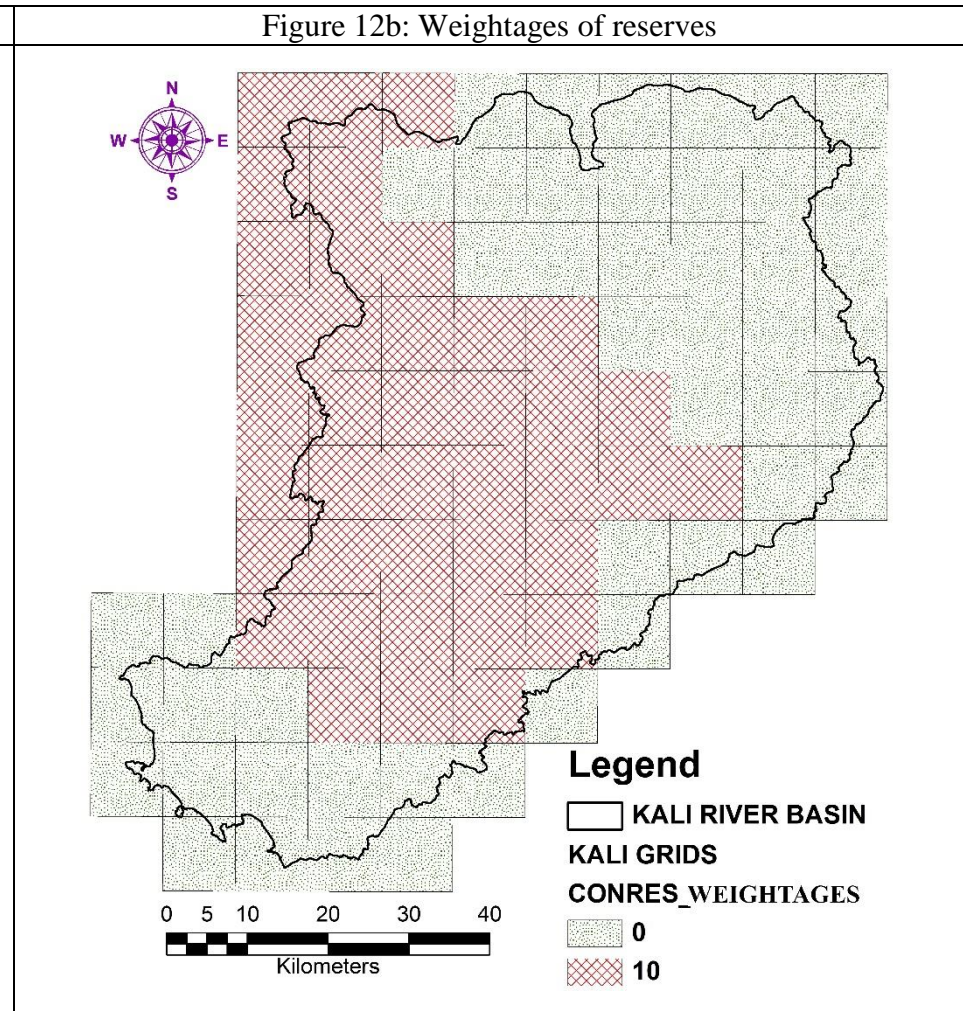


Figure 12b: Weightages of reserves



Geo-Climatic

Figure 13a: Altitude (m) of Uttara Kannada

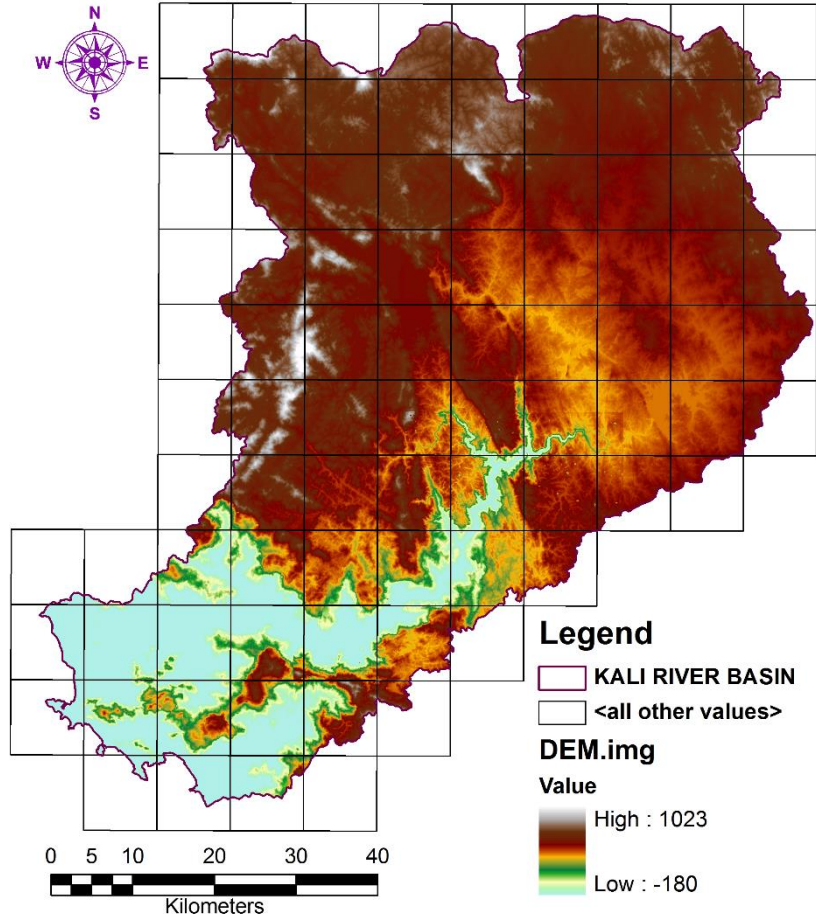


Figure 13b: Weightages of altitude (m)

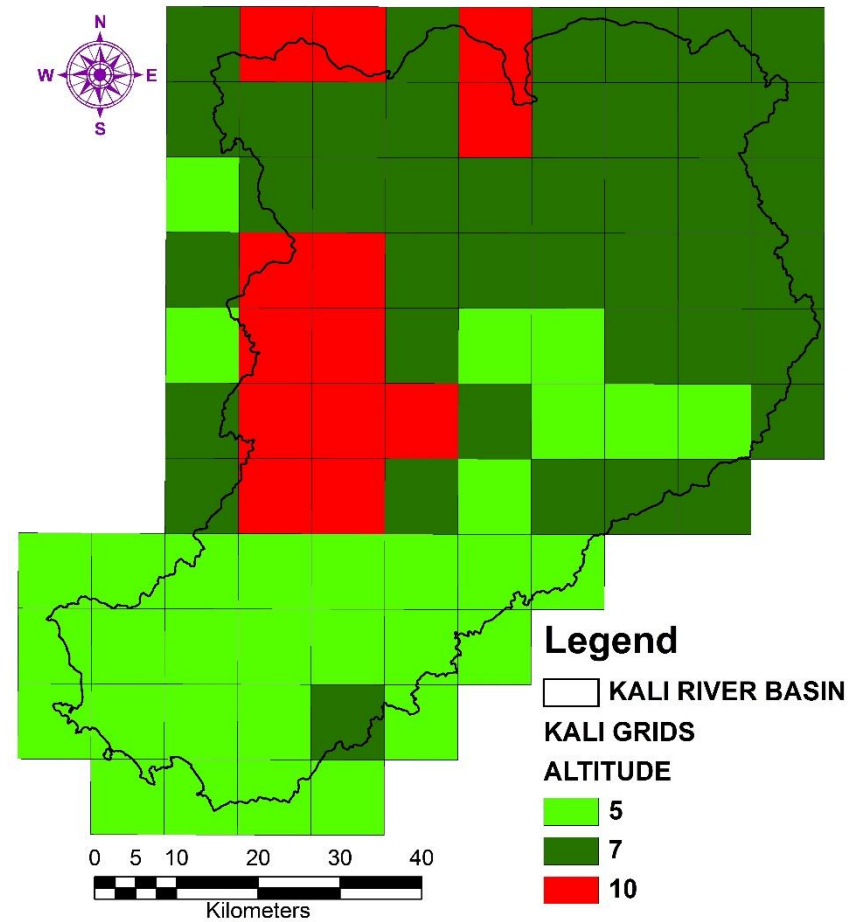


Figure 14a: Slope (%) map of Uttara Kannada

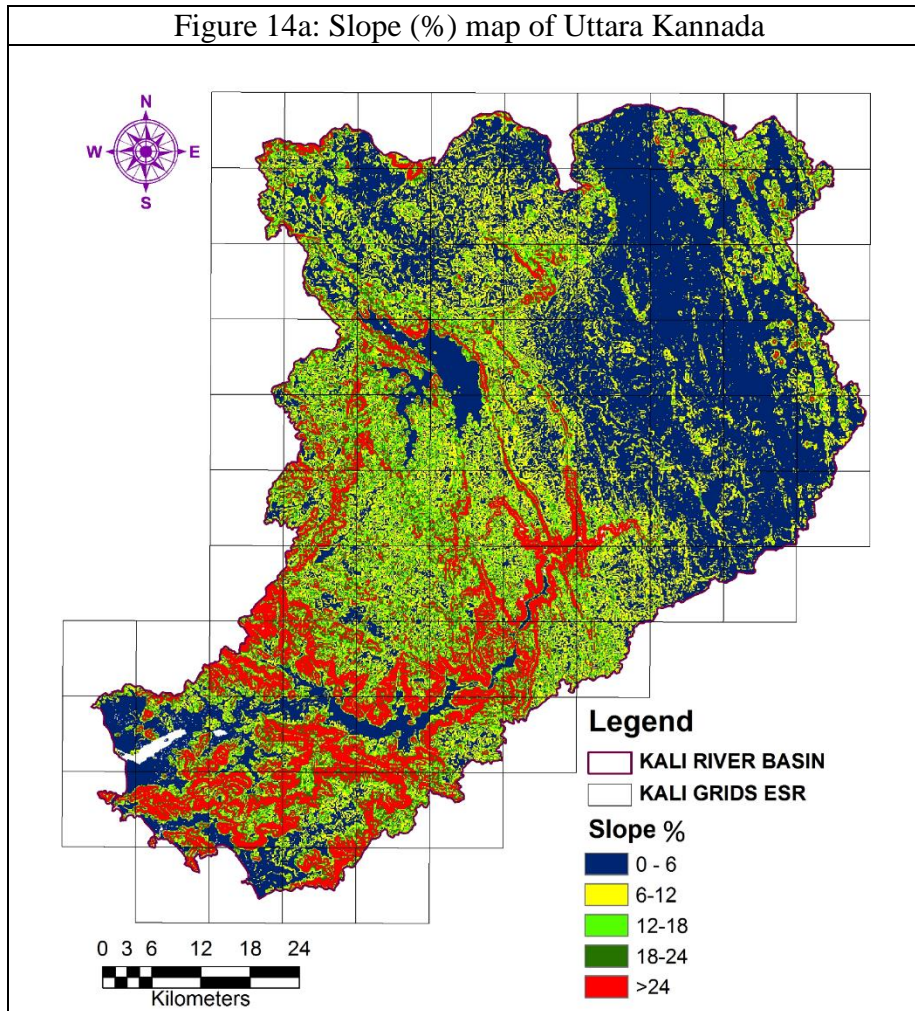


Figure 14b: Weightage map of slope values

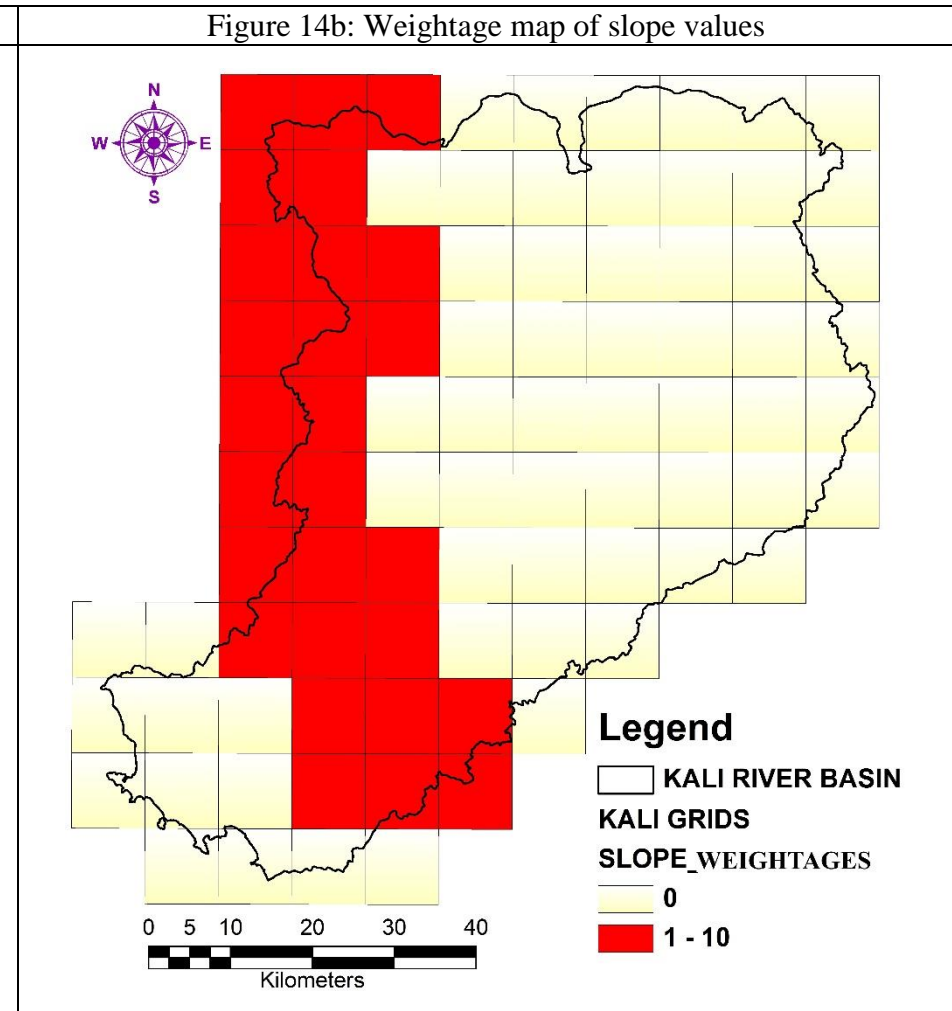


Figure 15a: Rainfall map of Uttara Kannada

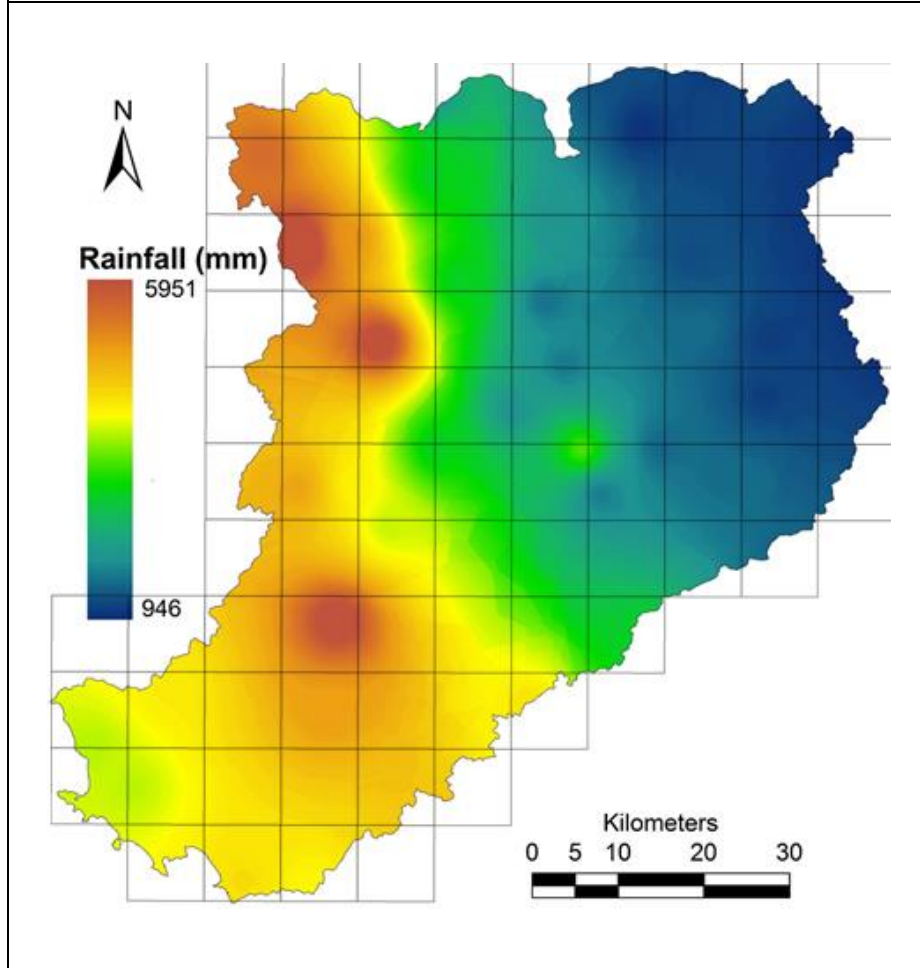
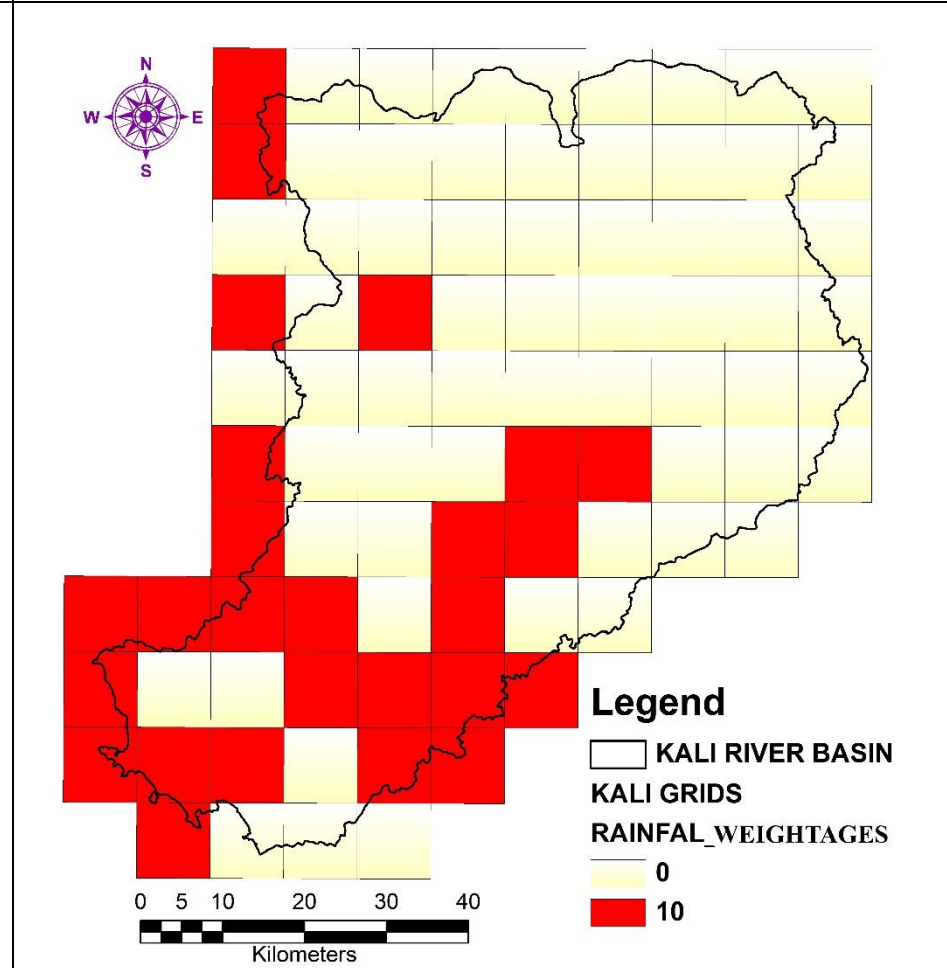


Figure 15b: Weightage map based on rainfall



Hydrology

Figure 16a: Stream flow status of Uttara Kannada

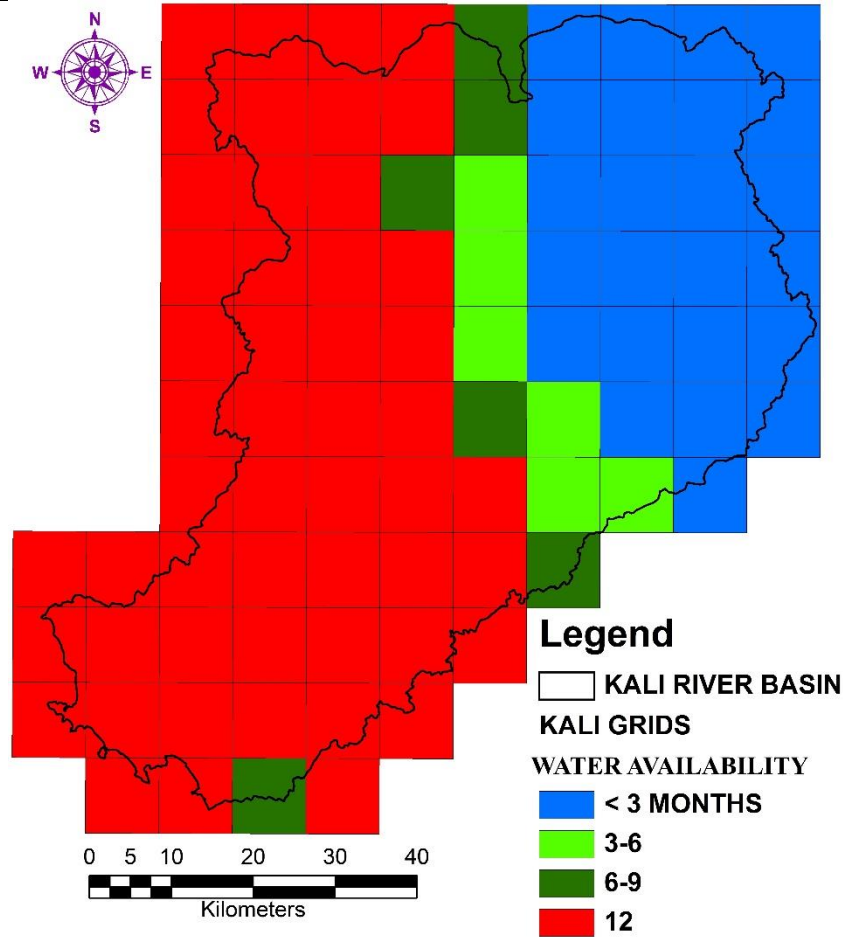
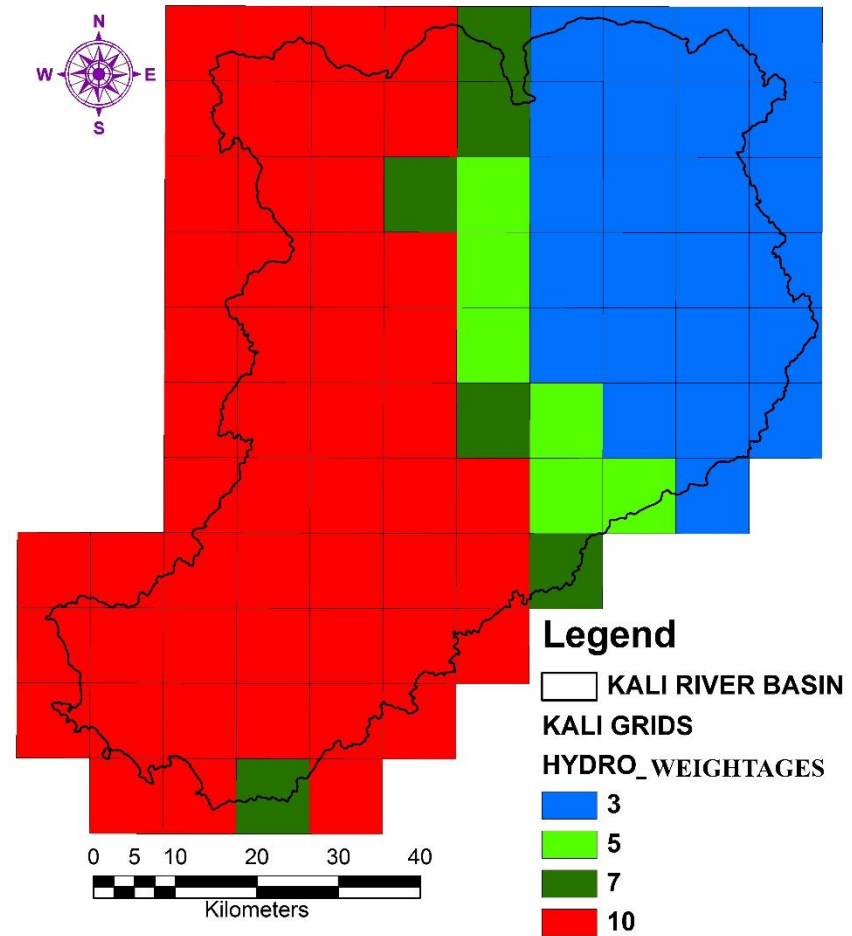


Figure 16b: Weightages for stream flow



Energy

Figure 17: Solar energy

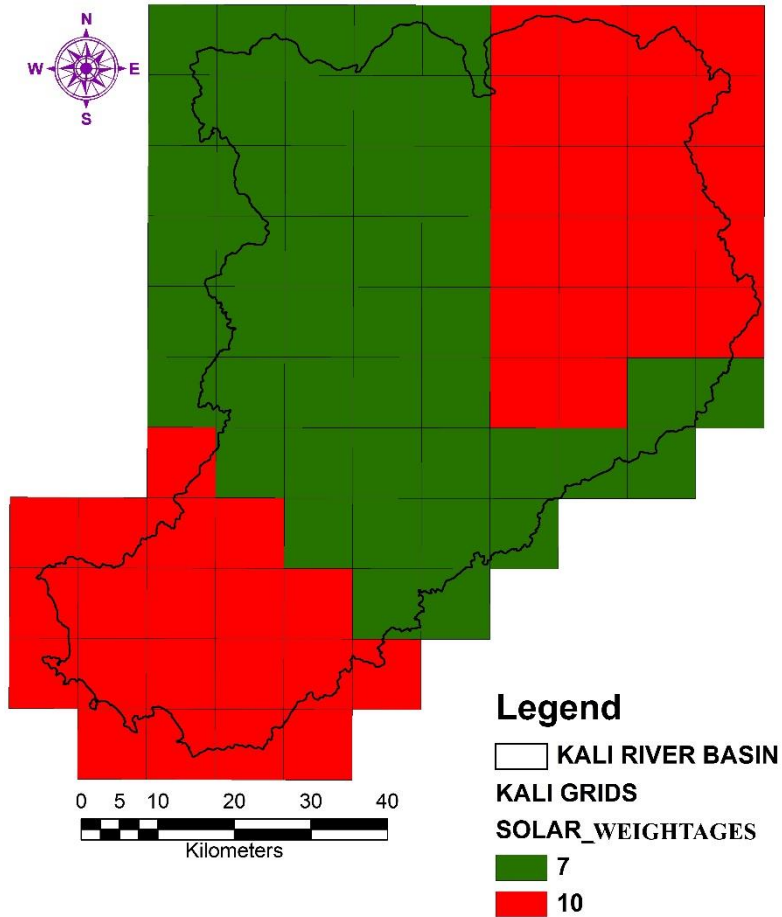
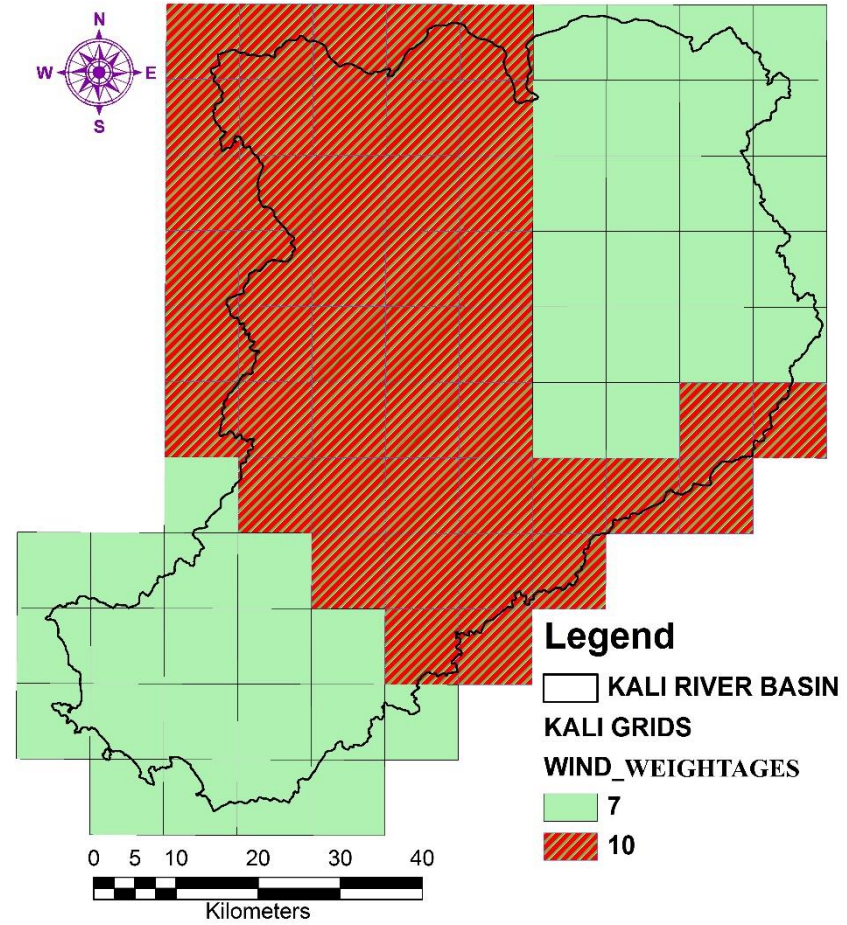
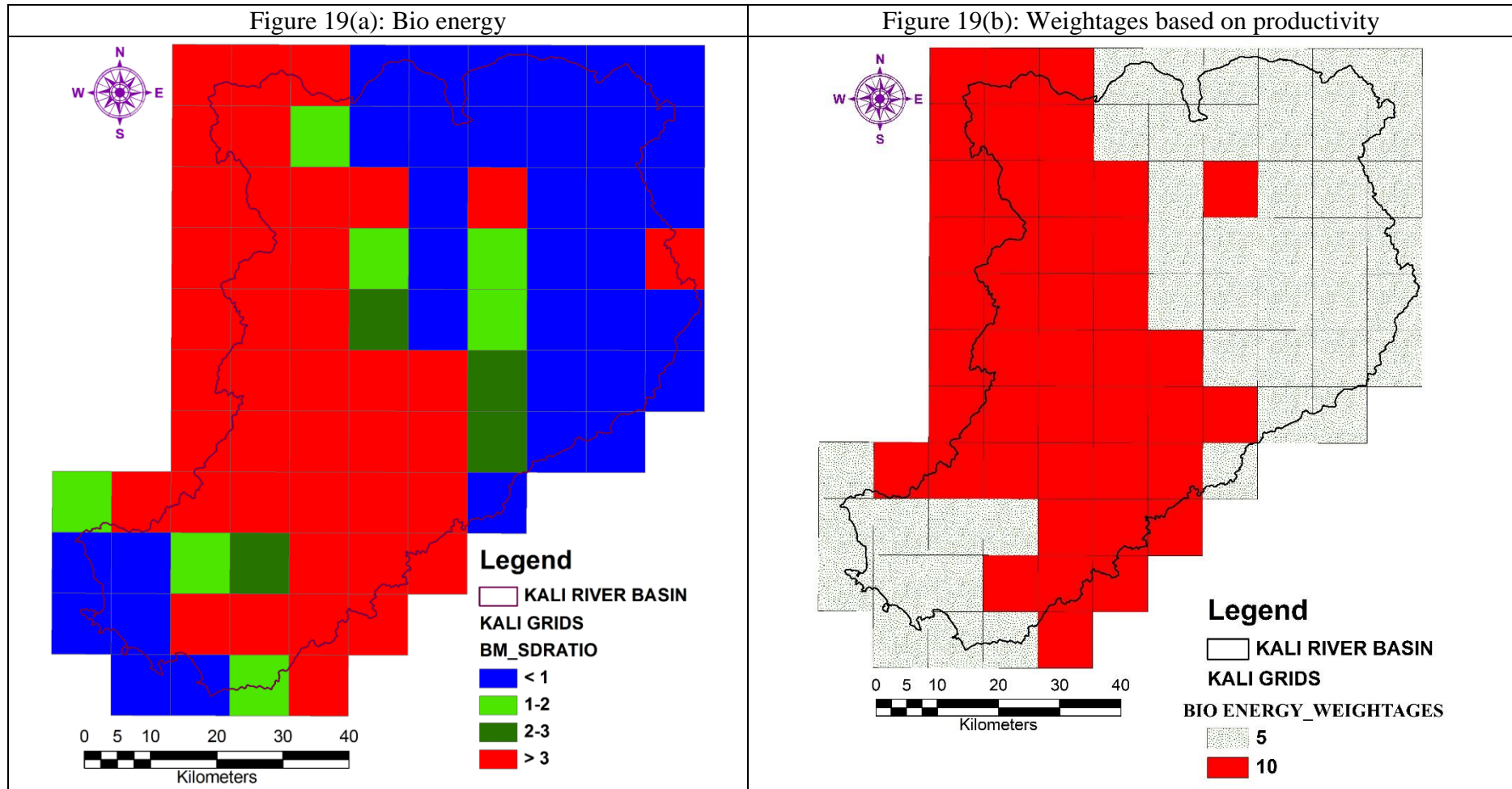


Figure 18: Wind energy





Social aspects

Figure 20a: Forest dwelling communities of Uttara Kannada

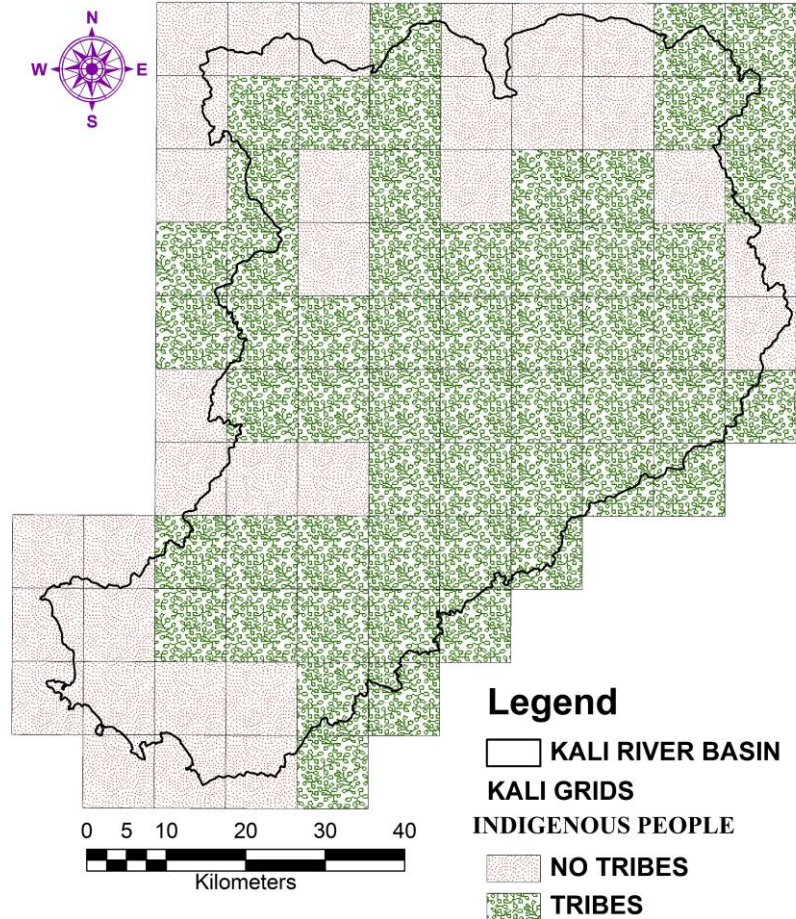


Figure 20b: Weightage map of forest dwelling communities

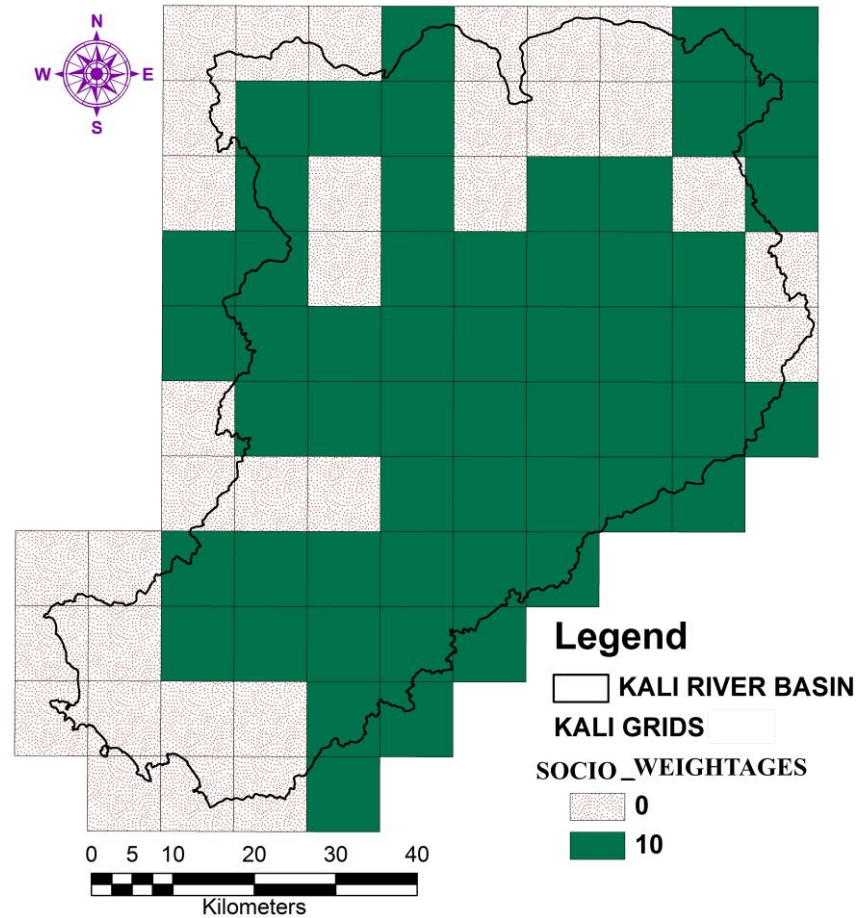


Figure 21a: Population density map

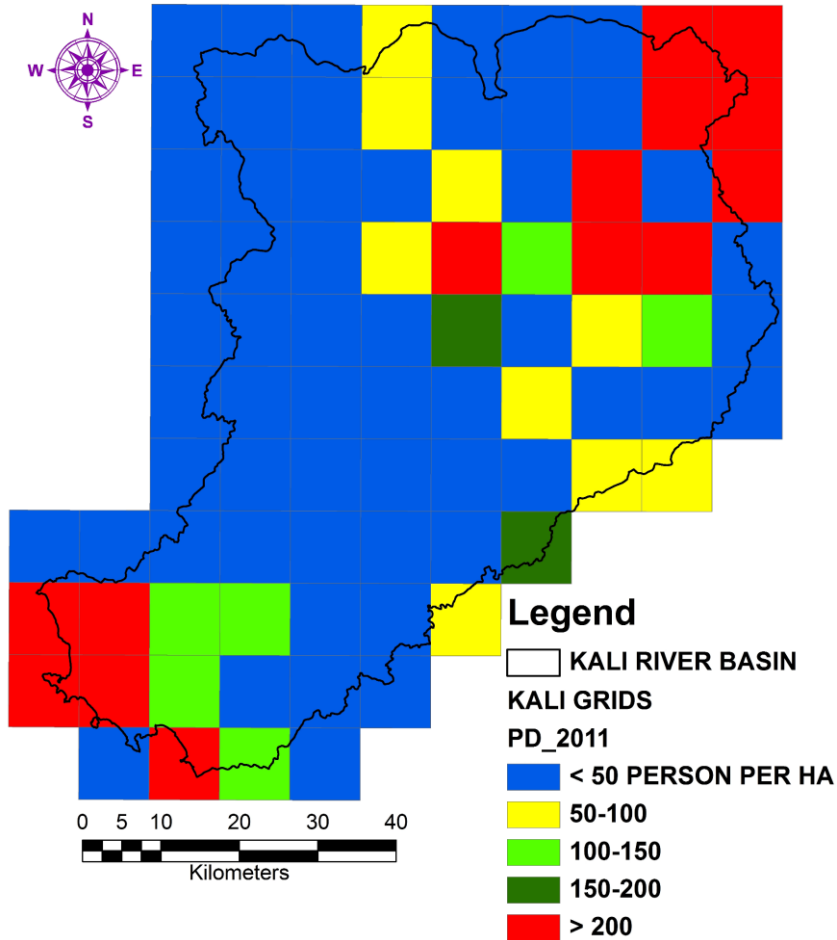
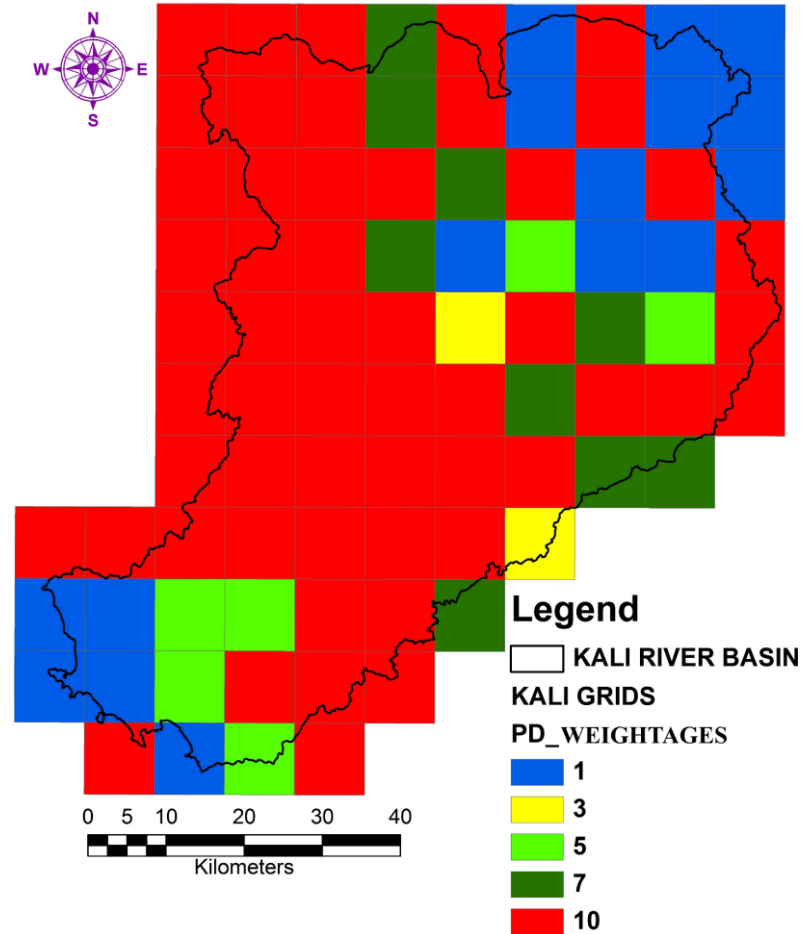


Figure 21b: Weightage associated with population density



Estuarine diversity

Figure 22: Estuarine diversity weightage map

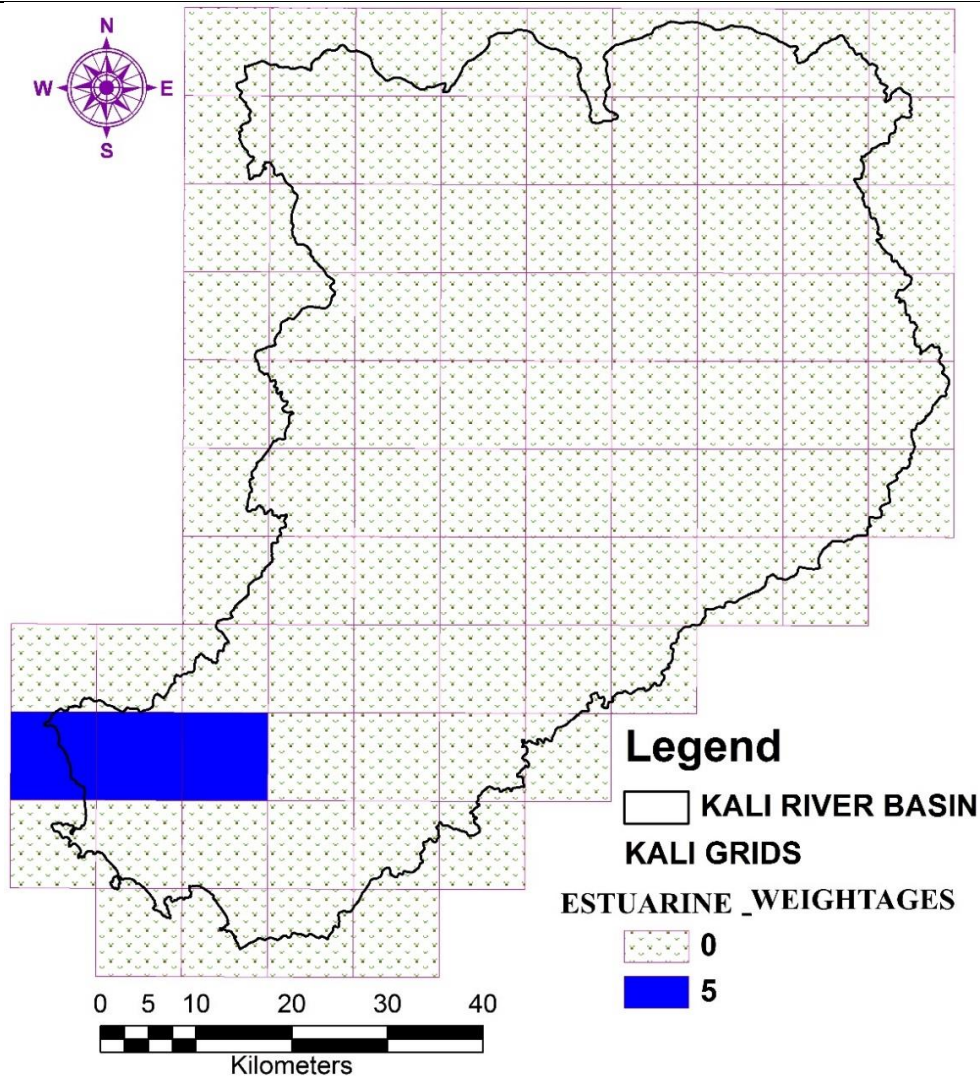


Figure 23: Ecologically Sensitive Regions of Kali river basin

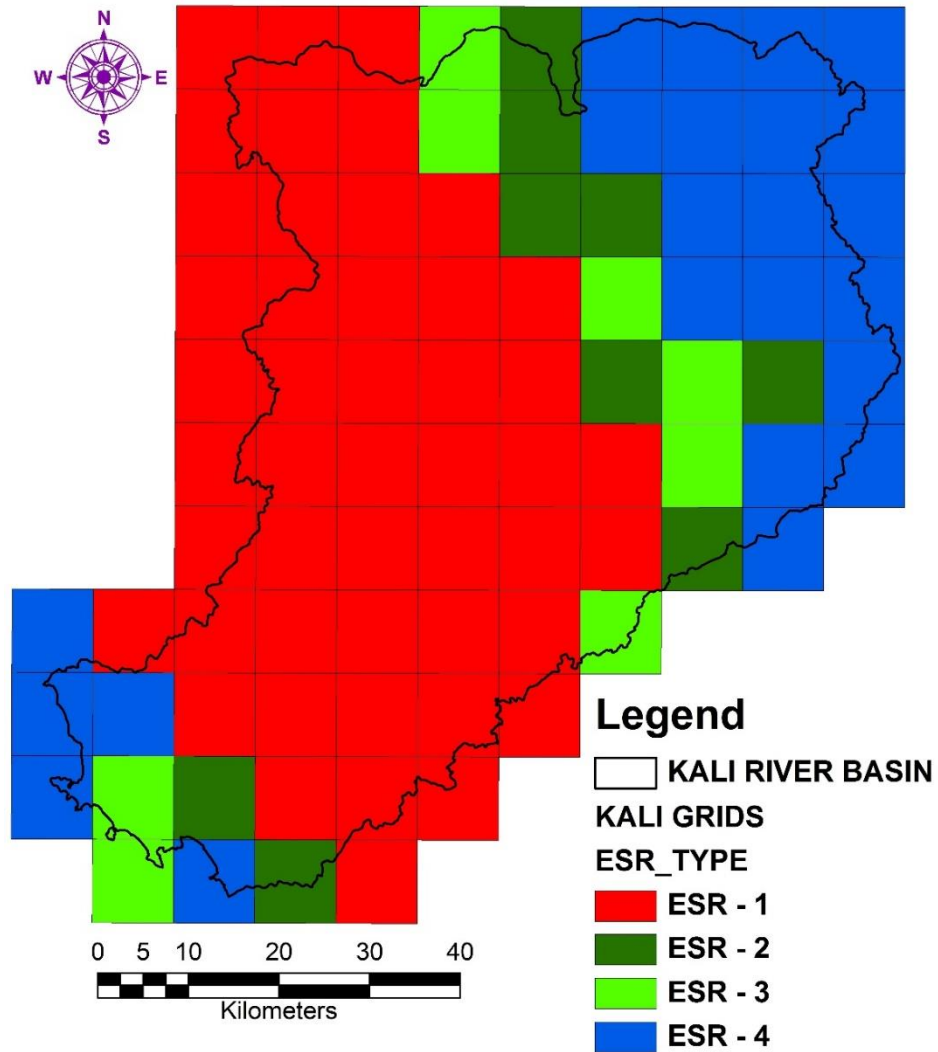


Figure 24: Ecologically Sensitive Regions of across various villages of basin

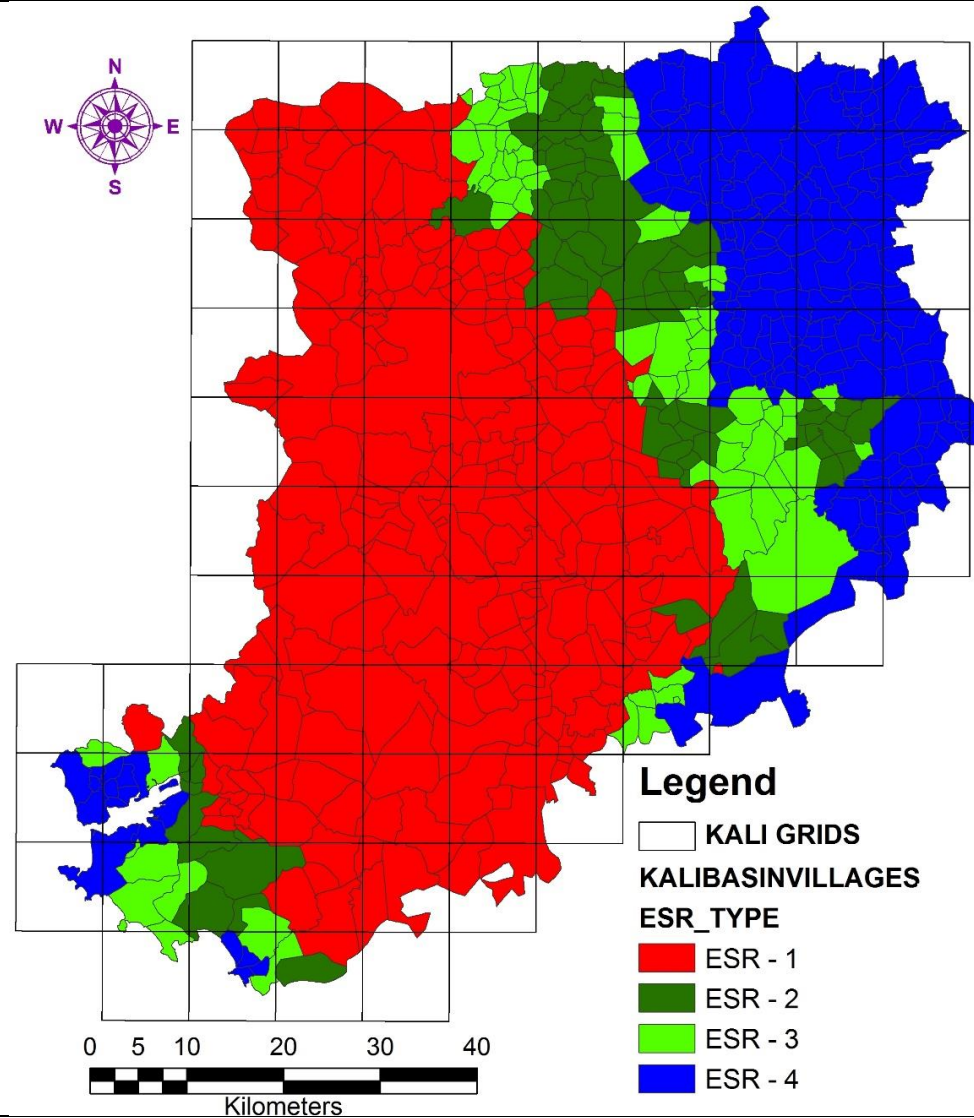


Figure 25: Ecologically Sensitive Regions of and KTR (ADTR)

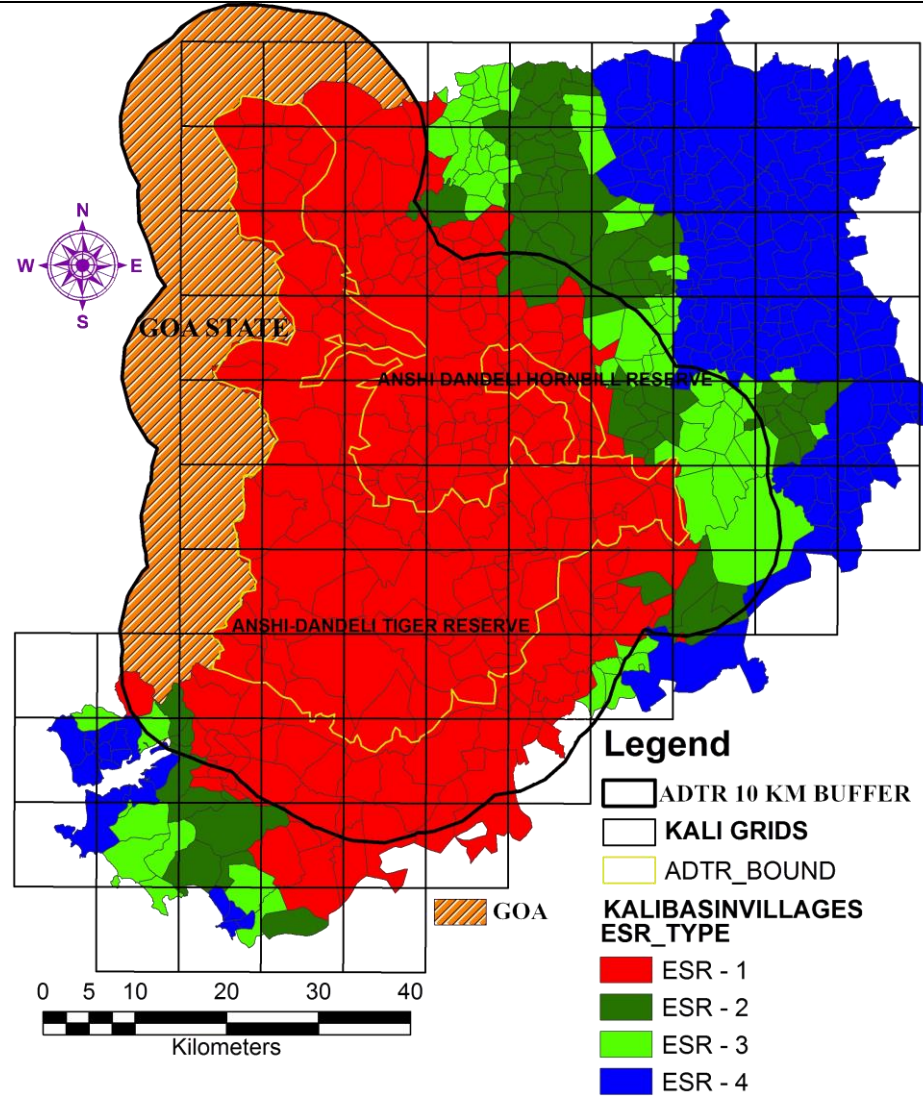


Figure 26: ESR map for villages of KTR (ADTR)

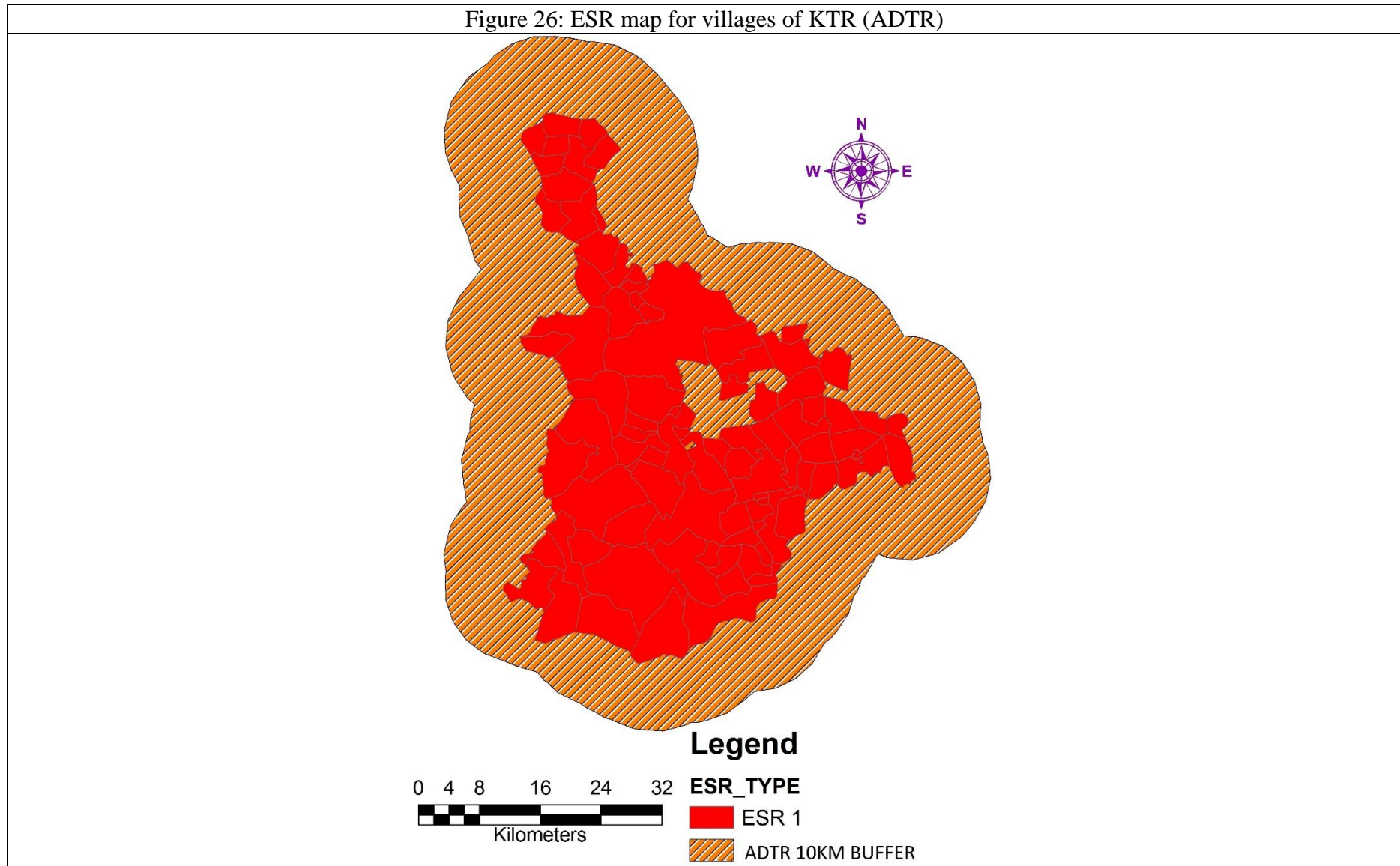
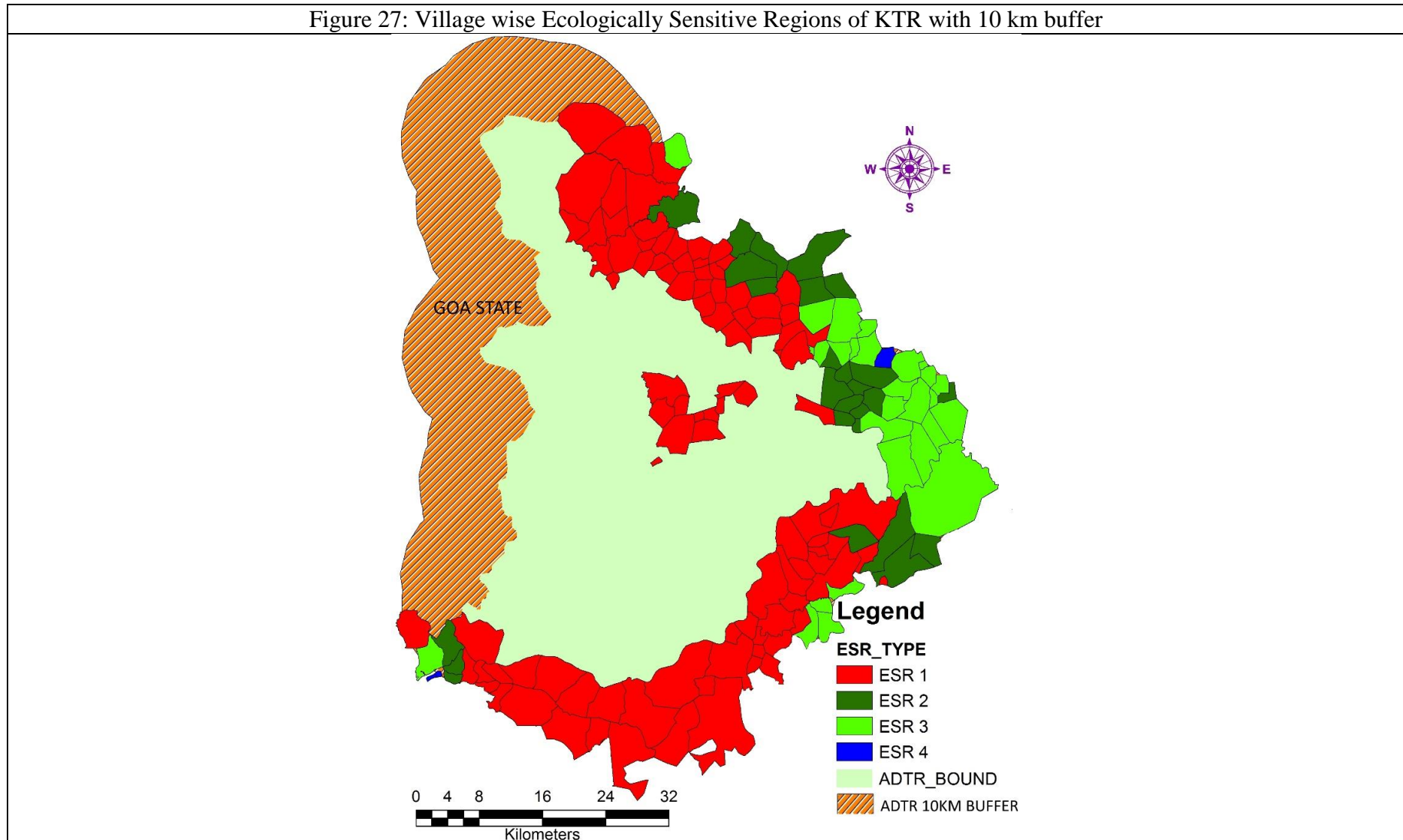


Figure 27: Village wise Ecologically Sensitive Regions of KTR with 10 km buffer



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