REPORT OF THE HIGH LEVEL WORKING GROUP ON WESTERN GHATS

Volume I

Ministry of Environment and Forests
Government of India
15 April 2013

Cover: Portion of peninsular India showing Western Ghats region depicted using multi spectral image of advanced wide field sensor (AWifs) on board RESOURCESAT-1 as natural color composite

Contents

Volume I

Volume II

REPORT OF THE HIGH LEVEL WORKING GROUP ON WESTERN GHATS

We, the Members of the High Level Working Group constituted to study the preservation of the ecology, environmental integrity and holistic development of the Western Ghats in view of their rich and unique biodiversity after due deliberation have adopted the Report for submission.

15/4/2013

1. DR K. KASTURIRANGAN.
CHAIRMAN

MEMBERS

2. (Professor C. R. Babu)

3. (J. M. Mauskar)

4. (Professor Kanchan Chopra)

5. (Dr. Jagdish Kishwan)

6. (Darshan Shankar)

7. (Sunita Narain)

8. (Dr. P. S. Roy)

9. (Ajay Tyagi)
Member Convenor

10. (Dr. Indrani Chandrasekharan)
Special Invitee

PREFACE

Western Ghats is a magnificent mountain range next only to Himalayas and is a biological treasure trove with a high degree of endemism (11% to 78%) and scenic beauty. This unique eco-system has been threatened by continuously increasing habitat pressures and declared as one of the world's hottest hotspots of biodiversity. Realizing the need to protect and rejuvenate the ecology of and for sustainable development in Western Ghats, the Ministry of Environment and Forests (MoEF) constituted a Western Ghats Ecology Expert Panel (WGEEP). The mandate of WGEEP was to demarcate ecologically sensitive zones and suggest measures to conserve, protect and rejuvenate the ecology of Western Ghats region. Taking into account the comments and suggestions made by different stakeholders including State Governments and Central Ministries on WGEEP Report, the MoEF constituted a High Level Working Group (HLWG) to suggest an all-round and holistic approach for sustainable and equitable development while keeping in focus the preservation and conservation of ecological systems in Western Ghats.

The Working Group has carefully examined the different approaches available for characterizing the Western Ghats System to get an insight so as to make pragmatic recommendations. The Working Group followed a detailed geospatial analysis for identification of Ecologically Sensitive Areas at a fine resolution of 24 m with village as unit. After extensive discussions with experts, the Working Group also defined the extent of Western Ghats; and as per HLWG's definition, the Western Ghats region spreads over an area of 1,64,280 km^2 and extends from North to South over a distance of 1500 km traversing Six States. Our analysis also revealed that already close to 60 per cent of the Western Ghats region is under cultural landscape - human dominated land use of settlements, agriculture and plantations (other than forest plantations) - and only 41 per cent of the land area can be currently classified as natural landscape. Of the natural landscape, the biologically rich area, with some measure of contiguity is roughly 37 per cent of the Western Ghats which is about 60,000 km^2. We have identified this 37% of natural landscape having very high and

high biological richness and low fragmentation and low population density and contain Protected Areas (PAs), World Heritage Sites (WHSs) and Tiger and Elephant corridors as Ecologically Sensitive Area (ESA) and recommend it to MoEF for notification.

Because of unprecedented threats to natural landscape of Western Ghats region by development projects and urban growth, the Working Group has recommended a non-tolerance policy with respect to highly interventionist and environmentally damaging activities like mining or polluting industries and made specific recommendations about prohibited activities and those that require high level of scrutiny and assessment before clearance within ESA. While recognizing the fact that list of non-permissible activities recommended may not be enough to fully manage the environmental fallout of development and also being fully aware that management through prohibition and fiat is often detrimental to the interests of the very people, the environment policy is aiming to protect. The Working Group has suggested a balanced and nuanced approach – to say no to the most damaging and high impact activities and at the same time creating an enabling process to incentivize environmentally sound development that benefits local livelihoods and economies.

The Working Group also took note of the environmentally friendly practices in coffee plantations in Kodagu and cardamom plantations in Idduki and Wayanad where integration of natural landscapes with human settlements exists. Indeed, it is because of this harmony between people and nature in the Western Ghats, the HLWG recommended policies to incentivize green growth that promotes sustainable and equitable development across the Western Ghats region. The future lies in working on green growth strategies that build on the natural endowment of the Western Ghats region to create a vibrant economy, while preserving, conserving and rejuvenating the ecology. As a part of the governance of Western Ghats ecology, the Working Group also recommended to MoEF for setting up of a “Decision Support and Monitoring Centre for Western Ghats”.

Even as we take urgent steps as outlined in this report, the future planning and regulations would call for constantly updating and improving our understanding of this multi-dimensional Mountain System. The Western Ghats ecosystem has a high degree of complexity arising out of a variety of non-linear interactions between its component elements such as rich Biodiversity (Flora & Fauna), Hydrological Systems, Geological and Geomorphological characteristics and Climatic Variations coupled with impacts of human interventions. Understanding of such a system and evolving specific strategies for sustainable development, after duly factoring conservation and preservation imperatives, demand insights into the behavioural pattern of this complex entity. Against this backdrop, our own understanding of the system behaviour has not even scraped the surface of the huge embedded knowledge bases and their interrelationships. The work of WGEEP and our own work can help to highlight the need for understanding this complex system in its variety of manifestations as we seek for maximum possible internal self-consistency between competing demands of development, conservation and local livelihoods. This is an area of research that can be carried out for several years involving some of the most brilliant minds. In this context, we feel that we should inspire generations of researchers to work on aspects relevant to the functioning of Western Ghats Ecosystem for greater insight into its behaviour. This in turn can also open up multiple pathways for decision making and facilitating the application of criteria like multi-parameter optimization.

In short, the WGEEP report together with the present Report can be, indeed, a starting point in a long and what could be an eventful odyssey to understand the man-environmental relations through the eyes of Western Ghats which in the view of its Creator can be a gift or a curse depending on how we judge and act. Recognizing this aspect should truly make us humble.

Members
High Level Working Group

ACKNOWLEDGMENT

The Members of the High Level Working Group (HLWG) would like to record their deep gratitude to the Hon'ble Minister of State (Independent Charge) for Environment & Forests, Smt. Jayanthi Natarajan for entrusting this important task to us, a task which was challenging and called for finding a right balance between the imperatives of conservation ecology and development for the complex Western Ghats System.

The task entrusted to the HLWG involved development of multi parameter criteria, analysis and modelling of different types of data and information. In executing this aspect of the activity, the HLWG relied heavily on the expertise of Indian Space Research Organization (ISRO) in general and National Remote Sensing Centre (NRSC) in particular. Specifically, the Working Group would like to express their sincere appreciation to the guidance provided by Dr. V.K. Dhadwal, Director, NRSC. Further, nearly all the important aspects of this specialized effort were carried out by Dr. Chandrasekhar Jha and Shri G. Rajashekar of NRSC who tirelessly worked on various aspects of analysis and interpretation. The high levels of expectations of HLWG were fully responded to by these scientists. We also recall with gratitude the special interest Dr. K. Radhakrishnan, Chairman, ISRO took in extending all the required support of ISRO for this purpose.

As a part of getting a second opinion through a peer review mechanism, the HLWG requested a committee of Dr. Y.V.N Krishna Murthy, Director, Indian Institute of Remote Sensing, Dr. V.B. Mathur, Dean, Wildlife Institute of India and Prof. Subhash Ashutosh, Indira Gandhi National Forest Academy for the critical evaluation of the methodologies used for identification of the Ecologically Sensitive Areas (ESA). We appreciate the high degree of professionalism brought to bear by these scientists in reviewing the methodology adopted.

The HLWG had contacted the Governments of the 6 States of Western Ghats to seek their specific views on the various recommendations made in the WGEEP report and their implications. The States not only responded to these enquiries with quality analytical inputs but also in most of the cases facilitated meetings of the working Group with the concerned State Government officials who made excellent presentations besides insightful discussions. Further, the HLWG had the privilege of meeting with Chief Ministers of Maharashtra, Goa and Kerala along with their Cabinet colleagues and elected representatives (MPs and MLAs belonging to different parties). This aspect of interaction with the State Governments, their elected representatives, functionaries and officials, provided the most valuable inputs for the Working Group to draft its recommendations. The Working Group would like to acknowledge with thanks the concerned functionaries at the State levels and in particular Chief Secretaries and Secretaries of relevant Departments.

The HLWG also made similar request to the Ministries/ Departments of the Central Government in the context of the WGEEP report. We would like to record our appreciation for the exhaustive responses that we received from the Central Ministries and Departments of the Government of India.

At the individual level, several important experts, professionals, NGOs and Activists interacted with the HLWG. Whereas, it is not possible to exhaustively acknowledge all the names, a few of them nevertheless merit mention. On the aspect of delineation of the Western-Ghats, the very illuminating discussions HLWG had with Prof. R. Vaidyanathan, Retd. Prof. of Geography and Geology, Andhra University, Dr. Balakrishna, Deputy Director General, Geological Survey of India and Prof. K.R. Subramanya of Geological Society of India are gratefully acknowledged. Further, the invaluable technical inputs and advice on Wildlife corridors provided by Prof. V.B. Mathur and Dr. Y.V. Jhala of Wildlife Institute of India are appreciated. Dr. Jayaraman of ISRO provided excellent inputs on the concept of Decision Support and Monitoring Centre for the Western Ghats.

One of the most important meetings that HLWG had at the individual level was with Prof. Madhav Gadgil, Chairman of WGEEP. The very extensive interaction of the individual Members of HLWG with Prof. Madhav Gadgil was deeply insightful even as we could glean his passion and commitment for the conservation of the Western Ghats ecology. Discussion with Prof. Madhav Gadgil provided valuable inputs for the HLWG, which also had discussions with many Members of WGEEP**.**

Many institutions provided useful information which were used by HLWG in conducting analysis and assessment. The State Biodiversity Boards, State Forest Departments, State Pollution Control Boards (SPCBs) and Tropical Botanical Garden Research Institute (TBGRI), Kerala State Electricity Board (KSEB) and Karnataka Power Corporation Limited (KPCL), to mention a few, provided valuable data on different issues ranging from Hydropower projects to biodiversity conservation.

HLWG also met a number of stakeholders including experts, experienced and knowledgeable citizens, associations of trade organizations, scientists and academicians, who offered valuable suggestions on the different facets of the Western Ghats. The HLWG also benefitted from meetings with some notable NGOs and Activists.

The HLWG thanks the Planning Commission, particularly Smt Indu Patnaik, Joint Advisor and Ms Urvana Menon, Young Professional (E & F) for their help in providing data inputs on Western Ghats Development Programme and analysis of the responses received.

Dr Amit Love, Deputy Director, Ministry of Environment and Forests, has been the major force behind the functioning of HLWG and it would have been impossible to accomplish the enormous task entrusted to HLWG without him.

The HLWG acknowledges the invaluable support provided by the scientists and staff, particularly Dr Rakesh Kumar and Shri Pankaj Kumar working at the Centre of Excellence Programme of the Ministry of Environment and Forests at the Centre for

Environmental Management of Degraded Ecosystems, University of Delhi in compilation and finalization of the report.

From the Ministry of Environment and Forests, we would like to particularly recognize the excellent presentation made by Dr. G.V. Subramanyam on the various aspects of WGEEP recommendations. Some of us also benefitted by the comprehensive briefing by Dr. Nalini Bhatt on the history of evolution of the several issues related to Athirappilly and Gundya projects. HLWG also acknowledges the inputs given by senior officers of the MoEF viz. Dr. S.K. Khanduri, Dr. Satpathy, and Dr. Burman. The HLWG would also like to express our thanks to Dr. V. Rajagopalan, Secretary, Ministry of Environment and Forests, for his keen interest in the progress of the HLWG and also extending the support of the Ministry whenever called for.

List of Tables

List of Figures

SUMMARY OF RECOMMENDATIONS AND ACTION PLAN

The observations and discussions presented in different chapters of this Report clearly indicate unambiguously that the eco-system of Western-Ghats is in need of urgent attention and action. Out of the estimated 1,64,280 km^2 of the Western-Ghats area, the natural landscape constitutes only 41 per cent. The area identified as ecologically sensitive is about 37 per cent i.e., about 90 % of the natural landscape. It is against this backdrop of a fast dwindling unique ecosystem, that we make these recommendations. Needless to emphasize, there is a great sense of urgency, in the implementation of the tasks arising out of these recommendations, even though, we fully recognize the sincere commitment that each of the Six States has displayed in the context of protecting the rich Bio-diversity of this mountain range. In making some of the general and sectoral recommendations, we are also aware that many of these are already inbuilt into the present strategies of the respective States. In repeating such recommendations, we are only underscoring the imperatives of implementing such recommendations in letter and spirit. The summary of recommendations are given below:

A. Delineation and demarcation of ecologically sensitive area in Western Ghats region

1. In the absence of accepted definition and delimitation of Western Ghats in terms of geology and geomorphological features, the talukas under Western Ghats Development Programme of Planning Commission and under Hill Development Programme and talukas located at the traditionally accepted northernmost boundary of Western Ghats (south of Tapti river) in Gujarat have been included in defining and delimitation of Western Ghats Region by HLWG. The delimited area of 188 talukas in 6 States of Western Ghats has been designated as Western Ghats Region which spreads over an area of 1,64,280 km^2 between 8°0'– 22°26' N and 72°55'– 78°11' E and extends over a distance of 1500km from Tapti River at the north to Kanyakumari at the south, with altitudinal range (ellipsoid) from 0 to 2674 m above sea level and

width ranging from 10km (at narrowest point) to 200km (at widest point). HLWG recommends the adoption of the boundaries as demarcated in the Report.

2. About 60,000 km^2 of natural landscape (approximately 37% of the total geographical area of Western Ghats Region) has been identified as Ecologically Sensitive Area (ESA) by HLWG, which represents more or less a contiguous band of vegetation extending over a distance of 1500 km across 6 States of Western Ghats region and includes Protected Areas and World Heritage Sites. The demarcation unit of ESA is the village. IRS LISS III derived spatial layers on vegetation type and landscape level indices (with a fine spatial resolution of 24 m) were used as the basis for identification of ecologically sensitive areas (ESAs).

To facilitate sustainable development in the WG region, which is inhabited by about 50 million people, the non ESA comprising mostly cultural landscape is also demarcated. HLWG recommends that the Central government should immediately notify the ESA area, demarcated by HLWG in public interest. The need for urgent action is evident. In this notified area, development restrictions as recommended in this report will apply.

3. MoEF should put the ESA map in the public domain, which will enable scrutiny and transparency in decisions.

B. Development Restrictions in proposed Ecologically sensitive areas

4. HLWG is recommending a prohibitory and regulatory regime in ESA for those activities with maximum interventionist and destructive impact on the ecosystem. All other infrastructure development activities, necessary for the region, will be carefully scrutinized and assessed for cumulative impact and development needs, before clearance.

5. There should be a complete ban on mining, quarrying and sand mining in ESA. All current mining areas should be phased out within the next 5 years, or at the time of expiry of mining lease, whichever is earlier.

6. No thermal power projects should be allowed in ESA. Hydropower projects may be allowed but subject to following conditions:

   (a) Uninterrupted ecological flow at atleast 30 per cent level of the rivers flow in lean season till a comprehensive study establishes individual baselines.
   (b) After a cumulative study which assesses the impact of each project on the flow pattern of the rivers and forest and biodiversity loss.
   (c) Ensuring that the minimum distance between projects is maintained at 3 km and that not more than 50 per cent of the river basin is affected at any time.

7. HLWG recommends that wind energy should be included in EIA notification and brought under purview of assessment and clearance.

8. All 'Red' category industries should be strictly banned. As the list of industries categorized as 'orange' includes many activities like food and fruit processing, there will not be a complete prohibition on this category. But all efforts should be made to promote industries with low environmental impacts.

9. Building and construction projects of 20,000 m^2 and above should not be allowed. Townships and area development projects should be prohibited.

10. All other infrastructure and development projects/schemes should be subject to environment clearance under Category 'A' projects under EIA Notification 2006.

11. Additional safeguard for forest diversion in ESA should be introduced. In cases of forest clearance required in ESA, all information of the project, from application stage to approval should be placed in the public domain on the website of MoEF and of the forest department of the respective States.

12. All development projects, located within 10 km of the Western Ghats ESA and requiring Environment Clearance (EC), shall be regulated as per the provisions of the EIA Notification 2006.

13. HLWG recommends a framework for governance and regulation of ESA, which draws on current regulatory institutions for decision-making, but simultaneously, strengthens the data monitoring systems and the participation and involvement of local communities in decision-making.

14. Existing regulatory institutions and processes for environment and forest clearances and project monitoring would need to be greatly strengthened for the governance framework to be enforced and monitored effectively.

15. The villages falling under ESA will be involved in decision making on the future projects. All projects will require prior-informed consent and no-objection from the Gram Sabha of the village. The provision for prior informed consent under the Forest Rights Act will also be strictly enforced.

16. The State Governments should also ensure consultation with local communities while planning for protection of wildlife corridors.

17. State Governments should immediately put in place structures for effective enforcement of development restrictions and ensuring sustainable development in ESA.

C. Financial arrangements and *Incentivising Green Growth in Western Ghats region*

18. HLWG recognizes that the Western Ghats even in those areas categorized as natural landscapes, is inhabited. It is not wilderness area, but the habitat of its people, who share the landscape with biological diversity. Conversely, the cultural landscape is also biologically rich and the economic growth of the entire region comes from its natural endowment of water, forests and biodiversity. For this reason, HLWG has recommended policies to incentivize environmentally sound growth across the Western Ghats.

19. HLWG recommends that the Western Ghats States should come together to negotiate for a grant-in aid from the Centre. The financial arrangement should be of the nature of a debt for nature swap. This is a mechanism whereby part of the outstanding debt of a State is swapped for new constructive initiatives by it to protect its natural resources. A part of these payments be retained by the State Governments and a part be used to finance local conservation trust funds (as in several countries), which disburse grants to community projects for improving forest productivity and ensuring sustainable forest based livelihoods in ESAs. In addition, the 14th Finance Commission should consider substantially increasing the fund allotted to States by the 13th Finance Commission for forest and environmental conservation.

20. HLWG recommends that there should be arrangements for Payments for Ecosystem Services accruing from ESA and non-ESA regions within the Western Ghats. HLWG also recommends that individual State Governments pursue such initiatives which may create possibilities for a dialogue on this issue between municipalities and relevant Panchayats within their States.

21. HLWG recommends considering extending Entry 20 (Economic Planning) in the Concurrent List, and introduce an appropriate new entry, say 20A, suitably titled, to ensure that developmental projects and activities are undertaken within an overarching environmental and ecological framework.

22. The Planning Commission should create a special Western Ghats Sustainable Development Fund, as proposed in this Report. This fund will be used to promote programmes specifically designed to implement an effective ESA regime and incentivize green growth in the region.

23. The 14th Finance Commission should consider options for ecosystem and other service payments in the Western Ghats as well as allocation of funds to ESA areas. It should also consider how these funds for environmental management would be made available directly to local communities who live in and around Western Ghats ESA.

24. The Planning Commission is currently working on a ranking of States based on Environmental Performance Index (EPI) developed by it. The EPI could be used to devolve funds to the States. ESA should get 'plus payments' which should be paid directly to the village community.

25. The strategy evolved for the continuation of the Western Ghats Development Programme, in the 12th Plan centres around, besides watershed based development, fragility of the habitat, and development needs of the people i.e. a Watershed + approach – an approach which emphasizes conservation, minimal ecological disturbance, involvement of locals along with sustainable model of economic development and livelihood generation with enhanced allocation. After a careful consideration of the strategy proposed, the HLWG recommends the following:

(a) Continuation of the WGD program with an enhanced allocation of Rs. 1000 crores,

(b) Continuation of the special category status to the program i.e. cost sharing of 90:10 between Centre and State,

(c) Revival and reconstitution of the High Level Committee consisting of CMs of the six States, for monitoring the implementation of the recommendations /suggestions of the HLWG and existing legislations and periodical review the status report of the Decision Support and Monitoring Centre for Western Ghats Region,

(d) Setting up / strengthening of the State WG cell with a mandate to liaise with SPCB, State Department of Forests, SEAC and SBA, and Regional office of the MoEF and service the information and decision support needs of the State Government.

26. Forest management for inclusive development should require policies to integrate forest accounts, including measurement of the tangible and intangible benefits into State and National economic assessments and policies to improve productivity of forests for economic benefits for local communities.

27. The current rules of timber transit, which do not incentivize forest production on private lands and community forestlands, should be reviewed and revised. The Forest Rights Act's categorization of minor forest produce, including bamboo should be promoted to build forest-based local economies.

28. To promote sustainable agriculture, HLWG recommends a focused programme to incentivize growers in the Western Ghats to move towards organic cultivation and to build a unique 'brand' for such premium products in the world market.

29. In order to promote sustainable tourism, HLWG recommends the following:

(a) Existing regulatory provisions to assess environmental impact of tourism projects must be strengthened.

(b) The tourism policy for Ecologically Sensitive Area of the Western Ghats must provide local community ownership and benefits.

(c) All tourism hotspots in the Ecologically Sensitive Area should be monitored for compliance with environmental conditions and development restrictions and assessed in terms of impact.

D. Decision Support and Monitoring Centre for Western Ghats

30. The management of Western Ghats ecology involves conservation, protection and rejuvenation as well as sustainable development in Western Ghats through periodic assessments of environment and ecology on a long term basis across the Six States of Western Ghats region using state-of-art geospatial technologies. The information generated will be used for wide range of purposes including planning and policy formulation from time to time, keeping in view of changes monitored both in time and space. A Centre with the mandate to: (i) use the existing and new knowledge to build a vibrant political dialogue in the region as a whole on the need to make shifts in development paradigm, given its particular vulnerability, (ii) assess and report on the state of ecology of the entire region, and (iii) provide a decision support function in the implementation of ESAs is essential. With this objective in view, HLWG recommends for setting up the "Decision Support and Monitoring Centre for Western Ghats" by MoEF and it will be hosted by one State and will have joint management of all Six States of the Western Ghats region for conservation of the ecology and sustainable and equitable development in Western Ghats Region.

31. For the first time in conservation ecology and sustainable development, HLWG with the help of NRSC developed a scientific, objective and practical way of identifying Ecologically Sensitive Areas (ESAs) at a fine resolution of

24 m with village as a unit, using IRS LISS III derived spatial layers of vegetation type and landscape indices (based on ground truthing involving 100's of sampling sites under DBT-ISRO project on Biodiversity Conservation). The maps generated on GIS platform having different layers have a wide range of applications. Consequently, the HLWG recommends that the approach followed for identification of ESAs serves as a model for replication elsewhere in the region and country.

E. Climate change and Western Ghats

32. The predictions on climate change have been made using Global Climate Models (GCMs) and Regional Climate Models (RCMs) with resolutions at 100km and 25km, respectively, which are very coarse for Western Ghats, the width of which varies from 10 to 200km. There is a need for downscaling of the data for ecosystem change models such as Dynamic Vegetation Growth Models (DVGM) and Ecological Niche Models. HLWG recommends that the proposed Centre may undertake these studies. In any case, the likely increase in temperature regime, rainfall and extreme events, besides decrease in the duration of precipitation which alone has serious concern for Western Ghats ecosystem - increased water stress to the forests, in fire incidences, evapo-transpiration and surface runoff. As a adaptive measure to these changes, a number of adaptive strategies such as (i) species-mix plantations, (ii) planting of hardy species that are resilient to increased temperature and drought risk, and (iii) launching of a few adaptive projects such as anticipatory plantation along altitudinal and latitudinal gradient and linking of PAs and forests fragments and implementing advance fire warning strategy, which have been outlined in Chapter 3, should be taken into account while formulating policies across Western Ghats region

F. ***Specific cases referred to HLWG***

33. HLWG is of the view that while the importance of the proposed Athirappilly hydropower project for meeting the peaking power requirements of the State cannot be disputed, there is still uncertainty about ecological flow available in the riverine stretch, which has a dam at a short distance upstream of the proposed project. It recommends that given the increased variability due to unpredictable monsoon, the project must be revaluated in terms of the generation of energy and whether the plant load factor expected in the project makes it viable against the loss of local populations of some species. Based on this revaluation and collection of data on ecological flow, the Government of Kerala, could take forward the proposal, if it so desires with the Ministry of Environment and Forests.

34. As the proposed Gundya hydropower project is located in the ESA, it must be proceeded upon with extreme caution. HLWG recommends that the Government of Karnataka should reassess the ecological flow in the downstream areas, based on a thorough evaluation of hydrological regimes in the area. The project should not be given the go-ahead, till such a review and reassessment is made. The Government's review must also assess local damage to all forests, which will emanate from the construction work and if at all, this can be mitigated. The HWLG has not proposed a complete ban on the construction of hydropower projects in the ESA, but its recommended conditions that balance the needs of energy with environment, must be followed.

35. HLWG has recommended that there should be a complete ban on mining activity in ESA and that current mining activities in ESA would be phased out within five years, or at the time of expiry of the mining lease, whichever is earlier. In view of the fact that the matter of iron ore mining in Goa is

pending before the Hon'ble Supreme Court, HLWG does not find it appropriate to make any other recommendation in the matter.

36. Sindhudurg and Ratnagiri districts have three categories of areas: (i) area under ESA, (ii) area under non ESA within Western Ghats and (iii) area outside Western Ghats region. HLWG recommends that the moratorium imposed should be lifted with the following conditions. As per the recommendations of this report, in the area of these two districts, which has been categorized as ESA, the sectoral restrictions and regulations will apply. In addition, all development projects located within 10 km of the Western Ghats ESA and requiring Environment Clearance (EC) shall be regulated as per the provisions of the EIA Notification, 2006. In the remaining area, including the area outside ESA but within Western Ghats, environment and forest processes and regulations will continue to apply. However, in order to ensure that such development projects do not adversely impact the environmental balance of the two districts, MoEF should monitor on regular basis the cumulative impact of projects, which may come up in these districts and take policy decisions at appropriate time based on such findings.

Action Plan

I Considering the urgency in protecting and safeguarding the remaining bio-diversity rich areas in Western Ghats, MoEF needs to notify ESA recommended by HLWG and also issue other notifications, regulations etc., as may be required to implement the aforesaid recommendations as soon as possible in public interest.

II The aforesaid recommendations clearly bring out the requirements for their implementation. MoEF should be the overall nodal Ministry to ensure timely implementation of these recommendations. Each of the Six State

Governments may identify the nodal department to co-ordinate the implementation of these recommendations in the State.

III On recommendations relating to financial arrangements and incentivising green growth in Western Ghats region, co-ordinated action needs to be taken by MoEF, Planning Commission and Ministry of Finance. In particular, the 14th Finance Commission should be persuaded to provide sufficient allocation of funds to the States in the Western Ghats for forest and environment conservation. Further, as recommended above, the Planning Commission should strengthen the implementation of Western Ghats Development Programme.

CHAPTER 1

Introduction

The Western Ghats (WG) or the Sahyadri is the majestic mountain range on the fringes of the west coast of India. It is one among the seven great mountain ranges in the country and is next only to the Himalayas. Its landscape is unique in terms of geology, biology and ecology. The mountain range extends over a distance of 1500-1600 km from Tapti river in the north to Kanyakumari in the south with an average elevation of more than 600 m and traverses through Six States viz. Gujarat, Maharashtra, Goa, Karnataka, Kerala and Tamil Nadu. Its geology and geomorphology coupled with high rainfall makes the Western Ghats as one of the most ecologically diversified landscapes. It is this ecological diversity of WG that supports: (i) a wide range of forest types ranging from tropical wet evergreen forests to grasslands, (ii) some 4000 species of flowering plants with high degree of endemism and (iii) rich fauna with endemism ranging from 11% to 78% among different groups. Consequently, Western Ghats constitutes not only one of the hotspots of biodiversity in the world, but also one among world's eight hottest hotspots.

The Western Ghats is the home for about 50 million people belonging to the Six States of the Country. It is the source of water for the entire Peninsular India, and also influences the monsoons. The life supporting and biodiversity rich ecosystems of Western Ghats are threatened today due to habitat pressures.

1.1 Background and Constitution of HLWG

The Ministry of Environment & Forests (MoEF), Government of India, has been concerned with degradation of Western Ghats in the past due to increasing population pressure. Keeping in view of the ecological sensitivity and significance of the region, complex interstate nature of its geography and also possible impacts of climate change, the MoEF constituted a 14- member Western Ghats Ecology Expert

Panel (WGEEP), with Professor Madhav Gadgil as its Chairman, on 4th March 2010. The Panel submitted its report on 30th August 2011.

Considering the complex interstate character of the Western Ghats and the recommendations of WGEEP which involved demarcation of Ecologically Sensitive Zones (ESZ) and zonal regulations of important sectors of activities, the Ministry sought comments/suggestions of all stakeholders. Over a thousand and seven hundred responses were received by the Ministry when the WGEEP Report was made public and put on the website of the Ministry.

It is in this background that the MoEF constituted the High Level Working Group (HLWG) vide office order dated 17th August 2012 (Annexure 1) with *inter alia* the following terms of reference:

(i) examine the WGEEP Report in a holistic and multidisciplinary fashion in the light of responses received from the concerned Governments of States, Central Ministries and Stakeholders, keeping in view the following matters: (a) sustainability of equitable economic and social growth in the region while preserving the precious biodiversity, wildlife, flora and fauna and preventing their further losses; (b) ensuring the rights, needs and developmental aspirations of local and indigenous people, tribals, forest dwellers and most disadvantaged sections of the local communities while balancing equitable economic and social growth with sustainable development and environmental integrity; (c) the effects and impacts of climate change on the ecology of Western Ghats region, (d) the implication of recognizing some sites in Western Ghats as world heritage sites in the conservation and sustainable development in Western Ghats and (e) the constitutional implications of Centre –State relations with respect to conservation and sustainable development in Western Ghats; (ii) to interact with the representatives of the Six States of Western Ghats region and other stakeholders, particularly environmentalists and conservation specialists; (iii) to suggest to the Government for further course of action on WGEEP Report; (iv) any other relevant matter that

may be referred to it by the Central Government; and (v) submission of Action Plan to implement WGEEP Report in the most effective and holistic manner.

1.2 Working of HLWG

During its tenure HLWG held 10 meetings, undertook four field visits and had interactions with State Governments and stakeholders (Annexure 2).

In the first meeting of HLWG, the MoEF presented an overview of the WGEEP Report and responses of State Governments, Central Ministries and Stakeholders. The Group decided to carefully review the Report of the WGEEP submitted in line with the terms of Reference assigned / its given TORs .

To achieve this and to address the issues raised by stakeholders on WGEEP Report, the HLWG decided to adopt a number of approaches. These approaches are described below. One approach followed was to visit different States in Western Ghats region and interact with democratically elected State Governments and other stakeholders. During its tenure, HLWG visited Maharashtra, Karnataka, Kerala and Goa.

In Maharashtra, HLWG held discussions with the Hon'ble Chief Minister Shri Prithviraj Chavan, his Cabinet colleagues, Chief Secretary and Secretaries of relevant Departments.

In Karnataka, the HLWG held discussions with Chief Secretary and Secretaries of relevant Departments and Forest Officials. Chairman HLWG also met the Hon'ble Chief Minister Shri Jagadish Shettar.

In Kerala, HLWG had discussions with Hon'ble Chief Minister, Shri Oommen Chandy, his Cabinet colleagues, Chief Secretary and Secretaries of relevant Departments and

Chairperson of State Biodiversity Board. The HLWG also met elected representatives of Parliament and State Legislature.

In Goa, HLWG had discussion with Hon'ble Chief Minister Shri Manohar Parrikar and Secretaries of relevant Departments.

During these visits, HLWG also met Stakeholders including representatives of civil society, NGOs, professionals, industry and trade associations, planter associations, professionals, academicians and local communities.

The second approach followed was to elicit responses from State Governments and Central Ministries to a questionnaire formulated by HLWG based on its ToRs. The third approach adopted was to make field visits to the sites of the developmental projects activities which were to be reviewed as per the ToR. As a part of wider consultations, HLWG also visited Pune and held discussion with Professor Madhav Gadgil, Chairman, WGEEP.

HLWG couldn't visit the States of Tamil Nadu and Gujarat as no convenient dates for the visit could be finalized in consultation with the State Governments. However, their inputs were received and were duly considered by HLWG while firming up its recommendations.

HLWG undertook field visits to assess the ground reality with respect to two proposed hydropower projects (Athirapilly and Gundya), development activities in Sindhudurg and Ratnagiri, Mining in Goa, and area specific issues related to Idukki and Wayanad. During these visits, HLWG interacted with Stakeholders, NGOs and activists besides the project staff and officials of district administration and concerned Departments of the States.

The following ten Central Ministries provided their comments to the HLWG for consideration (i) Ministry of Steel, (ii) Ministry of Mines, (iii) Ministry of Urban

Development, (iv) Ministry of Commerce, (v) Ministry of Railways, (vi) Ministry of Power, (vii) Ministry of Agriculture, (viii) Ministry of Tribal Affairs, (ix) Ministry of Rural Development, and (x) Ministry of Tourism.

HLWG solicited help of National Remote Sensing Centre (NRSC), Indian Space Research Organization (Hyderabad) to undertake geospatial analysis of Western Ghats region to demarcate and evolve scientific, objective and a practical approach for identification of Eco-Sensitive Areas (ESA) in Western Ghats, at a finer resolution with the village as the unit. HLWG had a number of detailed discussions with the Director and Scientists of NRSC for selection of criteria and the methodologies to be followed for geospatial analysis.

A one-day intensive brainstorming session was held at NRSC to look into the following technical issues viz. (i) the definition and demarcation of boundaries of Western Ghats in terms of geology and geomorphology, (ii) review of geospatial data sets available on WG and (iii) improvement of methodologies used in geospatial analysis for identification of eco-sensitive areas. Eminent geologists, geomorphologists, wildlife experts from Wildlife Institute of India (WII) and Wildlife Trust of India (WTI), University Departments and Geological Survey of India participated in the brainstorming session.

Based on these extensive and intensive discussions with experts, HLWG critically examined (i) the geospatial layers to be used, (ii) the data sets available and their compatibility at the level of resolution, (iii) the level of resolution, (iv) the processing load within a reasonable time frame, (vi) quality of analysis and (vii) optimization of 24 m resolution. After taking into account the evaluation of these parameters, it was decided to use the data sets generated under DBT-ISRO project at landscape level on natural and cultural landscapes, biological richness, fragmentation, human population density, the data sets of Protected Areas (PAs) and World Heritage Sites (WHSs), Tiger corridors available at WII, and dataset of

Elephant corridors of WTI for identification of ecologically sensitive areas, at a fine resolution of 24m using village as a unit.

The geospatial analysis carried out at NRSC and the results obtained were reviewed by a three member peer-review Committee under the Chairmanship of Dr. Y.V.N. Krishnamurthy, Director, Indian Institute of Remote Sensing, Dehradun (Appendix I).

1.3 Scope of the Report

The HLWG Report provides a set of recommendations and Action Plan for the conservation of the unique ecology and sustainable and equitable development in Western Ghats region based upon: (a) careful examination of the WGEEP Report, (b) the submissions received from State Governments, Central Ministries and Stakeholders on the Report, (c) direct interactions of HLWG (during field visits) with Four State Governments at different levels (Chief Ministers, Chief Secretary), elected representatives of State Legislative Assemblies and Parliament and other stakeholders, and (d) written responses submitted by all the Six States and Twelve Central Ministers to the questionnaire sent by HLWG.

This report is organized in two volumes. Volume I is the main Report and Volume II contains the Annexures to the main Report. The main Report has eight Chapters. The first chapter details the uniqueness of Western Ghats, the background that led to the constitution of HLWG by the Government and its ToRs, working of the HLWG and scope of the Report. Chapter 2 covers the evaluations of Comments / Observations of State Governments, Central Ministries and Stakeholders and provides statistical analysis of the responses received on WGEEP Report including the questionnaire sent to State Governments and Central Ministries. It also highlights the issues of concern communicated by the Six States and Twelve Central Ministries.

Chapter 3 outlines the impacts of climate change on the ecology of Western Ghats and provides the likely impacts of climate change in key sectors such as forests and biodiversity, agriculture, water, irrigation and hydropower in Western Ghats, and also suggests adaptive strategies to overcome some of the impacts. Chapter 4 explains the procedure adopted by HLWG to define and demarcate the boundaries of Western Ghats for identifying Ecologically Sensitive Areas in the absence of accepted definition of Western Ghats. The Chapter reviews the different approaches followed in the past for demarcating the boundaries of Western Ghats based on the geological origin and structure, geomorphology, altitude, vegetation cover and rainfall. Chapter 5 deals with the need for scientific, objective and practical strategy for delimiting Ecologically Sensitive Areas in the light of comments received on the shortcomings of the method of zoning in WGEEP Report. It explains the geospatial methodologies followed by HLWG and the procedures followed in delimitation of Western Ghats region into Natural and Cultural landscapes. It explains the methods of delineation of ESA within the natural landscape with village as a unit and at a fine resolution of 24 m, including the overlaying of PAs, WHSs and Wildlife corridors on the ESA. The results obtained based on the methodology adopted by HLWG are analyzed for 188 talukas in terms of the area covered under ESAs and number of villages falling under ESA. Maps of Western Ghats showing vegetation and land cover classes, natural and cultural landscapes, biodiversity richness, fragmentation and human population density and ESA, and Maps of each of Six States showing natural and cultural landscapes and ESAs are also provided.

Chapter 6 deals with the strategies proposed by HLWG for sustainable and inclusive development with environmental integrity in Western Ghats region. The Chapter also outlines recommendations for sector level planning and development restrictions in ESAs for major sectors such as mining, energy, industry, and infrastructure. It also explains the mechanisms and financial arrangement for incentivizing green growth and the challenges of having world heritage tag for 39 sites in Western Ghats region. It also recommends a frame work for governance and

regulation, with a key recommendation on the setting up a "Decision Support and Monitoring Centre for Western Ghats".

Chapter 7 outlines the details of proposed "Decision Support and Monitoring Centre" for Western Ghats to build a knowledge base and provide technical/decision support to the State Government. The Centre would enable monitoring, using geospatial technologies and this would lead to sustainable development of the region. The objectives of the proposed Centre and the modalities for its establishment are also detailed.

Chapter 8 reviews the two proposed hydropower projects at Athirappilly in Kerala and Gundya in Karnataka, development activities in Sindhudurg and Ratnagiri and mining in Goa, keeping in view the: (i) assessment made by WGEEP, (ii) discussions held with State Governments and local stakeholders, and (iii) field visits to the sites by HLWG.

In summary, this report has addressed the Terms of Reference mandated to the HLWG, reviewed the current status of Western Ghats including the contents of WGEEP Report, outlined the approaches adopted for defining Western Ghats boundaries, described the methodology used for delineating the ESA and has provided the details for interpretation and conclusions leading to a set of recommendations and the follow up actions.

CHAPTER 2

Evaluation of Comments of Stakeholders, State Governments and Central Ministries

2.1 Introduction

To elicit the views of the Stakeholders, concerned State Governments and Central Ministries and to assess the implications of the WGEEP Report for the Western Ghats region both in terms of Conservation of Ecology and Sustainable Development, the MoEF hosted the WGEEP Report on the website on 23rd May 2012. The HLWG evaluated the responses received from the stakeholders and further called for detailed comments and views through a questionnaire drafted by the Group from the six Western Ghats States (Gujarat, Goa, Maharashtra, Karnataka, Kerala and Tamil Nadu) and held discussions with Four State Governments, viz. Maharashtra, Karnataka, Kerala and Goa. Discussions with the State Governments of Tamil Nadu and Gujarat were not held as mutually convenient time could not be fixed. However, their inputs were duly considered by HLWG while firming up its recommendations.

Secretaries of twelve concerned Central Government Ministries, i.e., Power, Steel, Agriculture, Commerce & Industry, Urban Development, Railways, Rural Development (Department of Land Resources), Tribal Affairs, Tourism, Water Resources, Mines & Surface Transport were also requested by the HLWG for comments on the WGEEP Report. This Chapter provides an analysis of the responses received.

2.2 Analysis of Responses received from Stakeholders

2.2.1 Responses received from Stakeholders on the WGEEP Report before the constitution of HLWG

Over a thousand seven hundred and fifty responses were received from stakeholders including local Self Governments, Industry, Experts, local individuals etc. The summary of the comments /suggestions received on the WGEEP Report are given in Annexure 3**.** The responses received were analysed and were assigned under two major groups viz: Responses 'not in favour' and 'in favour' to WGEEP Report. Eighty one percent of the communication received expressed concerns regarding the recommendations and also the methodology followed. All the responses were further analysed for issues of concern and categorized under the above two major categories of responses.

Responses "not in favour" of the WGEEP report could be classified into six heads namely 1. Zoning Methodology, 2. Moratorium on Lote Parshuram, 3. Mining in Sindudurg , 4. Mining in Goa, 5. Establishment of WGEA and 6. General Comments. While the Responses "in favour" of the report dealt with, Gundiya Hydropower project, implementation of the WGEEP Report, translation of the report in local languages and extension of time limit for responses and General Comments (Annexure 4)**.** The percentage responses under both the heads category wise is illustrated in (Fig 1a & Fig-1b).

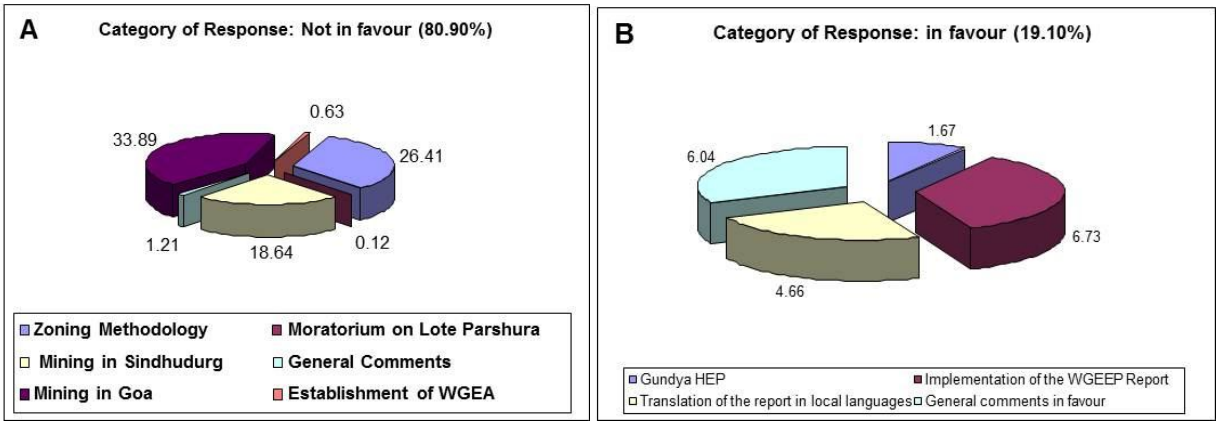

Figure 1: Percent of Responses under categories 'Not in favour' (A) and 'in favour' (B), to WGEEP Report and distribution pattern of percent responses to different aspects of WGEEP Report

2.2.2 Responses received from Stakeholders after the constitution of HLWG

A hundred and forty five responses were received by the HLWG till the end of March 2013 from stakeholders. The Group carefully analyzed the responses received and made an attempt to address the concerns expressed. Of the 145 responses received, only 30.34% of the responses supported the WGEEP Report. Of the remaining 69.66 % responses, most of them commented on the inappropriateness and un implementable nature of the recommendations made in the Report. A few also suggested modifications to enable acceptance of the report to some extent. The responses received include specific comments on large Grid Size used, boundaries of talukas, cultivation of GM crops , livelihood issues and project specific comments especially w.r.t. Athirappilly and Gundya HEPs. The issue of moratorium on new clearances for mining, setting up of red and orange category industries in Eco-sensitive Zones, establishment of an authority for monitoring and implementation of the recommendations, enforced organic cultivation, Cumulative EIA and decommissioning of dams and HEPs have been extensively mentioned among these responses.

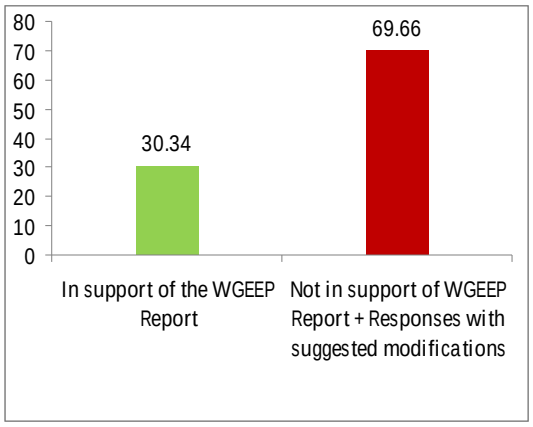

Figure 2: Frequency distribution of responses under the two categories 'in support' and 'not in support' to WGEEP Report

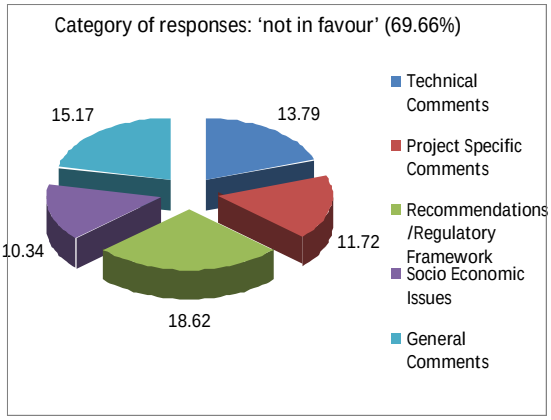

Figure 3a: Distribution pattern of response classified to different aspects of WGEEP Report under category 'not in favour'

Figure 2 depicts distribution of percent responses under 'in support' and 'not in support' which also includes the ones which support the WGEEP Report with suggested modification.

The responses received to WGEEP Report were grouped under two categories- 'in favour' and 'not in favour' and then analysed. The percent distribution of responses to five aspects viz. Technical, Project/Area Specific, Socio-economic Concerns, Recommendations/ Regulatory Framework and General are given in Figure 3a & b (Annexure 5).

Detailed analysis of the two categories of responses 'for' and 'against' to specific concerns on eco-sensitive zones, need and acceptability of Hydel Power, new institutional mechanism for approvals, monitoring and implementations, scientific methodology and cumulative EIA was also carried out (Figure 4).

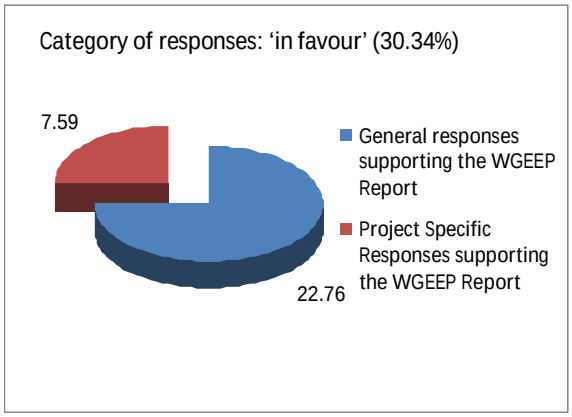

Figure 3b: Distribution pattern of percent responses to different aspects of WGEEP Report under category 'in favour'

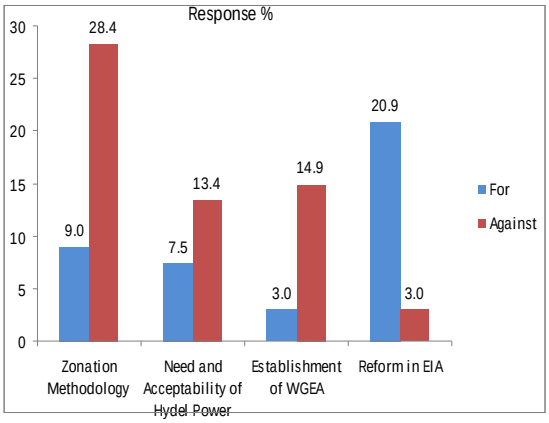

Figure 4: Frequency distribution pattern of responses to different aspects of WGEEP Report under each of the two categories

2.3 Comments received from State Governments

A comparative statement of major comments of the six State Governments to Sectoral recommendations and the WGEEP Report is at Annexure 6.

The comments received were grouped under mining, quarry and sand mining, land use, transport, non conventional energy (wind energy etc), power/ energy including hydro power, water – irrigation and inter basin diversion of water from rivers, polluting industries (red/orange), agriculture, tourism, forestry on public and

private land, biodiversity, waste treatment, animal husbandry, area development, green buildings and Genetically Modified Organisms (GMOs).

The responses received from the States on the above sectors/issues are summarized below:

1. Citing socio economic development needs, possible law and order situation and livelihood imperatives, a complete ban on mining in ESZ 1 has not been agreed to by the States except Karnataka which has stopped the issue of permissions for mining in Western Ghats.
2. The need to allow quarrying and sand mining with Environmental Impact Mitigation measures without compromising ecological and environmental balance and on institution of a special scheme for regulating mining has been stressed by the States of Maharashtra, Kerala and Gujarat.
3. Recommendations regarding no change in land use in ESZ areas, no new permission for Special Economic Zone and no new hill stations in public land have not been agreed to by the State of Maharashtra. The State of Kerala has accepted the recommendation subject to the relevant provisions of law as existing legal provisions do not permit such conversion in the State.
4. The States of Maharashtra, Kerala and Gujarat have clearly indicated that restriction on transport infrastructure recommended in the Western Ghats Region is unacceptable.
5. The States of Maharashtra, Kerala and Gujarat have indicated the need to set up solar and wind energy infrastructure which are sources of green energy.
6. The embargo on new Hydroelectric projects and the conditions imposed on them are unacceptable to the States of Kerala, Maharashtra and Tamil Nadu.
7. The State of Karnataka has indicated that the recommendation on Hydropower projects will be taken into consideration while taking up projects in the WG Region in the State. Restriction on dam height and recommendation regarding decommissioning of dams and thermal power projects has been strongly opposed by the States of Kerala, Maharashtra, Tamil Nadu and Gujarat.

8. Indicating that the recommendation on no inter basin diversion of water from rivers is against the Water Policy and suggesting that water needs to be allowed for human needs from water surplus to water deficit basin, the States of Maharashtra, Kerala and Tamil Nadu have strongly registered their objection to this recommendation.
9. Many of the recommendations especially w.r.t. water sector like catchment area treatment, protection of high altitude valley, swamps, water bodies, water conservation measures, rehabilitation of mined areas and improved river flow and scientific water quality management have been accepted by the States of Maharashtra and Kerala.
10. Maharashtra State has clearly indicated that the complete ban on red and orange industry imposed would greatly affect the 37 MIDC areas falling under the ESZ. Hence it is strongly opposed to such a move.
11. The States of Kerala and Maharashtra have suggested imposition of stringent pollution standards and monitoring of red and orange category industry.
12. The States of Karnataka, Kerala and Maharashtra have accepted promotion of organic agricultural practices including phasing out of use of insecticides, promoting ecological farming etc. They have, however, recommended incentives for farmers shifting to organic farming including budgetary support.
13. With a caveat that the ecotourism policy of the MoEF shall be refined by the State of Karnataka, Karnataka and Kerala have accepted the safe tourism practices advocated.
14. Recommendations with regard to forest and biodiversity and implementation of the Forests Rights Act, have been accepted by the States of Karnataka, Kerala and Maharashtra. The State of Kerala has suggested possible introduction of incentives for maintaining natural vegetation.
15. Introduction of incentives for biodiversity conservation has been accepted by the State of Kerala subject to Special Funds being made available to Biodiversity Management Committees and devolution of funds to the State Department of Environment.

16. The State of Kerala has accepted the recommendation regarding no hazardous and toxic waste processing unit in ESZ1 and ESZ2.
17. Recommendations regarding introduction of incentives for maintenance of land races of livestock, redeploying subsidies for chemical fertilizers and related recommendation w.r.t. Protected Areas have been accepted.
18. The State of Kerala has also accepted the need for best practices for construction, top soil conservation, green building certification etc. regarding area treatment and development subject to legislation in the State and local conditions.
19. The State of Kerala has stated that exclusive building code for the Western Ghats region is unacceptable.
20. Karnataka, Kerala and Tamil Nadu have accepted the recommendation that Genetically Modified Crops should not be allowed in the Western Ghats. The State of Kerala has however qualified the acceptance subject to State policy.
21. The State of Kerala has indicated that the plastic bags are being managed and would be managed as per existing rules 'The Recycled Plastic (Manufacture and Usage) Rules" notified under the Environment Protection Act, 1986.
22. The Govt. of Tamil Nadu has constituted a Hill Area Conservation Authority (HACA) in 1990/2003. HACA is a regulatory authority for Thirty One talukas in Nine districts which fall in Western Ghats of the State.
23. The recommendations on the establishment of Western Ghats Ecology Authority (WGEA) has not been accepted by all the State Governments.

2.4 Comments received from Central Government Ministries /Departments.

Ten out of the twelve concerned Central Government Ministries, viz; Power, Steel, Agriculture, Commerce & Industry, Urban Development, Railways, Rural Development (Department of Land Resources), Tribal Affairs, Tourism, Water Resources, Mines and Surface Transport have communicated their views/ comments on the WGEEP Report.

The Ministry of Power has indicated the need to examine individual projects especially hydro power on the merits and demerits and take a decision on a case to case basis, instead of a blanket ban which is recommended. They have also suggested a review based on the need and progress made on Athirappilly and Gundya projects. An omnibus ban on mining activity in the ecologically sensitive zones of the WG is considered inappropriate by the Ministry of Mines.

As per the Ministry of Commerce, if the recommendations of Gadgil Committee are accepted, species indigenous to India like cardamom, pepper and some of the tree spices might suffer heavily, which will adversely affect our trade in spices.

Ministries of Urban Development, Tourism and Tribal Affairs suggested that recommendations and action points mentioned in the WGEEP Report on demarcation of WG, Sustainable tourism and implementation of FRA, may be adopted. The Gist of the Comments received from Central Ministries is given in Annexure 7.

Annexure 8 givers responses received from State Governments and Central Ministries.

2.5 Summary

The foregoing analysis of responses from the Stakeholders, the Six WG States, and the Ten Central Ministries indicate, that delineation of Western Ghats, Zonation of Eco-Sensitive Zones, moratorium on Mining, establishment of Western Ghats Ecology Authority, restriction on infrastructure development and decommissioning of dams are areas of great concern to all the stakeholders, however the need to promote Organic farming,, phasing out pesticides, banning Red category industries in eco-sensitive zones found acceptance. The locals including members of the local bodies and elected representative were categorical about specific issues such as translation of WGEEP Report in to local language and extension of time for

comments, restriction on mining in Goa and Sindhudurg, inclusion of certain talukas in ESZ and non grant of permission for Gundya Hydroeclectric project.

The concerns expressed and comments/suggestions made by the State Governments, Central Ministries and Stakeholders on the WGEEP Report and on the implications of its recommendations have, after careful scrutiny and scientific analysis, been addressed in various chapters of the Report of the HLWG.

CHAPTER 3
Impact of Climate Change on the Ecology of Western Ghats

3.1 Introduction

Climate change is not only a major global environmental problem but is also an issue of great concern and challenge to a developing country such as ours. The earth's climate has demonstrably changed on both global and regional scales since the pre-industrial era, with some of these changes attributable to human activities. The observed changes in regional climate have already affected many of the physical and biological systems and there are also indications that social and economic systems have also been affected. Climate change is likely to threaten food production; increase water stress and decrease its availability; lead to sea level rise flooding crop fields and coastal settlements; and increase the occurrence of disease such as malaria. India has limited capacity to develop and adopt strategies to reduce their vulnerability to changes in climate in the wake of adequate resources, access to technology and finances (NATCOM, 2012).

Assessment of impacts of projected climate change on natural and socio economic systems is central to the whole issue of climate change. Climate change impact assessment involves the following:

- Identification, analysis and evaluation of the impact of climate variability and change on natural ecosystems, socio economic systems and human health
- Assessment of the vulnerabilities which also depend on the institutional and financial capacities of the affected communities such as farmers, forest dwellers and fishermen
- Assessment of the potential adaptation responses
- Development of technical, institutional and financial strategies to reduce the vulnerability of the ecosystems and populations.

India has low adaptive capacity to withstand the adverse impacts of climate change due to high dependence of majority of the population on climate sensitive sectors such as agriculture, forestry and fisheries, coupled with poor infrastructure facilities, weak institutional mechanisms and lack of financial resources. India is, therefore, seriously concerned with the possible impacts of climate change such as:

- Water stress and reduction in availability of fresh water due to potential decline in rainfall
- Threats to agriculture and food security since agriculture is monsoon dependent and rainfed agriculture dominates many States in India
- Shifts in area and boundary of different forest types and threat to biodiversity with adverse implications for forest dependent communities
- Impacts on human health due to increase in vector and water borne diseases such as malaria
- Increased energy requirements and impacts on climate sensitive industry and infrastructure.

Assessment of climate change impacts, and vulnerability and adaptation to climate change, requires a wide range of physical, biological and socio economic models, methods, tools and data.

Principally, the studies on impact of climate change on Western Ghats have been undertaken on forests and crops grown in the region. The methods for assessing the vulnerability, impacts and adaptation are gradually improving but are still inadequate to help policy makers to formulate appropriate adaptation measures, due to uncertainties in regional climate projections, unpredictable response of natural and socio economic systems and the inability to foresee future technological development.

3.2 Impacts of Climate Change on Forests and Biodiversity

3.2.1 Impacts on Forests

The impacts of climate change on forests in India have been assessed based on the changes in area under different forest types, shifts in boundary of forest types, and net primary productivity (NPP). The Assessments in India's Second National Communication to UNFCCC was based on (i) spatial distribution of current climatic variables, (ii) future climate projected by relatively high-resolution regional climate models for two different periods for the A1B* climate change scenario, and (iii) vegetation types, NPP, and carbon stocks as simulated by the dynamic model IBIS v.2, or Integrated Biosphere Simulator. The vegetation distribution simulated by IBIS illustrates an expansion of tropical evergreen forests in the Eastern India Plateau and in Western Ghats.

The assessment of climate impacts show that, at the national level, about 45% of the forested grids are likely to undergo change. Vulnerability assessment showed that the vulnerable forested grids are spread across India. However, their concentration is higher in the upper Himalayan stretches, parts of central India, northern Western Ghats, and Eastern Ghats. In contrast, north- eastern forests, southern Western Ghats, and the forested regions of eastern India are estimated to be least vulnerable. Currently, within the forested area of 69 Mha, only 8.35 Mha is categorized as very dense forest. More than 20 Mha of forest is monoculture, and more than 28.8 Mha of forests are fragmented (open forest) and have low tree density. Low tree density,

---

***A1B scenario:**

This scenario assumes significant innovations in energy technologies, which improve energy efficiency and reduce the cost of energy supply. Such improvements occur across the board and neither favour nor penalize the particular groups of technologies. A1B assumes, in particular, drastic reductions in power generation costs through the use of solar, wind, and other modern renewable energies, and significant progress in gas exploration, production, and transport. This results in a balanced mix of technologies and supply sources with technology improvements and resource assumptions such that no single source of energy is overly dominant.

Source: IPCC (2000)

low biodiversity status as well as higher levels of fragmentation contribute to the vulnerability of these forests. **Western Ghats, though a biodiversity hotspot, has fragmented forests in its northern parts. This makes these forests additionally vulnerable to climate change as well as to increased risk of fire and pest attack.**

Forests are likely to benefit to a large extent (in terms of NPP) in the northern parts of the Western Ghats and the eastern parts of India, while they are relatively adversely affected in the western and central India. This means that afforestation, reforestation, and forest management in the northern Western Ghats and eastern India may experience carbon sequestration benefits.

Impact on Net Primary Productivity (NPP): An increasing trend over India of NPP based on A1B Scenario has been predicted. An increase on an average of 30.3% by 2035 and 56.2% by 2085 is predicted.

3.2.2 Implications for Biodiversity

In the Western Ghats climate change is expected to increase species losses. Changes in phenology are expected to occur in many species. The general impact of climate change is that habitats of many species will move poleward. Species that make up a community are unlikely to shift together. Ecosystems dominated by long-lived species will be slow to show evidence of change and slow to recover from the climate related stress.

3.3 Impact of Climate Change on Agriculture

Even though there are not many recorded observations on the impact of climatic extremes in the past on crops grown in the area, some of the striking effects have been the adverse impact of the drought of 1983 on many plantation crops.

The analysis of past weather data from different locations representing the major coconut growing Western Ghats areas and yield data from the respective districts,

indicates warming trends in most of the areas . The increase in average maximum temperature varies from 0.01 to 0.04^{0}C /year. On the other hand, average minimum temperatures are decreasing in many places. The range in change varies from –0.03^{0}C to +0.03^{0}C/ year. Dry spells are in increasing trends in districts of Karnataka and Kerala, whereas reducing trends in coastal Maharashtra. Change in dry spells varies from –1.98 to 0.27 days/year. Change in coconut yields across the country range from –114 to 270 nuts/ha/year.

Agriculture in the relatively high elevation areas (average elevation 1200 m) is characterized, in general, by four typologies:
(i) Large tea, coffee and rubber estates; (ii) Other plantations and spices, which are generally grown as inter crops; (iii) Annual crops-based farming consisting of mainly paddy, vegetables, pulses, tuber crops and millets and (iv) Homestead farming. The homestead farming is one of the key features of WG area, wherein a large number of species of trees (jackfruit, mango, papaya, guava, kokum etc), spices (pepper, nutmeg etc), medicinal plants, plantation crops (coconut, areca nut etc.), biennials and annuals including banana, pineapple, paddy, vegetables and tuber crops are grown.

The key findings of the Indian Network of Climate Change Assessment (INCCA 2012) for scenarios of 2030 are as under:

Rice: The simulation analysis indicates that the productivity of irrigated rice in Western Ghats region is likely to change +5 to –11% in PRECIS A1B 2030 scenario depending upon the location. Majority of the region is projected to lose the yield by about 4%. However, irrigated rice in parts of southern Karnataka and northern-most districts of Kerala is likely to gain. In these areas, current seasonal minimum and maximum temperatures are relatively lower (20-22^{0}C Tmin; 27-28^{0}C Tmax). The projected increase in temperature is also relatively less in these areas (0.5^{0}C-1.5^{0}C). In the case of rain-fed rice, the projected change in yield is in the range of –35 to +35% with a large portion of the region likely to lose rice yields up to 10%. The

results thus indicate that, irrigated rice is able to benefit due to CO_2 fertilization effect as compared to rain-fed rice, which is supplied with less amount of fertilizers. Farmers in Western Ghats regions falling in north-west parts of Tamil Nadu, northern parts of Kerala and in some parts of Karnataka can reduce the impacts of climate change and can reap higher harvests by adopting crop management strategies and by growing varieties tolerant to climate change.

In addition to Rice, Climate change is likely to reduce the yields of maize and sorghum by up to 50%, depending upon the area in this region. These crops have C_4 photosynthetic systems and hence do not have relative advantage at higher CO_2 concentrations.

Coconut: Coconut yields are projected to increase by as much as 30% in the majority of the region by the 2030. Increase in coconut yield may be mainly attributed to the projected increase in rainfall (~10%) and relatively less increase in temperature, apart from CO_2 fertilization benefits. However, some areas like south-west Karnataka, parts of Tamil Nadu, and parts of Maharashtra may show reduction in yields by up to 24%.

Cocoa: Cocoa is grown as the intercrop either under areca nut or coconut. Being a shade-crop, cocoa is influenced only indirectly by the increase in atmospheric temperature. Analysis indicates that a rise in temperature by 1°C should be beneficial for crop productivity. The improvement is likely to be about 100 kg of dry beans/ha. The cocoa growing foothills of the Western Ghats of Karnataka are more likely to benefit than central Kerala. However, crop management and irrigation supply should be maintained or improved to exploit this benefit. Further, an increase in temperature beyond 3°C is likely to reduce cocoa yields

Livestock Productivity: The Heat Stress Days per annum are likely to increase with the Temperature – Humidity Index (THI) above 80 in 2030s in the Western Ghats.

This would lead to severe thermal discomfort to livestock resulting in negative impact on the productivity.

Agriculture Crop Diversity is important as it can be used to combat risks such as pests, diseases and variations in Climate. Other impact of crop diversity is on nutrition.

3.4 Water, Irrigation and Hydro Power

The potential impacts of climate change on water yield and other hydrologic budget components are quantified by performing SWAT hydrological modeling with current and future climate scenarios for the regional systems. Impacts of climate change and climate variability on the water resources are likely to affect irrigated agriculture, installed power capacity, environmental flows in the dry season, and higher flows during the wet season, thereby causing severe droughts and flood problems.

Detailed outputs have been analysed in the 2nd NATCOM report with respect to the two major water balance components of water yield and actual evapo-transpiration that are highly influenced by the weather conditions dictated by temperature and allied parameters. Majority of the river systems show increase in the precipitation at the basin level. The only two river basins that show some decrease in evapo-transpiration under the EC scenario are Cauvery and Krishna rivers which originate from the Western Ghats.

It is also seen that there is an increase in the moderate drought development for Krishna, Pennar, and Cauvery basins, which have either predicted decrease in precipitation or have enhanced level of evapo-transpiration.

The maximum water withdrawal takes place from Godavari and Krishna river basins in Western Ghats in all the years. Though at basin-level, the comparison between water availability and water demand indicates a comfortable position, but

due to wide temporal and spatial variation in the availability of water, there exists a water crisis-like situation in most areas of the country. It is expected that due to climate change, water availability situation is likely to be aggravated.

Hydro capacity is expected to increase, but its share decreases from the total installed capacity by 2100. The slow growth in capacity is due to barriers of high investment requirements and long gestation periods. A number of socio-environmental issues are related to dam construction, flooding of areas, damages to the ecology, and resettlement and rehabilitation of the population.

3.5 Adaptation Strategies and Measures

Several measures/strategies have evolved during the Eleventh Plan period to address various issues pertaining to Climate Change which have been further improved in the 12th plan outlined as under:

1. In respect of Agriculture in the medium term, the focus is on improving yields with the existing available technology, timely availability of water through expansion of the irrigation system, and also improvement of existing irrigation systems.

2. A species-mix plantation that maximizes carbon sequestration is suggested.

3. Hardy species, which are resilient to increased temperature and drought risk, be planted in Forests of the western and central India.

4. A few pilot adaptation projects could be launched, incorporating adaptation practices, particularly in the most vulnerable regions identified. These include:

    (i) Modifying the forest working plan code, preparation process and incorporating the projected climate change and likely impacts,

(ii) Initiating research on adaptation practices, covering both conservation and forest regeneration practices,

(iii) Linking Protected Areas and forest fragments,

(iv) Anticipatory planting of species along the altitudinal and latitudinal gradient,

(v) *in situ* conservation,

(vi) adopting mixed species forestry in all afforestation programs,

(vii) Incorporating fire protection and management practices and implementing advanced fire warning systems.

According to the Second National Communication on Climate Change (NATCOM, 2012), the Western Ghats is expected to experience increase in temperature regimes, rainfall and extreme events due to climate change. There is also a high probability of significant decrease in the duration of the precipitation (NATCOM, 2012). This may have serious consequence for the Western Ghats ecosystems which may face decrease in the moisture regimes and increase in fire incidences due to low moisture content in the ecosystems. The projected changes in the precipitation may also induce changes in the hydrological regimes especially increase in evapo-transpiration and increased runoff (Hamlet et al., 2007). Although the projections are modelled using robust climate models which include Global Climate Models (GCMs) and Regional Climate Models (RCMs) with best possible resolution of 100 km and 25 km respectively, the data are very coarse for any study on ecosystem level changes in the Western Ghats which has a width ranging between 10 to 200 km. There is need for downscaling of the data for ecosystem level change models such as Dynamic Vegetation Growth Models (DGVM) and Ecological Niche Models (Franklin et al., 2012). Availability of accurate downscaled projected climate data will help in modeling accurately the decline in the density and abundance of the moisture sensitive species in the Western Ghats. This will also help in modeling the migration or shift of the moisture sensitive species up the moisture gradient as well as in increase and spread of the invasive species (IPCC, 2007).

CHAPTER 4

Definition and Delimitation of Western Ghats Region

4.1 Introduction

Although, references to the Western Ghats have been made several millennia ago, its definition and delimitation is still controversial due to complexity of its geology and geomorphology, and there is also no consensus on its origin and evolution. From a scientific perspective, understanding of the geology and geomorphology is critical for defining and delimitation of any landform. But the attempts made to define and delimit Western Ghats on this basis in the past have thus far met with little success.

A review of different approaches followed for defining and delimiting Western Ghats has been presented in this Chapter. The definition and delimitation of Western Ghats Region as adopted in the present Report by HLWG are also given.

4.2 Geology and Geomorphology

Gross landforms are defined in terms of geological and geomorphological features; physiographic features have also been used for defining landforms. The delimitation of Western Ghats is problematical because of diverse opinions on the origin of Western Ghats among geologists. The Memoir 47 (1 & 2) of the Geological Society of India (Bangalore) on "Sahyadri –The Great Escarpment of the Indian Subcontinent" edited by Y. Gunnell and B.P. Radhakrishna (1967) gives details on the geology and geomorphology and origin of Western Ghats. Radhakrishna defined WG as the long unbroken wall extending for a length of 1600 km paralleling the West Coast and marking an important physiographic feature of Indian Peninsula. He observed that its origin is one of the major unsolved problems of Indian Geology**.** Traditionally this magnificent range which fringes the west coast of India is also known as Sahyadri. The Western Ghats of Indian Peninsula extend in a NNW-SSE direction for a distance of over 1600 km lying between latitudes 08° and 21° 06 and longitudes 73° and 78° (Radhakrishna, 1967).

Radhakrishna (1967) described WG as follows: “Western Ghats starts as a bold westerly escarpment south of the Tapti estuary in Gujarat, reaching almost immediately to a height of over 3000 feet (914.4 m) and then extends in the form of a wall down to Kanyakumari (Cape of Comorin) with only one break or gap at Palghat (Palghat gap); throughout this length the Ghats retain an average elevation of 900 m above sea level with peaks as high as 1800-2400 m, and traverse many geological formations of differing physical and structural characteristics. According to him the WG are not true mountains ranges but represent only the precipitous western edge of a plateau uplifted to its present position and represent as an edge of an upraised disrupted continental block, with early Miocene as its probable date of formation. The Ghats form the dividing line between two erosional surfaces - the low-lying plains of marine denudation and a peneplaned plateau at elevations of over 900 m”.

Wadia (1975) considered that the greater part of the Peninsula is constituted by Deccan plateau, which is a central table land extending from 12° to 21° north latitude raising above 600 m mean elevation above sea, and to its west are Sahyadri or Western Ghats which extend unbroken to the extreme south of Malabar, where the WG merge into uplands of the Nilgiris, and from Nilgiris the WG extend (after a solitary Palghat Gap) through Anaimalai hills to extreme south of the Peninsula, with mean elevation of 900 m.

Dixit (1981) explained the geomorphic aspects of Western Ghats and suggested that the origin of Western Ghats is in-separably linked with the origin of west facing scarp (escarpment), which is not fully explained and remains hypothetical; consequently, the origin of Sahyadri also remains unsettled question. Three hypotheses are proposed to explain the origin of escarpment by different geologists – (i) the Fault escarpment hypothesis, (ii) the Erosional escarpment hypothesis, (iii) the hypothesis of a dead cliff. Dixit also pointed out that most of the passes

recognized as Ghats are located at an altitude of 600 m. He also discussed relief of Western Ghats in terms of three parallel but contrasting components:
(i) the relief of the plateau – east of the continental divide,
(ii) the relief of the crest zone of Western Ghats proper, and
(iii) the relief of the Western face and the projecting escarpment.
The last two aspects are explained by him with respect to Sahyadri divide line / Western Ghats divide line.

Valdiya (2010) in his paper entitled "Geological framework and tectonics of Western Ghats" defined Western Ghats as the zone of escarpment representing seaward western flank of the mountainous Sahyadri range extending 1600 km south from the Tapti valley to Kanyakumari with broken multiple precipitous scraps alternating with irregular terraces. The Western Ghats consisting of Sahyadri range, the Western Ghats escarpment and the coastal belts constitute one geological domain or province. In other words, there are units within the Western Ghats – (i) the high linear mountain ranges of Sahyadri stretching 1600 km from the Tapti river in the north to Kanyakumari in the south and form the western border of the Peninsular India, (ii) the escarpment in the form of 'landing stair' of sorts of the seaward western bank flank of Sahyadri called as Western Ghats because of resemblance of shape and pattern of 600-700 m high scraps alternating with irregular terraces to the bathing ghats on the banks of river and shores of ponds or lakes and (iii) the undulating terrain with smaller hillocks and spurs known as Konkan- Kanara-Malabar coastal belt. This concept of WG has not been accepted by geologists.

The published map of Geological Survey of India shows that the geology of northern and southern segments are different. They are affected by Western Ghats tectonic process after the origin of these formations. The northern segment is covered by Deccan traps (basalts) and southern segments by Charnockites, Khondalites, and Granulites etc. However these two diverse set of rocks were affected by the Western Ghats faulting events and hence has more or less same regional structural imprints.

It is evident from the above that WG can not be demarcated using geological and geomorphological features because of the complexity of geological and geomorphological features, and whatever maps available on WG are conceptual. But it can be defined as a physiographic unit, as physiographic aspects of WG are not influenced by underlying geology or rock structure.

4.3 Delineation of Western Ghats for Western Ghats Development Programme of the Planning Commission

The Planning Commission initiated Hill Area Development Programme (HADP) with prime objective of promoting socio-economic development of the Hill people in harmony with the preservation of ecological balance. Activities on eco-restoration, eco-preservation and eco-development have been emphasized in the programme and the focus is on fulfillment of basic needs of hill people i.e. food, fuel, fodder, health, education and drinking water. The list of Hill areas were identified for the first time by the Committee of National Development Council (NDC) on Hill areas in its meeting held on 12 March 1965. The States or Union Territories identified Hill Areas in their jurisdiction. In this exercise, Tamil Nadu identified Nilgiris as a Hill area under the programme.

The Planning Commission constituted a Working Group on Hill Area Development during 7th Plan. In its first meeting it was decided to use scientific criteria for delineating hill areas in the country. A subgroup of the Working Group was constituted for removal of the anomalies and to suggest inter alia delineation of hill areas on uniform and scientific basis. A Technical Committee of the subgroup was constituted to work out the scientific criteria for delineation of Hill areas. Based on the scientific criteria suggested by the Technical Committee, the working group adopted the following criteria for delineation of new Hill areas in the country for inclusion in the National Programme of Hill Development in the country other than Himalaya and Western Ghats (1986).

"A geographical area must satisfy two conditions to qualify as hill area namely it should contain an area (a) with an average slope of 30° or more which may be designated as the core and (b) the relative relief of 300 m or more". These criteria were not applicable for Himalayas and Western Ghats Development Programme (Planning Commission, 1986).

For the first time Western Ghats Development Programme (WGDP) was conceived at a meeting taken by the then Minister of Planning, Shri C. S. Subramaniam on 31.05.1972 with Chief Ministers of Maharashtra, Karnataka and Planning Minister of Goa, Tamil Nadu and Kerala were associated in subsequent meetings. In the delineation of Western Ghats, 'Contiguous talukas/blocks along the Ghats having at least 20% of their area at an altitude of 600 m or above were included in WGDP and covered under HADP since 1974-75.' The unit of demarcation of Hill Areas in Western Ghats is taluka.

The High Level Committee constituted (vide, Report of the Expert Group on Delineation of New Hill Areas, 1986) for the development of the Western Ghats identified various districts/talukas falling in Maharashtra, Karnataka, Kerala, Tamil Nadu and Gujarat and subsequently included Goa, as per the Map of Second Irrigation Commission Report Atlas showing Western Ghats in the scale of 1:60,00,000, which was a replicate of the Map of Physiographic Regions of India prepared by National Atlas Organization of Ministry of Education, Government of India (1964). According to this map Western Ghats is one of the 5 subdivisions of the Peninsular Plateau which constitutes the fourth and largest Physiographic divisions of India which has been divided into Seven such broad Physiographic divisions. The map gives broad outlines of Western Ghats based on the earlier works by Baker, Dudley Stamp and others. To identify the districts and talukas in Western Ghats based on the map, it was 'necessary to define the boundaries so that no area that should be included is omitted and area not really falling in the Western Ghats is not included'. Western Ghats was defined in geological terms as the uplifted Western border of the Deccan Peninsula formed of different geological formations of

varied origin and structure running about 1600 km along the Western border of Peninsular plateaus from the mouth of the river Tapti to Cape Comorin (Kanyakumari). It was divided into 3 physiographic subunits – the northern part which is built of horizontal sheets of lava which on erosion have given rise to a typical trap landscape; Ghats, which runs from a little south of 16^0 N parallel latitude to the Nilgiris, are formed of granitold gneisses which on weatherly have given rise to a more rugged topography; and the southern part of the Ghats (Southern Ghats) is separated from the main Ghats by the Palghat Gap which appears to be a rift valley. Three ranges of Southern Ghats radiate in three different directions from Anai Mudi Peak (2695 m) – the Anaimalai range to the north, the Palni to the north east and the Elamalai (Cardamom hills) to the south.

After a detailed study of the map of Western Ghats area (1:1,00,000) the Committee found that the Ghats proper (dissected belt) was only 'a few km wide as a rule and have height of 760-915 m'. Taking this area as the Western Ghats, the Committee imposed it on the administrative maps of talukas and districts of the same scale and thus led to the inclusion of all areas with an elevation of 600 m or above also which were contiguous to the higher altitudes and formed part of the administrative boundaries of the talukas. This led to the omission of talukas which were wholly coastal or only marginally hilly (having less than 20% of the taluka area) and inclusion of talukas which had high altitudes as defined above and actually constitute Western Ghats (Source: Report of the Expert Group on Delineation of New Hill Areas, Planning Commission, 1986).

4.4 Definition and Delineation of Western Ghats as Proposed by WGEEP

WGEEP defined Western Ghats from an environmental view point in the following way:

"The term Western Ghats refers to the practically unbroken hill chain (with the exception of the Palakkad Gap) or escarpment running roughly in a north-south direction, for about 1500 km parallel to the Arabian sea coast from the river Tapti

(about 21° 16' N) down to just short of Kanyakumari (about 8° 19' N) at the tip of the Indian Peninsula". WGEEP adopted the term Western Ghats in broad sense and included the entire tract of hills from the Tapti to Kanyakumari. It also discussed the problems of boundary demarcation in relation to Eastern Ghats, which meet Western Ghats (Nilgiri), and the presence of eastern and Western spurs. It also mentioned that there is no consensus among different workers on the precise boundaries of Western Ghats due to differences in the drivers used for defining boundaries. WGEEP used the altitude and forest area or vegetation as drivers defining the boundaries and used forest area above a certain altitude as the operational definition of Ghats. On the eastern side, the cut off elevation was above 500 m as the WG rise discretely from the Deccan plateau and on the west this cut off of forested area was at 150 m and above or the coastline itself in case the forests spring from the edge of the coastline. The land-use map developed by Forest Survey of India was used to demarcate forest areas and GTOPO30 (Global 30 ArC – Second Elevation Data set) for altitude details at 1x1 km resolution was used. NDVI (Normalized Differential Vegetation Index) values were also used as a surrogate for vegetation or forest cover.

About 150 km stretch of Biligirirangan range of Eastern Ghats of Karnataka and Tamil Nadu running in a north-south direction was also included as a part of WG. As per these boundaries, the WG as delimited by WGEEP spreads over an area of 129037 sq. km between 8° 19' 8" - 21° 16' 14" N and 72° 56' 24"- 78° 19' 40" (E) and extends to 1440 km from Tapti in the north to Kanayakumari in the south, with the width ranging from 48-210 km (excluding Palghat).

Western Ghats as defined by WGEEP do not correspond exactly to particular administrative units such as districts and talukas. WGEEP also mentioned about the Western Ghats Development Programme of Planning Commission and the delineation of Western Ghats at taluka level under that programme. WGEEP considered that talukas do constitute a reasonable administrative unit for defining

the Western Ghats. Infact, taluka was used as unit for zonation of ecologically sensitive areas.

WGEEP, however, writes that, "We must however admit that the Western Ghats Ecology Authority, which put in place, will have to take another look for boundaries, we suggest, since we have not been able to find time to examine and refine these with enough care".

4.5 HLWG's definition and delineation of Western Ghats region

HLWG examined the definition and delimitation of WG proposed by geologists, geomorphologists, geographers, ecologists and conservationists. Most of these definitions are conceptual in nature and precise boundaries are not demarcated (Table 1). It is difficult to define and demarcate WG in terms of geology and geomorphology because of its complex geology and geomorphology and unsolved problem of its origin. As has been explained above under section 4.2 of this chapter: (i) the mean elevation of Deccan Plateau is 600 m above sea level; (ii) the WG has mean elevation greater than 600 m (about 900 m) through its length from Tapti estuary on the northern most tip to Kanyakumari at the south end; and (iii) the elevation of most of the Ghats is 600 m and above.

An attempt was initially made by HLWG to define WG geologically and geomorphologically, keeping in view of the observations made by geologists. For this purpose one full day meeting of geologists (Dr K. Vinod Kumar) from NRSC, Geological Survey of India (Dr Balakrishnan) and University Departments of Geology and eminent Geomorphologists (Professor R. Vaidyanathan, who was also a member of Expert Committee constituted for identification of Hill Areas under Hill Area Development Programme of Planning Commission) was held at NRSC, Hyderabad. All the geologists and geomorphologists confirmed that it is not possible to define Western Ghats and demarcate its boundaries geologically and geomorphologically. Though it is possible to define WG in terms of north-south band (the ridge) but the

same would require substantial time to work it out. The other alternative is to look for physiographic features such as altitude, slope, topography rainfall and others.

Further, the High Level Working Group also requested the State Governments to share with the HLWG any exercise done by them to demarcate Western Ghats region in their respective jurisdiction. The HLWG noted that no information has been received except from the State Government of Karnataka. The Karnataka Forest Department had used (i) forest and land use pattern, (ii) rainfall and (iii) geomorphology as variables to define the Western Ghats in Karnataka. The Group felt that the Karnataka methodology is very specific to the State and the criteria adopted may not apply to the other States.

HLWG, in the absence of geologically and gemorphologically sound criteria in demarcating WG, decided to adopt the criteria followed by the Western Ghats Development Programme of Planning Commission which defined WG in terms of geology conceptually, but has taken altitude as the criterion for identification of talukas/blocks under Western Ghats Development Programme of Planning Commission as recommended by High Level Committee, because the Ghats are usually 760-915 m high. All those talukas/blocks at 600 m and above elevation and those talukas having more than 20% of the area at 600 m and above elevation that are contiguous to higher altitudes and formed part of the administrative boundaries of Western Ghats Development Programme are listed under Western Ghats Development Programme. This criterion has geological connotation – that at 600 m on the east the WG springs from Deccan Plateau, on an average the mean elevation of WG all along its length from north to south is greater than 600 m, and most of the Ghats have height of over 600 m.

The data on elevation and rainfall in different districts of Western Ghats (Table 1) also support the criterion used by Western Ghats Development Programme of Planning Commission.

Table 1*: Elevation and rainfall at various sections of Western Ghats region

Districts (West to East)	Sections	Elevation West (m)	Elevation East (m)	Rainfall West (cm)	Rainfall East (cm)
Dangs & Nashik	1	150	955	200	80
Thane & Nashik	2	170	695	240	200
Thane & Ahmadnagar	3	60	1030	240	80
Sindhudurg & Kolhapur	4	130	790	320	240
Kozhikode, Wayanad, Nilgiri, Erode & Salem	5	65	970	320	80
Trishshur, Coimbatore & Dindigul	6	50	840	320	140
South Goa, Uttar Kannad & Dharwad	7	40	540	280	120
Dakshin Kannad & Hassan	8	70	940	320	200
Ratnagiri & Satara	9	80	720	240	160
Sindhudurg & Kolhapur	11	60	640	240	280
Pattanamtitta & Tirunelveli	12	150	150	320	80
Kanniyakumari & Tirunelveli	13	95	110	140	120

***Source: DBT-ISRO Project (Roy.et al 2012)**

Table 2 provides a comparative evaluation of different approaches followed in defining and delimiting Western Ghats.

Table 2: Different approaches followed in delimitation of Western Ghats

Delimitation Criteria	Delimitation of Western Ghats boundaries
Physical geographical definition	Western Ghats is the most important orographic feature of the peninsula, fringing the Western coast from the Tapti estuary to cape comorin (Source: E. H. Pascos in A Manual of Geology and Burma ed. 3 1950 and also in Memoir of Geological Society 47:67-69, 2001). **No boundaries were demarcated.**
Geology and Geomorphology	Valdiya (2010) demarcated a conceptual boundary of Western Ghats based on homogeneity of geological structural elements especially the northern, southern and extreme eastern boundaries. As the geology of northern and southern segments are quite different and were effected by tectonic process after the origin of these formations. The northern segment is covered by Deccan traps (basalts) and southern segments by Charnoclites, Khondalites, Granulites, etc. These diverse set of rocks were affected by the Western Ghats faulting events and hence more or less the same regional structural imprints. It is not possible to draw a boundary based on these structural imprints without ground truthing. Further, the definition of Western Ghats by Valdiya also includes coastal plain which was formed by the recent geological processes and hence cannot be a part of Western Ghats block faulting process. Consequently, the Valdiya's definition has not been accepted. According to Radhakrishna (2001) Western Ghats traverse many geological provinces and structural elements and defined that it extends from 8 to 21.06 degree and 75 to 78 degree (Source: Dr K. Vinod Kumar, NRSC). **No boundaries were demarcated.**
Topography, Temperature and Rainfall	Western Ghats are influenced by topographic variations and tropical south-west monsoon system; the Western Ghats show diverse bioclimatic conditions at macro and micro levels. Exacerbated by orographic effect, windward side of the Ghats receives full intensity of summer monsoon, with rainfall sometimes exceeding 7000 mm. However, the climatic conditions along the Ghats are not uniform. Since the monsoon arrives from the south and retreats in the reverse direction, the rainy season is longer in the south than in the north. The second aspect is that the monsoon rains diminish rapidly once they cross the Ghats summit (includes rain shadow zone). The third climatic gradient is the fall

	of temperature with altitude. High rainfall, dense network of drainage and substantial forest cover made the Western Ghats as a 'water sink' of the Southern Peninsula. **No boundaries were demarcated.**
Forest/Vegetation	The Western Ghats harbors one of the best 'non-equatorial' forests. These types are closely correlated with the temperature and rainfall regimes. Wet evergreen, dry evergreen, moist deciduous and dry deciduous climax types are clearly distinguished along the mean annual rainfall gradient; whereas low, medium and high elevation wet evergreen types are found in areas characterized by decrease in minimum temperature with the increase in altitude. Since the rainfall, temperature and altitude varies from north to south, uniform criteria of vegetation cannot be used for delineation of Western Ghats. **No boundaries were demarcated.**
Forest Vegetation Cover Geomorphology Isohyets greater than 800 m	Western Ghats region of Karnataka has been defined as an administrative unit based on the three criteria: (i) all villages having more than 25% of the area under forest cover, (ii) areas with isohyets greater than 800 m on the eastern edge, with village as the unit and (iii) the three regions of hilly tracts - the escarpment (Ghats), Malanad, (including semimalanad) and hilly hinterland. These criteria were used only for identification of fringe villages which form the boundary of Western Ghats and all those areas within the boundary of Western Ghats, irrespective of whether they fulfil above criteria or not are included in Western Ghats region (Source: Report submitted by B. R. Ramesh and G. Muthasankar (French Institute of Pondicherry) to Karnataka Western Ghats Task Force in 2011 and information provided by the Forest Department of Karnataka). It may be noted that the first layer used was the talukas recognized under Western Ghats Development Programme. The criteria are not applicable to the entire Western Ghats that traverse Six States, as the criteria vary significantly across the Western Ghats.
Vegetation cover and altitude	WGEEP defined WG from environmental point of view. It uses forest cover (FSI, 2009) and altitude as criteria for delineating the Western Ghats region. NDVI has also been used as surrogate for vegetation or forest cover. On the eastern side the cut off elevation was above 500 m as the WG rise discretely from the Deccan plateau and in the west this cut off of forest area was at 150 m and above or the coastline itself in case the forests spring from the edge of the coastline. The conventional northern and southern limits (Northern limit is south of Tapti river extending up to Kanyakumari in South) have been used. According to K. R.

	Subrahmanya (personal communication), consideration of 500 m as the eastern edge by WGEEP would cover 90% of the Deccan Plateau which is not appropriate in delimitation of boundaries. The natural forest cover of evergreen forest on the western slope also changes from moist to dry deciduous types on the eastern slopes, and as such it is difficult to make a clear geographical boundary. WGEEP also included Biligirirangan (Eastern Ghats) as a part of Western Ghats because of topographic and forest contiguity and this also makes it difficult to make a clear geographic boundary. No unit was used to delimit boundaries. However, for assigning three layers of ecological sensitivity, taluka was used as a unit.
Altitude (under Western Ghats development Programme of Planning Commission), slope and relief (under Hill development Programme of Planning Commission) and traditional northernmost talukas of Gujarat located on the south of Tapti river	A review of criteria for delimitation of Western Ghats was undertaken by eminent experts in brain storming session at NRSC. It was decided that Western Ghats can not be defined in terms of geology and geomorphology. The experts suggested a multicriteria approach (vegetation, rainfall, slope, geology, landform and altitude) can be used to delineate Western Ghats. In the absence of such delineation, topographic aspects were followed for delimitation of talukas/blocks under Western Ghats Development Programme and Hill Area Development Programme of Planning Commission. The criteria adopted have also geological connation - that beyond 600 m in the east the WG springs from Deccan Plateau, on an average the mean elevation of WG all along its length from north to south is greater than 600 m. In addition most of the Ghats have height of > 600 m. A total of 188 talukas constituted Western Ghats region and the boundaries are demarcated using outer boundaries of peripheral talukas.

A GIS map of delineated WG was generated by using the outer limits of peripheral talukas as boundary of Western Ghats on all sides (Figure 5). The method used for delineation of map is given below.

4.6 Generation of Spatial Layers on Western Ghats

The administrative spatial layer indicating boundary of India (International and coastal), States, districts, talukas and villages have been taken from Survey of India spatial layer. Talukas identified by Planning Commission for Western Ghats Development Programme and Hill Area Development Programme and seven talukas of Gujarat (annotated separately from the existing database on the basis of their

location to south of Tapti river from where Western Ghats starts at the north) were mapped using standard GIS software (Figure 6). This spatial layer has been used for further analysis and modeling Ecologically Sensitive Areas as per the details given in Chapter 5.

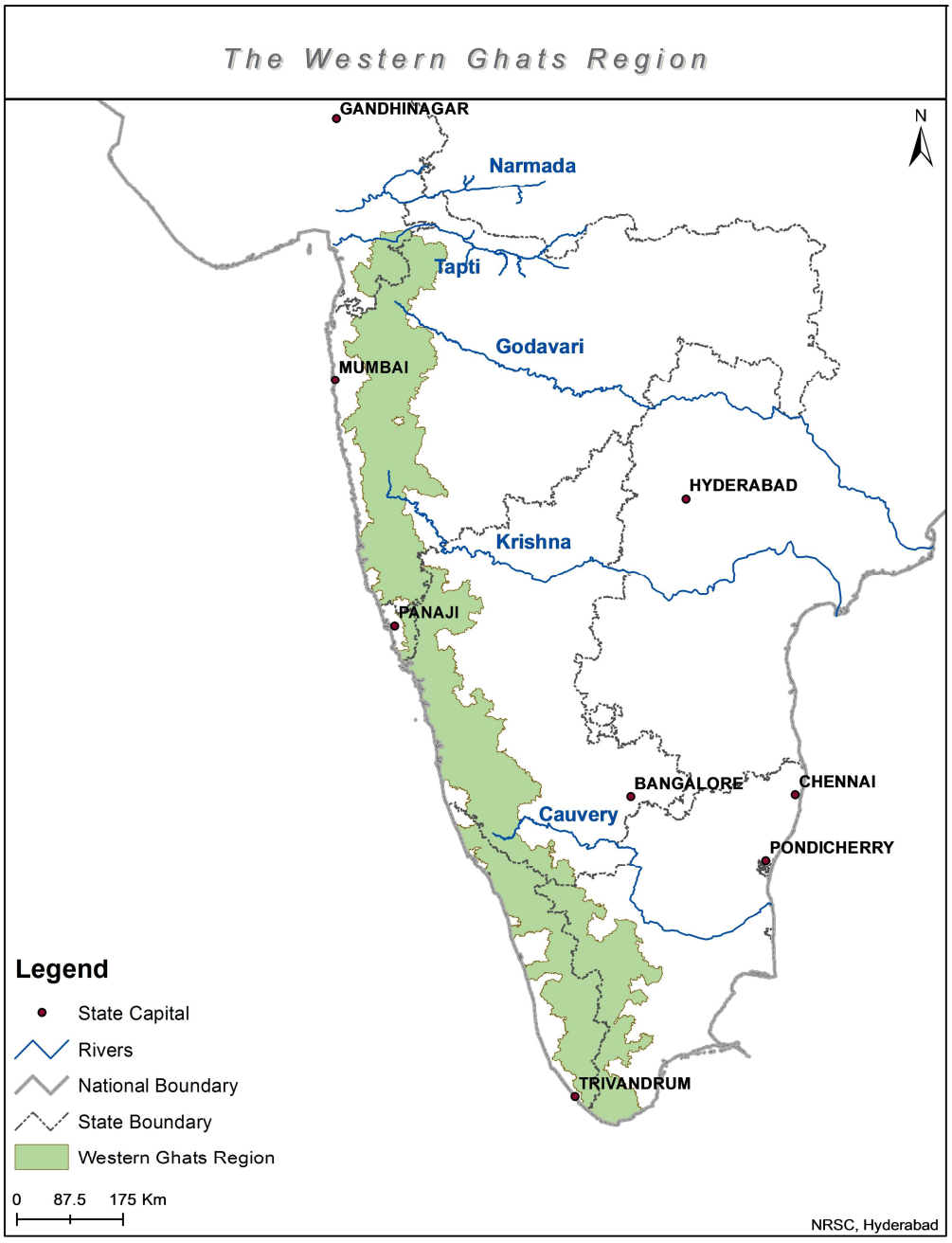

Figure 5: Map of Peninsular India showing Western Ghats region and origin of major rivers, with Tapti river as the northern boundary of Western Ghats.

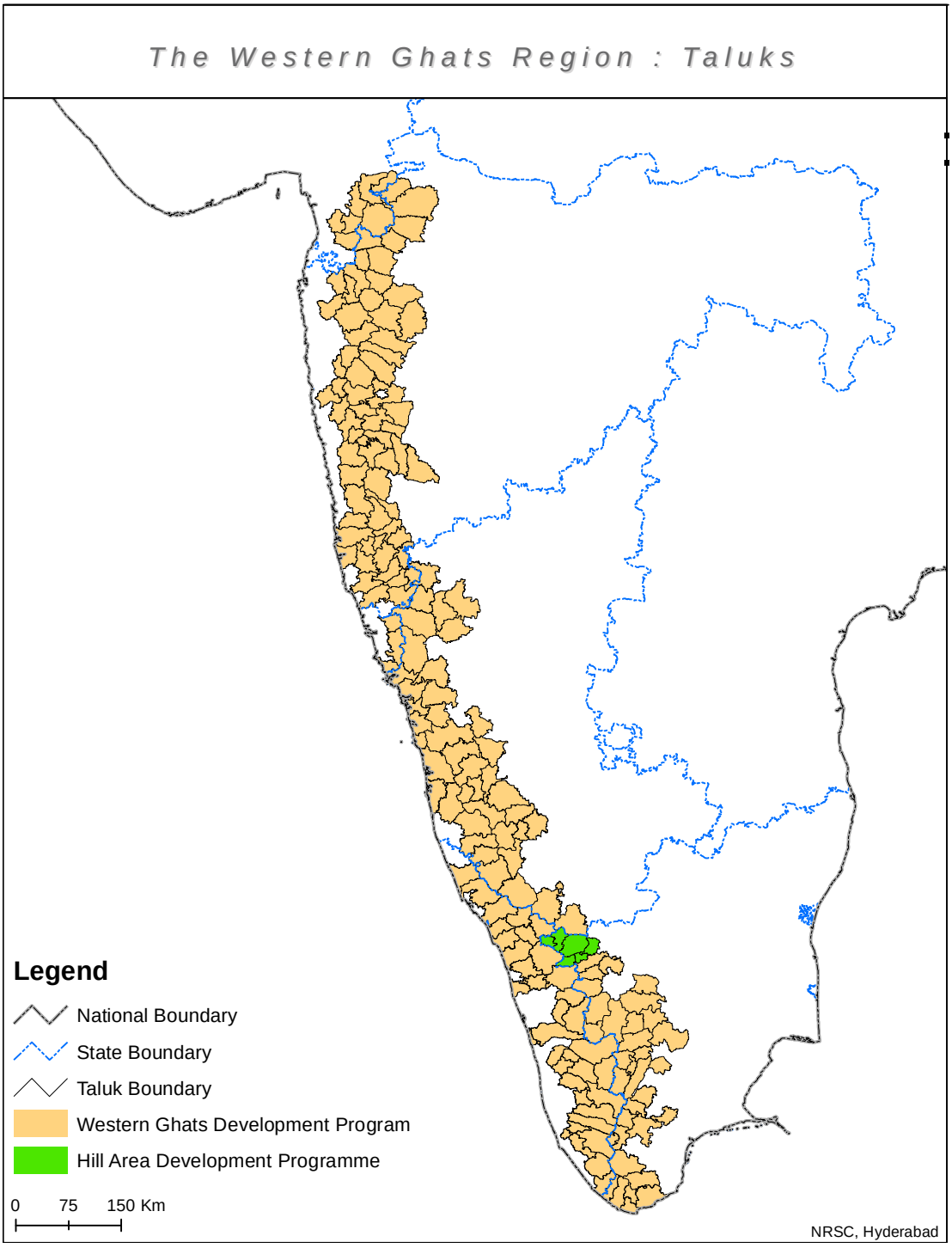

Figure 6: Map of Peninsular India showing 188 talukas of Western Ghats region that includes Seven talukas of Gujarat located to south of Tapti river – the northernmost limit of Western Ghats region.

To sum up, the WG region defined by HLWG has the following features:

Northern Limit : 8° 0' N 22° 26'.

Eastern Limit : 72 ° 55'' E 78 ° 11'

Area : 1, 64,280 km^2

Length : 1500 km

Width: 10 km (at narrowest point) – 200 km (at widest point)

Altitudinal range (minimum and maximum) (*Ellipsoid height) : 0 to 2674 m

* estimated by NRSC using public domain ASTER DEM.

The list of 188 talukas that constitute Western Ghats region are given in the Table 6 of Chapter 5.

The merits of WG delineation by HLWG are (i) that taluka is taken as unit to demarcate WG, (ii) that the talukas identified as geological (scientific) connotations, and (iii) that talukas listed are based on criteria used by WGDP and HADP of Planning Commission and Seven talukas of Gujarat located on the south of Tapti river which forms the northern most boundary of Western Ghats.

CHAPTER 5

Identification of Ecologically Sensitive Areas in Western Ghats Region

5.1 Background

As a part of environmental protection, the Ministry of Environment & Forests (MoEF), Government of India has been developing strategies for conservation of ecologically sensitive or fragile areas. In 1990, the MoEF brought out a report on parameters for determining Ecological Fragility. The Task Force set up by Planning Commission also brought out a Report on 'Conserving Ecologically Fragile Ecosystems' in 1996. In 1999 the MoEF constituted a committee under the Chairmanship of Dr Pronab Sen (the then Advisor in Planning Commission) to work out parameters for designating an area as ecologically sensitive which require special protection under Environment (Protection) Act 1986 (EPA) in a way that the processes of designation of such areas is objective, scientific and transparent.

The Pronab Sen Committee submitted its Report in 2000 and defined Ecological Sensitivity 'as the imminent possibility of : (a) permanent and irreparable loss of extant life forms (species); or (b) significant damage to ecological processes affecting natural evolution and speciation'. The Committee also clarified that it is not the intention to curtail activities while defining the ecological sensitivity and pointed out that India has a special responsibility to conserve and use resources in a sustainable manner. The Committee listed three primary criteria of Ecological Sensitivity and these criteria were grouped into 3 categories – (i) species based criteria (endemism, rarity, endangered species and centres of evolution), (ii) ecosystem based criteria (specialized ecosystems, special breeding sites/areas, frontier forests, areas with intrinsically low resilience, sacred groves and wildlife corridors), and (iii) geomorphological features based criteria (uninhabited islands in the sea, steep slopes and origins of rivers) besides Seven auxiliary criteria such as centres of less known food plants, wetlands and grasslands, upper catchment areas, not so steep slopes, high rainfall areas and other uninhabited islands. To ensure

additional protection to the protected areas such as National Parks, Sanctuaries and Tiger Reserves, Protected and Reserve Forests, Biosphere reserves, Coastal Regulation Zone I (i) and Hill Stations which are already known as ecologically Important or under ecological stress, the Sen Committee recommended to prioritize such areas and accord them wholly or partly the status of Ecologically Sensitive areas after applying the criteria listed by it.

The Committee also remarked that 'the nuances of ecological sensitivity are such that excessive rigidity on this count could defeat the very purpose of this exercise, which seeks to strike a balance between preservation of our ecological endowments and the needs of development'**.** The Committee recommended that the protection under EP Act should not be restricted to only areas satisfying one or more of these criteria, and other environmental concerns should be appropriately addressed and hence a separate exercise should be undertaken to frame parameters to delineating environmental sensitivity.

The Committee also mentioned that the system presently being followed for notifying environmentally sensitive areas under EPA is appropriate and adequate, subject to only minor modifications.

WGEEP adopted Pronab Sen Committee's concept of Ecologically Sensitive Area and designated the entire Western Ghats as an Ecologically Sensitive Area (ESA) and assigned three levels of sensitivity to different regions within the ESA. The WGEEP discussed the Twelve primary criteria and Six auxiliary criteria proposed by Pronab Sen Committee in very general way and with one or two examples from entire Western Ghats and with a remark **"incomplete information"** under each parameter and recommended the entire WG as ESA (Part II of WGEEP Report). In the absence of any guidelines by Pronab Sen Committee on management regime for ESA and since it is not feasible to evolve a uniform regime for entire Western Ghats, the WGEEP adopted 3-layered approach and attempted to assign relative levels of ecological sensitivity to areas based on 8 parameters using 9x9 km or 5'x5' grids.

WGEEP recognized Three Ecologically Sensitive Zones (ESZ) – ESZ1, ESZ2 and ESZ3 based on a scoring system assigned to the states/variants of each of the 8 parameters on a scale of 0-10, and average score for each grid was calculated. Similarly the average scores of grids of PAs were calculated and ranked them in descending order in each State. If the average score of the grid was equal or higher than the lowest rank grid of PAs then it was treated as ESZ 1, and about 25% of grids having average scores of grids equal to lowest rank grids of PA were treated as ESZ2 and the remaining ones were treated as ESZ3. This was done based on the stipulation that protected areas (PA)+ESZ1 in each State should not exceed 60% of the total area and PA+ ESZ1 +ESZ2 should make it 75% of the total as forest cover. Using the following ESZ assignment algorithm the grids were assigned to different ESZs:

$$p+x+y+x = 100, \text{ where}$$

p=percentage of area falling in existing protected area

x=percentage of area assigned to ESZ1

y=percentage of area assigned to ESZ2

z=percentage of area assigned to ESZ3

Three scenarios were generated in terms of p based on the existing percent forest cover. For example in scenario 1 where p>75%, all the grids outside PA were assigned to ESZ3 and no grid was assigned to either ESZ1 or ESZ2; similarly in scenario 2 when p<60<75%, lowest scoring 25%, grids were assigned to ESZ3 and the rest were assigned to ESZ2 and no grid was assigned to ESZ1; and in scenario 3, the 25%, lowest scoring grids were assigned to ESZ3 and the rest were assigned to ESZ1 and ESZ 2.

If the desired results are not met under any of the scenarios, WGEEP also made provisions to rank the parameters selected in order of their importance after ignoring the least important parameters and then rework the scores so that the desired results are achieved. WGEEP slightly modified the zonation criteria for Goa and used 1'x1' grids rather than 5'x5' grids. The ESZ were extrapolated and reported for taluka which was taken as a unit in mapping. The parameters selected by WGEEP

for zonation were (i) number of endemic species, (ii) number of IUCN red listed mammal species (iii) percent of area covered by unique evergreen ecosystem, (iv) percentage of forest area, (v) elevation (vi) slope and (viii) riparian forest vegetation. WGEEP generated geospatial maps for taluka wise ESZ for each State of Western Ghats. Regulatory regimes for different ESZs were also formulated.

WGEEP did not completely use the methodology outlined in their *Current Science* Paper.

To ensure conservation of ecological systems and sustainable development in Western Ghats region as per the mandate given by MoEF to HLWG and in light of responses received from the stakeholders, State Governments and Central Ministries on WGEEP Report (see also Chapter 2), the HLWG examined critically the basis for identifying entire WG as Eco-sensitive area, the criteria selected in identifying different eco-sensitive zones (ESZs) within the ESA of WG and mode of assigning ESZs to talukas in each of the districts of each State included in WG as defined by WGEEP. The HLWG, while appreciating the efforts made by WGEEP in designating WG as ESA and assigning the talukas to different ESZs, found the following limitations: (i) using criteria with incomplete back up information for designating entire WG as ESA and (ii) identifying ESZs without taking into account the human cultural component which is a part of biodiversity, livelihood and developmental needs of human populations, and disturbance regime, and (iii) coarse grid size used for zonation. There is also some redundancy in criteria selected, subjectivity in zonation and inclusion of entire talukas having only a small area of ESZ1/ESZ2 as a part of ESZ1/ESZ2. Realizing these limitations, the WGEEP itself suggested that ESZs designated require refinement and further examination.

Keeping this in view and the need for sustainable development approach for the conservation of Western Ghats ecology, the HLWG in their deliberations decided:
(i) to utilize geospatial methods and the best available spatial datasets that would be applicable at fine spatial resolution for demarcating ESA and (ii) involving NRSC for

geospatial analysis. The HLWG also constituted a subgroup consisting of Professor C. R. Babu, Professor P. S. Roy and Dr Indrani Chandrasekharan to interact with NRSC for evolving scientific, objective and a practical method for geospatial analyses leading to identification of ecologically sensitive areas in WG region.

The ecological glory of Western Ghats, the methodologies adopted for geospatial analyses, and the results and outputs generated from geospatial analyses are given in this Chapter.

5.2 General Aspects of Western Ghats Region

5.2.1 Geographical Features

The magnificent range fringing the west coast of India in the form of a gigantic wall is the Western Ghats. It is great escarpment of Indian subcontinent and stretches nearly 1600 km in length from Tapti river in north to Kanyakumari in the south and abruptly rises to a height of 2000 m above sea level. Western Ghats traverse through Gujarat, Goa, Maharashtra, Karnataka, Kerala and Tamil Nadu run parallel to the west coast at a distance of 40 km, on an average, from the shore line.

The mean elevation of the Western Ghats is higher than 600 m and exceeds 2000 m at some places. The Nilgiri plateau has several peaks above 2000m and the most prominent one is Dodda Betta (2637m). The Anaimudi peak in the high ranges of Kerala rises to the height of 2695m and is the highest peak south of the Himalayas. There is a major discontinuity in this otherwise continuous hill tract stretching from the north to south and is known as the Palghat gap which is about 30 km long and 100m high above mean sea level. The Western Ghats correspond to two major categories of rock formation, one is the highly varied Pre-Cambrian shield, and the other, to the north of Goa, is the basaltic lava flows of the Deccan Trap. The Western Ghats are essentially the Western edge of the Indian peninsular plateau, which is the stable mark of Archaean and Pre-Cambrian formations, where the mountain building was ceased in the Pre-Cambrian times (Radhakrishna, 2001). Nine

geological landscapes are recognized in Western Ghats. The region is rich in minerals and has high potential for hydroelectric power generation, besides containing rich bio-resources.

The Western Ghats form the major watershed in Peninsular India and as many as Fifty Eight major Peninsular Indian rivers originate from it. Forty seven of these rivers flow towards the west, Eight rivers flow east ward and Three rivers flow south wards. The Godavari, the Krishna, the Cauvery, the Kali, the Bedthi, the Tadri and the Sharavati are major rivers in the region (Tewari, 1995). Ghats are an important source of water for the entire Peninsular India. The area receives between 2,000 and 8,000 millimeters of rainfall annually within a short monsoon period and performs important hydrological and watershed functions. Approximately 245 million people live in the peninsular Indian states that receive most of their water supply from rivers originating in the Western Ghats. The great range of Western Ghats – the most striking feature in the geography of India – influence the climate of India, particularly the rainfall pattern.

Fast running rivers and steep slopes have provided sites for many large hydro-power plants. There are about Fifty major dams along the length of the Western Ghats and the earliest hydro-power plant setup was in 1900 at Khopoli in Maharashtra. Most notable hydro-power plants are the Koyna Hydro-power plant in Maharashtra, the Parambikulam Dam in Kerala, and the Linganmakki Dam in Karnataka. There are hill torrents that discharge their monsoon flows into Arabian sea within 48 hours after precipitation.

The hot and humid tropical climate coupled with heavy precipitation from southwest monsoon and favorable edaphic factors create ideal conditions for the luxuriant growth of plant life, which can be seen only in few parts of the world. Forestry is the second largest user of land. The high western slopes of the Ghats harbor evergreen forest, and as one moves from western to eastern slopes the vegetation changes to moist and dry deciduous forest types along the rainfall

gradient. The vegetation attains its luxuriant development towards the southern tip in Kerala, where rich tropical rain forests flourish. The commercially most important species, teak, grows best in tracts of moderate rainfall where the natural vegetation consists of moist deciduous forest. The commercial plantations of coffee, cardamom, tea, *Acacia* and *Eucalyptus*, cashew, rubber, bananas, arecanut, coconut, etc. occupy large area and also make the forest landscape highly mosaic.

The exact total area under Western Ghats varies due to lack of well-defined boundaries of Western Ghats. For example, according to WGEEP the total area under WG is 1,29,037 km^2, but others put the area under WG anywhere between 1,36,800 km^2 to 260,962 km^2. About Fifty million people inhabit Western Ghats. As per HLWG's definition, Western Ghats spreads over an area of 1,64,280 km^2 and traverse across Six States of Peninsular India.

5.2.2 Biogeography

The Western Ghats region stretches from 8° N to 22° N along a 1500 km north west gradient. The region has a considerable temperature and rainfall gradients, and this permitted the evolution of several distinct species associations. Longitudinally, the Ghats spring from sea level in the west, rise abruptly to a highly dissected plateau upto 2700 m and then descend often equally abruptly to the dry Deccan plateau. The elongated mountain chain has been cut by wide valleys at few places, and thus preventing dispersal of less motile species and favouring local speciation. This zone harbours one of the major formation of tropical evergreen forest of India and it is also a zone of ecological stress due to anthropogenic pressures. The Western Ghats are divided into Twelve regions (Rogers and Panwar, 1988). These are:

(i) Dangs-Below Ghat areas, (ii) Upper Krishna Drainage, (iii) Kanara, (iv) Coorg, (v) Mysore–Lower Nilgiris, (vi) Wyanad Plataeu, (vii) Nilgiri, (viii) Anamalai, (ix) Palni, (x) Periyar-Cardamom, (xi) Varushanad-Andipatty and (xii) Agasthyamalai

5.2.3 Biodiversity

The Western Ghats has unique taxonomic hierarchies, remnant ecosystems and strong endemic associations. The sholas, mangroves, kans, dry evergreen forests, swamps, reeds and riverine belts represent the unique ecosystems. The forests of WG are some of the best representatives of non-equatorial evergreen forests in the world. The resource value of this mega diversity centre spans from timber-non timber category through wilderness–ecotourism to gene pools of plants of medicinal-aromatic-food-industrial value.

This kind of luxuriant biotic communities evolved over geologic time scale and witnessed various land use practices depending upon the resource demand and ingress of human dimension. This has induced considerable alteration in the Western Ghats biogeography bringing in commercial agriculture, commercial forestry, hydropower, mining and biotic pressures within the forest ecosystems. Consequently there is a need for sustainable development approach that enable ecological protection and development takes place in tandem.

Floristically the Western Ghats is one of the richest areas in the country and harbours as many as 4000-4600 species of flowering plants of which 56 genera and 2100 species are endemic. Gramineae (Poaceae) has the highest number of endemic genera and the genus *Nilgirianthus* has the maximum number (20) of endemic species. In Western Ghats Bamboos are represented by 8 genera with over 24 species; out of 8 species of *Ochlandra* (Bambusae) found in India, 6 species occur in Western Ghats. Among herbaceous plants, the genus *Impatiens* has about 175 species in India, out of which 77 species are reported from the southern Western Ghats alone. The leguminous genus *Dalbergia* has about 100 species in the world, of which 22 species are from Western Ghats. Of the known orchids of Indian Peninsula, 37 percent are endemic to the Western Ghats region. Taxa with extremely restricted distribution are found in Western Ghats. A number of endangered or rare plant species have their type locations in Western Ghats. For example, the Chemmunji Peak area in the Agasthyamalai Range is the type locality for half a dozen endemic

species. Diversity as well as endemism is equally high among animals species of the Western Ghats. Blanford recorded 48 genera of mammals, 275 genera of birds (with 28 endemic forms) and 60 genera of reptiles from Western Ghats (Tewari, 1995).

The Biodiversity in Western Ghats is threatened due to habitat pressures. The existing forests are highly degraded and facing the prospect of increasing degradation. The area covered by Protected Areas is 16,930 km^2 which constituted 10% of the total Western Ghats. The Western Ghats is one of the two biogeographic zones in India with the highest level of coverage by Protected Areas and other one is Andaman and Nicobar Islands.

5.2.4 Vegetation Types and Land Cover

There are four major phenological forest types in the Western Ghats, moist deciduous forests occupy the largest area followed by semievergreen, evergreen and finally dry deciduous.

Evergreen forests: The highest levels of endemism are found in the evergreen forests. These forests occur in areas having annual rainfall of 2,500- to 5,000-millimeter. The habitat types of the southern Western Ghats tropical evergreen forests include the wet montane evergreen forests and shola-grassland complexes in the higher elevation (1,200-2,200 m). More than half the tree species found in these forests are endemic, especially among the families Dipterocarpaceae and Ebenaceae.

Semi-evergreen forests: Semi-evergreen forests occur primarily in the states of Maharashtra, Goa, and Karnataka of Western Ghats (IIRS 2002). This forest type includes secondary evergreen Dipterocarp forests, lateritic semievergreen forests, bamboo brakes, and riparian. These forests also tend to have high levels of tree diversity and endemism

Moist deciduous forests: The moist deciduous forest type occupies the largest area within the Western Ghats. It occurs in areas with mean annual rainfall of 2,500-3,500 mm.

Dry deciduous forests: The dry deciduous forests occur on the leeward side of the Western Ghats Mountain Range in areas with 900-2,000 millimeters mean annual rainfall. They extend across the southern Indian states of Karnataka and Tamil Nadu.

5.3 Methodologies (Geospatial Analyses)

Remote Sensing, GIS, spatial statistics, photogrammetry and models are the tools to execute the principles of the landscape ecology. Landscape ecology helps in understanding the priority in conservation and resolves conflicts, as it emphasizes that land use/cover types, amounts and arrangement of these on the landscape elements, ultimately determines the dynamics and landscape structure. The spatial datasets, their scales and resolution of satellite data are important for analysis and modeling. Remote Sensing satellite data provides resolution from <1 m to 1000 m. The landscapes are best depicted and mapped using medium resolution (20-50 m) satellite data. Indian Remote Sensing satellite; Resourcesat I and II provide three resolutions in AWifs (50 m), LISS III (24.5m) and LISS IV (5.4 m). The LISS III sensor is widely used for regional mapping of resources and landscape ecological analysis. ISRO has been undertaking such mapping under various projects and has access to required geospatial datasets. Accordingly, HLWG requested ISRO for geoprocessing.

The subgroup of HLWG interacted with scientists of Forestry and Ecology Group of National Remote Sensing Centre (NRSC) of ISRO for two days at Hyderabad to work out methodologies for identification of Ecologically Sensitive Areas (ESAs) in Western Ghats region defined by HLWG. The Director of NRSC also participated in the discussion.

The group discussed the different options available for scientific, objective and practical ways of delineating ecologically sensitive areas at the landscape level using different layers representing ecological characteristics. The group examined the datasets available for different layers at NRSC and other Institutes at the fine resolution level. Finally, after a thorough discussion, it was decided to utilize the datasets generated in the DBT-DOS project (Appendix 2; Roy et al 2012) and these datasets cover: (i) the landscape level characteristics of existing land use /land cover (habitats), (ii) fragmentation, (iii) disturbance, and (iv) ecological parameters (endemicity, ecosystem, species diversity and total bioresource value index) collected from ~20000 ground sample points and used these date sets to map biologically rich areas (Appendix 2).

Using these data sets, a pilot proof of concept project was undertaken for identification of ecosensitive area in three districts – Uttarkannada in Karnataka, Idduki in Kerala and Ratnagiri in Maharashtra. The methodology adopted and the GIS maps thus generated were explained to HLWG. The HLWG reviewed the results of the pilot project and recommended landscape level evaluation for demarcating eco-sensitive areas.

The key premise is that the landscape level indicators would be based on the vegetation, particularly the primary vegetation types.

The HLWG approach for the delineation of eco-sensitive area starts with the natural vegetation consisting of major vegetation types, the scientific reasons for it are several. Primarily, the only fine scale, spatially consistent information on plant species distribution for the Western Ghats is the vegetation type map. These vegetation types are generated using multi-spectral remote sensing data in conjunction with suitable ground inventory of plant species. Finally the spatially consistent species surrogate information, that vegetation types provide, can be used as the basis for estimating landscape level metrics such as biological richness and forest fragmentation.

The HLWG effort for the identification of ecologically sensitive areas based on landscape level indicators have utilized the layers generated from the national project on landscape level biodiversity characterization under the collaborative study of the Department of Space and Department of Biotechnology, based on multi-season IRS LISS-III data. It provides spatial information on the vegetation types consisting of natural and managed vegetation. The satellite image elements were correlated on ground with the sampling intensity varying from 0.002% to 0.005%, depending upon the vegetation heterogeneity. Details of the study methodology, sampling technique and biological richness modelling have been published (Roy et al 2012). Besides the remote sensing data, other collateral databases used include phytosociological data collected from 16,578 field sample plots (with 7596 plant species, wherein 648 species are endemic, 23 are endangered, rare or threatened (ERT), 1879 medicinally important and 2803 are economically important species). The datasets were collected during 1998-2010 under Department of Biotechnology and Indian Space Research Organization joint programme (Roy et al 2012).

The project combined the spatial information generated on vegetation types with the species level information and landscape level parameters to generate modelled layers on biological richness and disturbance regimes stands. The spatial database of these layers have served as the baseline data for habitat suitability assessment, prioritization for microscale habitat studies, corridor connectivity and landscape planning, identification of species-rich areas, conservation methods for protection of rare species. These databases have been used for identification of ecologically sensitive areas.

The geospatial analysis for the identification of ESZ uses two of the landscape level spatial layers - forest fragmentation and biological richness. The geospatial analysis for the generation of theses layers is described in Appendix 2. The different datasets used in the analysis and their sources are given in Table 3. The analysis carried out is schematically represented in Figure 7.

Table 3: Datasets (layers) used in geospatial analysis and their sources

S.No.	Layer/Data	Source	Remarks
1.	Forest and Vegetation Types	Department of Space-Department of Biotechnology (DOS-DBT) Project on Biodiversity Characterisation at Landscape level (2007)	Based on interpretation of ortho- corrected IRS LISS III (23 m) data of 2005-2006; Projection: LCC, Datum: WGS84
2.	Natural and Cultural Landscapes	Derived from forest and vegetation types layer (S. No. 1)	Projection: LCC, Datum: WGS84
3.	Forest fragmentation and biological richness	Department of Space-Department of Biotechnology (DOS-DBT) Project on Biodiversity Characterisation at Landscape level (2007)	Projection: LCC, Datum: WGS84
4.	Village boundaries	Survey of India	The village boundaries and areas are indicative; Projection: LCC, Datum: Everest
5.	Population density	Village-level Population: Census of India (2001); Village boundary layer: Survey of India	Spatial data organisation and tagging of census data with village layer by NRSC, Hyderabad
6.	Administrative boundaries	Survey of India	Western Ghats landscape as defined by the Planning Commission, Govt. of India, under WGDP and HDP (consisting of 188 Talukas)
7.	Protected Areas, World Heritage Sites and Tiger Corridors	Wildlife Institute of India	Projection: LCC, Datum: Everest
8.	Elephant corridor	Wildlife Trust of India	

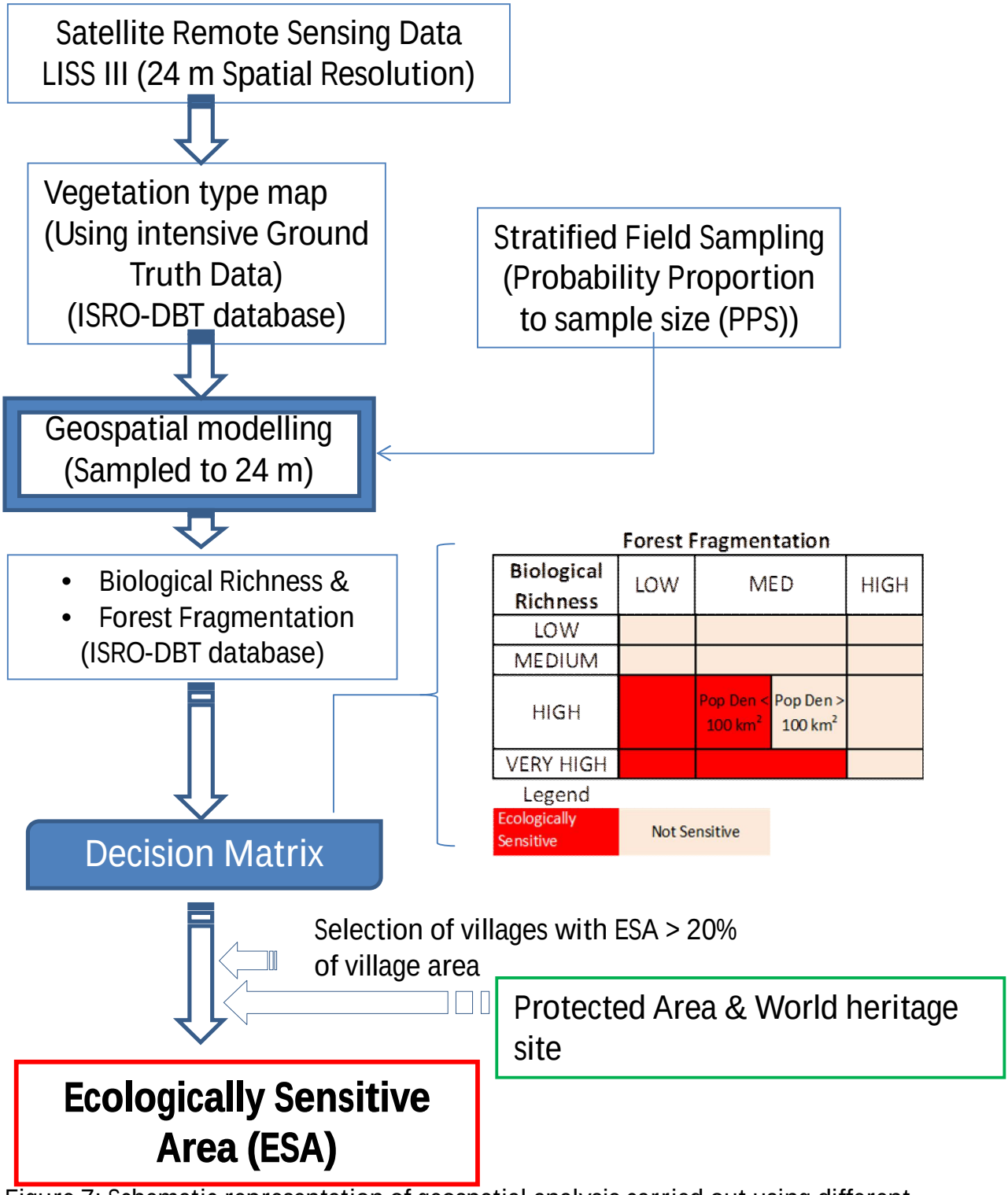

Figure 7: Schematic representation of geospatial analysis carried out using different datasets for identification of ESAs.

The fragmentation layer provides insights into the effects of forest fragmentation on landscape patterns, biodiversity and ecological processes. The biological richness .

layer identifies areas that should be treated on a priority basis for the conservation of biodiversity. The biological richness layer is spatially modelled by combining information on disturbance metrics (fragmentation, juxtaposition, porosity and patchiness), ecosystem uniqueness, total importance value, and endemicity. It covers only natural landscapes. It may be noted that disturbance metrics included as one of the components of biological richness index and it includes not only fragmentation but also juxtaposition porosity and patchiness. Consequently, fragmentation used in biological richness index is insignificant and does not represent double count. The spatial layers categorize biological richness in four classes (low, medium, high and very high) and forest fragmentation in three classes (low medium and high). Figure 7 explains the steps in processing the datasets for generating eco-sensitive areas.

While very high biological richness with low and medium fragmentation and high biological richness with low fragmentation has been taken as ESA as such, the high biological richness medium fragmentation class was included only where the population density was lower than 100 persons/km^2. The population data from the 2001 census (Govt. of India, 2001) was combined with spatial data on village boundaries (Survey of India) to prepare a spatial layer on population density. The reason that less than 100 person/km^2 was chosen because in hilly areas the usual density is<100 persons/km^2.

The Ecologically Sensitive Areas (ESAs) thus identified are at the smallest administrative unit - the village. Village was taken as the unit of ESA. Villages were selected on the basis of the proportion of ESA to the geographic area of the village. A threshold of 20% proportional ESA was used to mark villages as ESU. This approach is much more conservative, and indeed meaningful, than treating an entire taluka as an ESA. Finally all protected areas and World Heritage sites (spatial data provided by the Wildlife Institute of India) are treated as Ecologically Sensitive. It should be noted that the village boundaries from SOI used in the study are indicative. The spatial resolution used was 24 m. The observation made from data set on Tiger

corridor (from WII) and Elephant corridor (from Wildlife Trust of India) were used to overlay on ESA.

The methodologies described above were discussed at HLWG meetings and also used to map ESAs in Mudigere taluka of Chikmagalur district in Karnataka as another case study.

5.4 Observations

5.4.1 The observation made from geospatial analysis are given below:

5.4.2 Case Study on the Identification of ESAs in Mudigere Taluka of Chikmagalur District of Karnataka

Chikamagalur is a district in the Western Ghats region of Karnataka. The rivers Tunga and Bhadra originate from this district. The first coffee plantations in the country were established in this district. The Kudremukh National Park and Bhadra Wildlife Sanctuary are located in the area. The District is divided into seven talukas grouped into two Revenue Sub-Divisions viz., Chikmagalur and Tarikere. Out of seven talukas, five talukas Chikmagalur, Koppa, Mudigere, Narasimharajpura and Sringeri are part of the Western Ghats region delineated.

The forests in the taluka are of evergreen, semi evergreen, *sholas* and moist deciduous types.

Figures 8 & 9 shows that a little over a third of the taluka is occupied by orchards and plantations and constituted the cultural landscape (54% of the taluka). The natural landscape accounts for 46% of the taluka area.

About 63% of the natural landscape is characterized by high and very high biological richness, with almost 60% of it falls under low fragmentation category.

The village database shows that there are 140 villages in the taluka and 58 of them harbour population density below 100 persons/km^2.

Figure 10 indicates that ESA constitutes 570 km^2 covering 27 villages. These villages include all those having 20% or more of the area covered under ecologically sensitive area. The total ESA includes 184 km^2 of the Kuderemukh National Park located at the north western part of the taluka.

ESZs of WGEEP was overlaid on the ESA of HLWG (Figure 11). As per WGEEP methodology, out of 28 grids of 9x9 km, 17 were assigned to ESZ 1 and 10 were assigned to ESZ 2.

These results on the case study substantiate that the methodologies followed for identification of ESA are objective, scientific and practical in delineation of ESAs at fine resolution with village as a unit. This is further confirmed by Peer Review Committee (see item 5.5 of this Chapter).

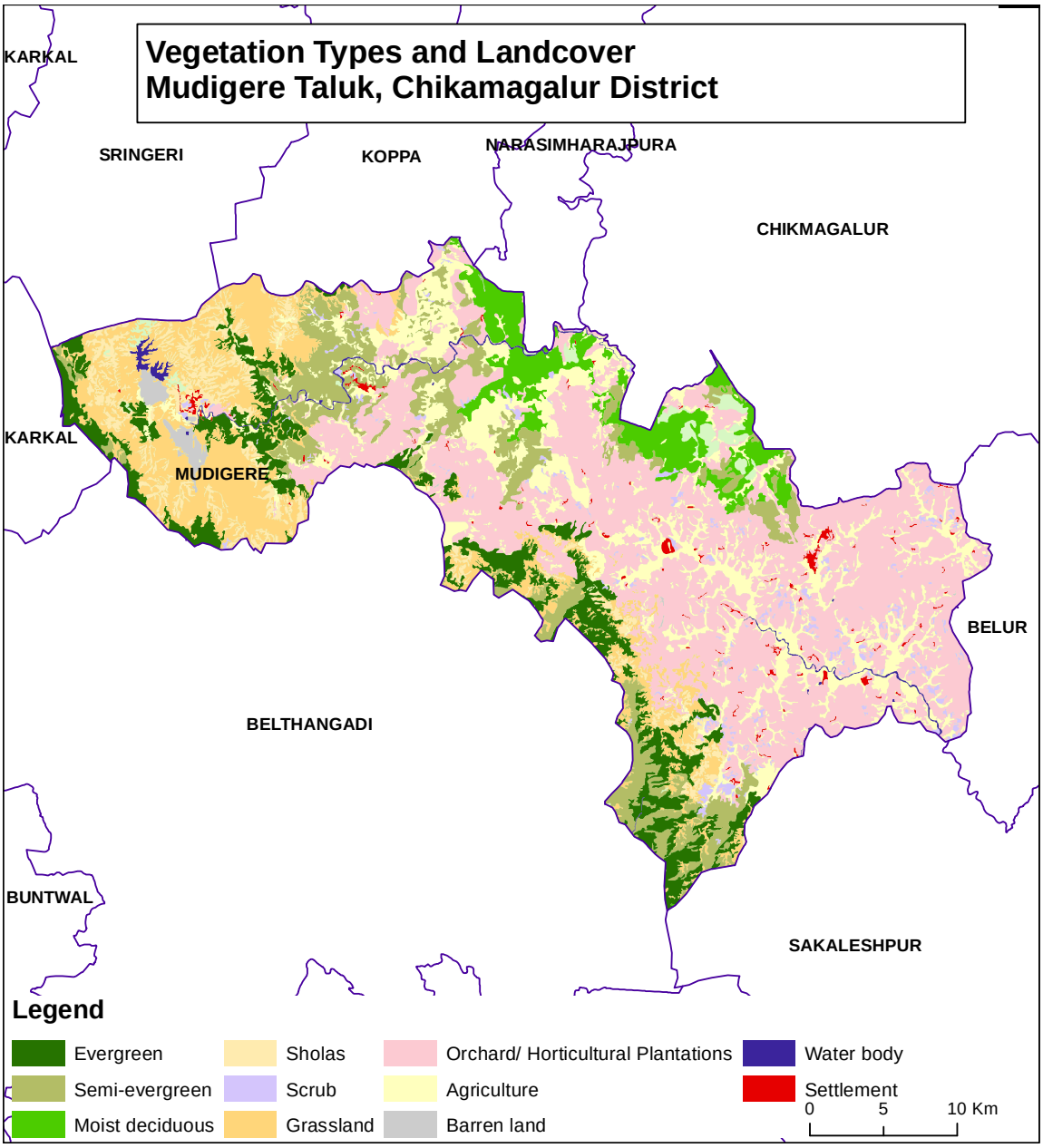

Figure 8: Mudigere taluka showing vegetation and land cover types.

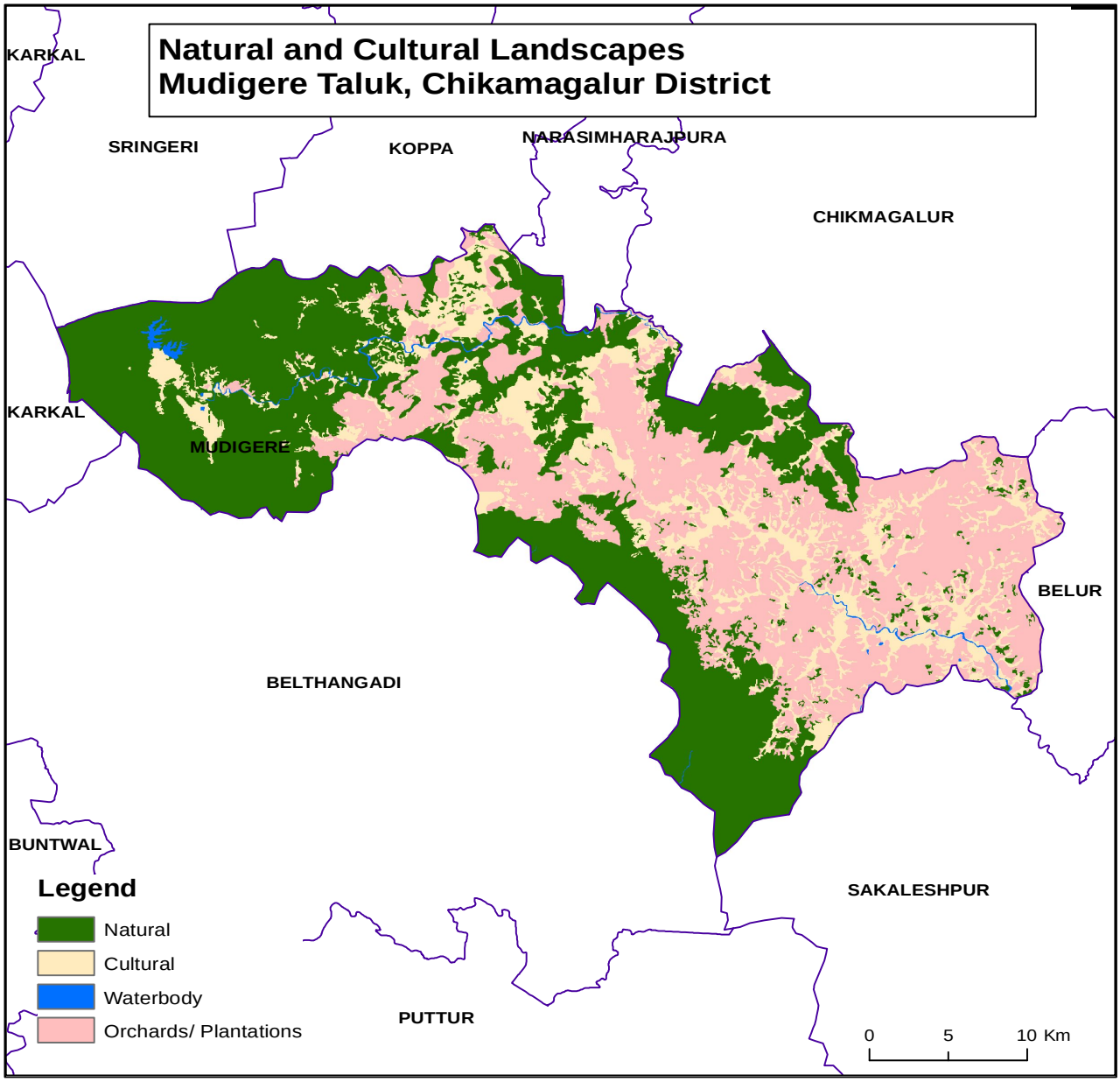

Figure 9: Mudigere taluka showing natural and cultural landscapes.

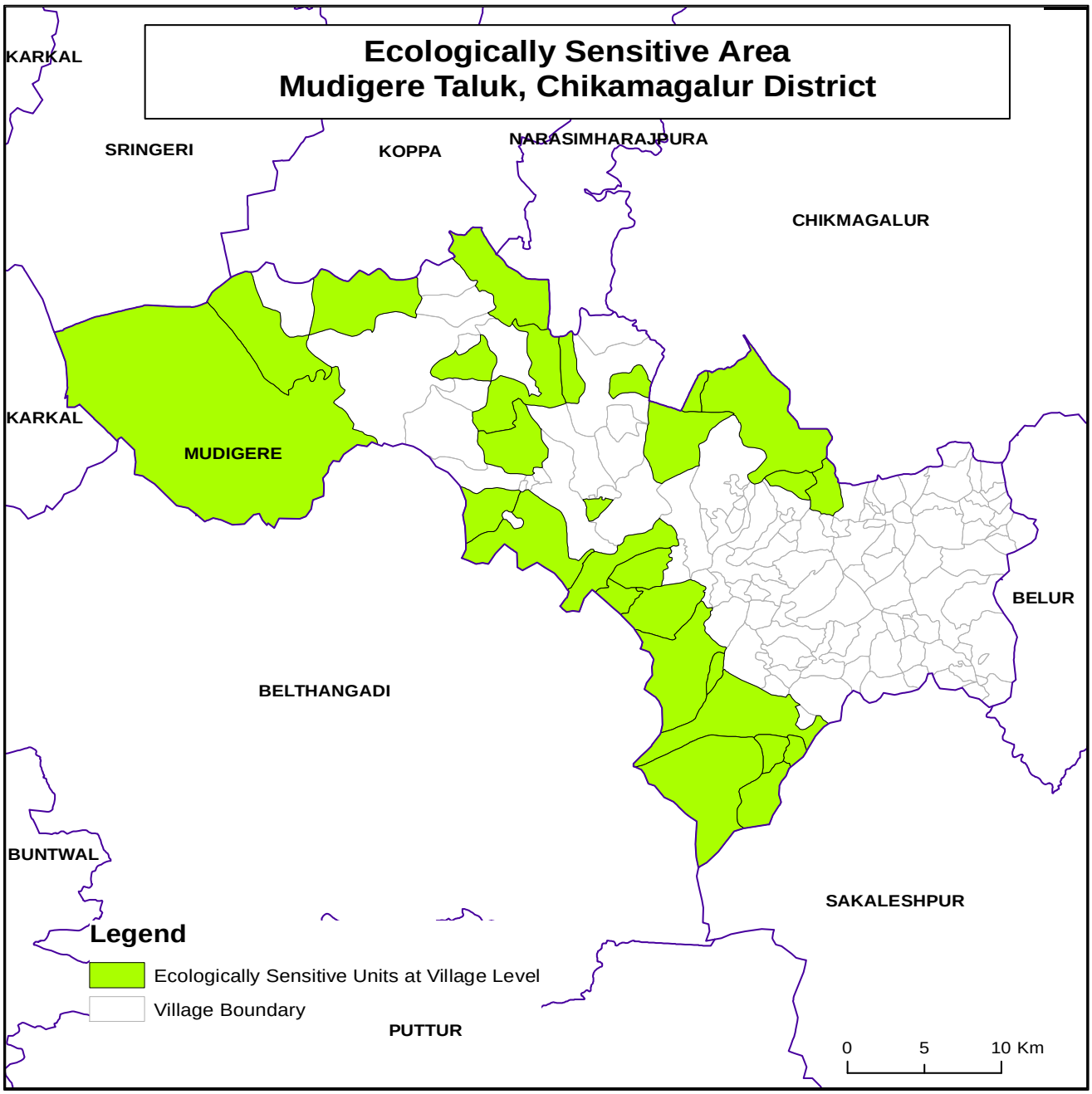

Figure 10: Mudigere taluka showing ESAs.

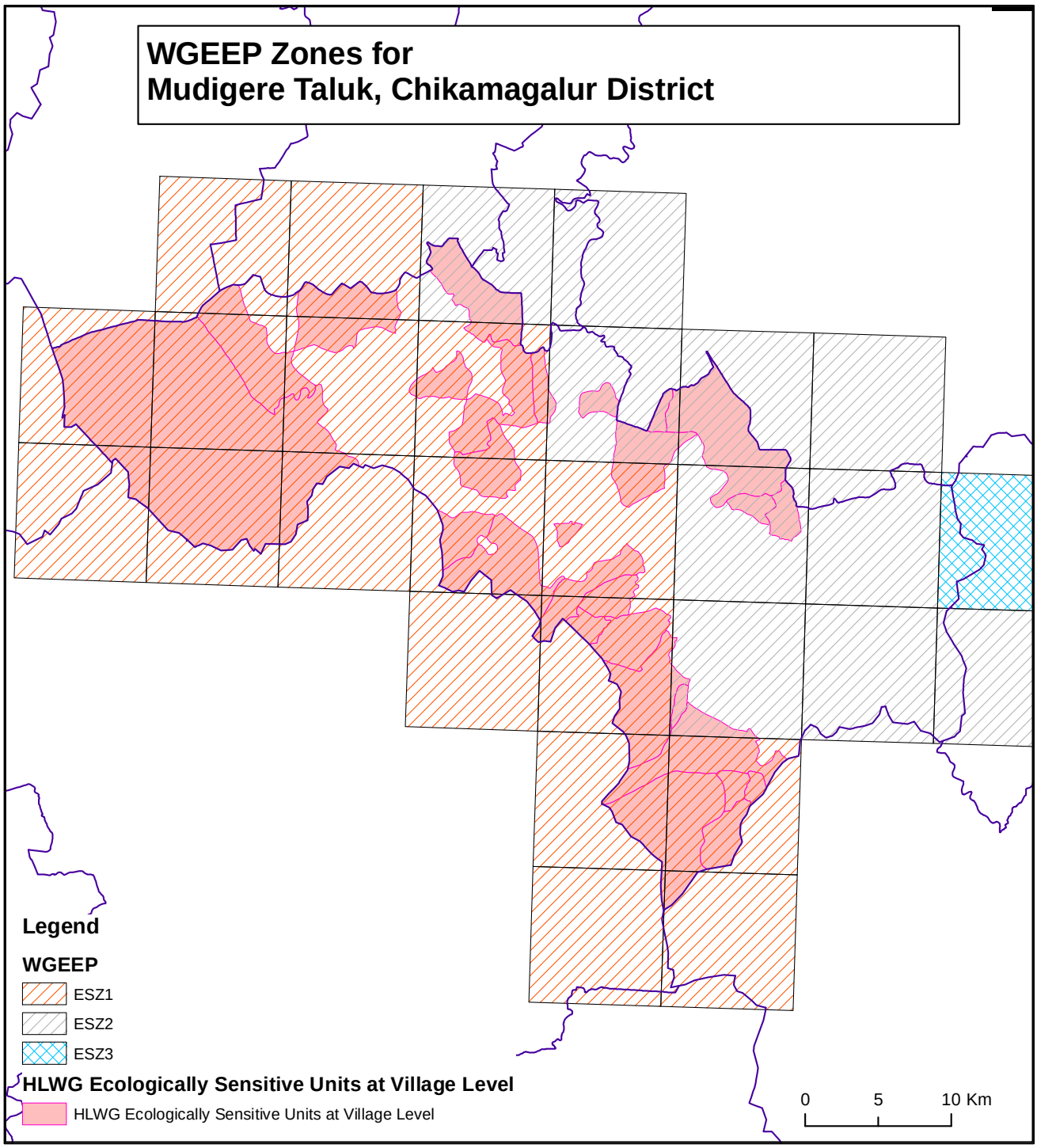

Figure 11: Mudigere taluka showing ESZs of WGEEP overlaid on ESAs.

5.4.3 Identification and Delineation of ESAs in Western Ghats Region

5.4.3.1 Different layers used in the delineation of ESA across Western Ghats region

The methodologies thus tested by HLWG were used in the identification and delineation of ESAs in Western Ghats Region as defined by HLWG.

The vegetation and land cover classes found in natural and cultural landscapes are given in Table 4 and Figure 12. The area under natural and cultural landscapes is 68,249 km^2 and 96,031 km^2 respectively and thus making the total geographical area of Western Ghats as 1,64,280 km^2. The four forest types (49,926 km^2), grasslands (5,549 km^2) and scrub (8,972 km^2) cover most of the natural landscape; of the four forest types, moist deciduous forest is predominant (25,479 km^2). Agriculture (81,239 km^2) and orchard/horticultural plantation (7,815 km^2) are dominant land uses in cultural landscape.

Landuse and landcover data clearly depict that the Western Ghats are prominently dominated and deeply integrated by cultural landscapes along with unique and ecologically sensitive natural landscapes (Figures 8 & 9). Therefore, any strengthening of conservation efforts in Western Ghats should also take into account this integrative practice and sustainable development that makes conservation very effective.

It may be noted that the total area under water bodies is 4,351 km^2, of which 3,617 km^2 area of waterbodies shares boundary with atleast one polygon of natural landscape in Western Ghats region. Consequently, the area of 3,617 km^2 under waterbodies is included under natural landscape and the remaining area under waterbodies is part of cultural landscape. Of the 3,617 km^2 area under waterbodies, 1,526 km^2 area falls under ESAs (Source: NRSC).

Table 4: Vegetation and Landcover classes in Natural and Cultural Landscapes

Natural Landscape		Cultural Landscape	
Sl No	Class	Sl No	Class
1	Sholas	1	Agriculture
2	Evergreen	2	Arecanut
3	Semi-evergreen	3	Orchard/ Horticulture
4	Moist deciduous	4	Water Body*
6	Teak	5	Settlement
7	Bamboo		
8	Dry deciduous		
12	Grassland		
13	Kans		
14	Mixed plantation (forest)		
15	Sacred groves		
16	Riverine		
18	Scrub		
19	Mangrove		

*Also found under natural landscape (see also section 5.4.3.1 of this Chapter)

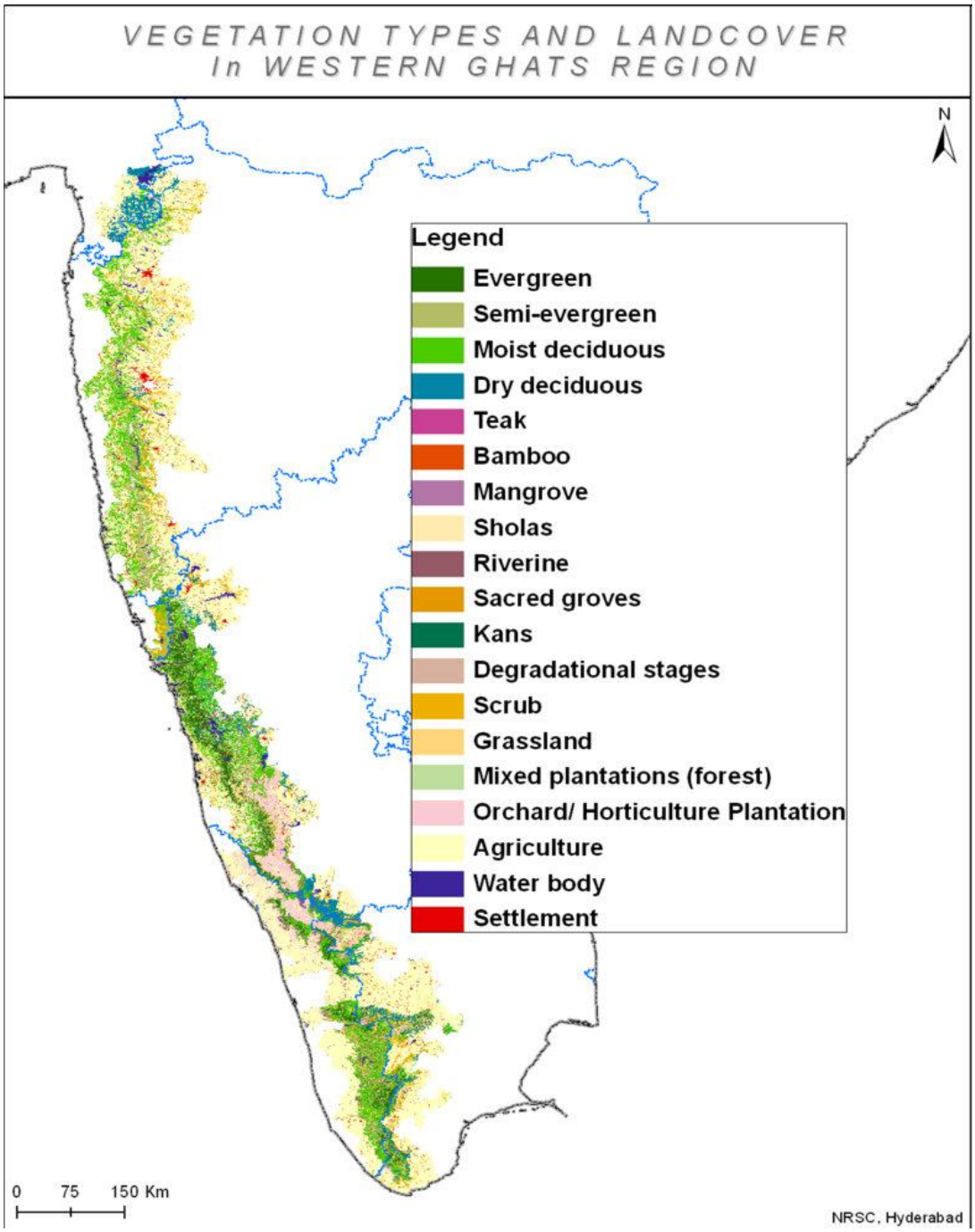

Figure 12: Vegetation and Land cover types in WG region.

Figure 13 depicts area of Western Ghats region covered by relative portions of Natural and Cultural Landscapes. Out of the total 1,64,280 km^2 area, the ratio of Natural to cultural landscape is 68,271 km^2: 96,008 km^2.

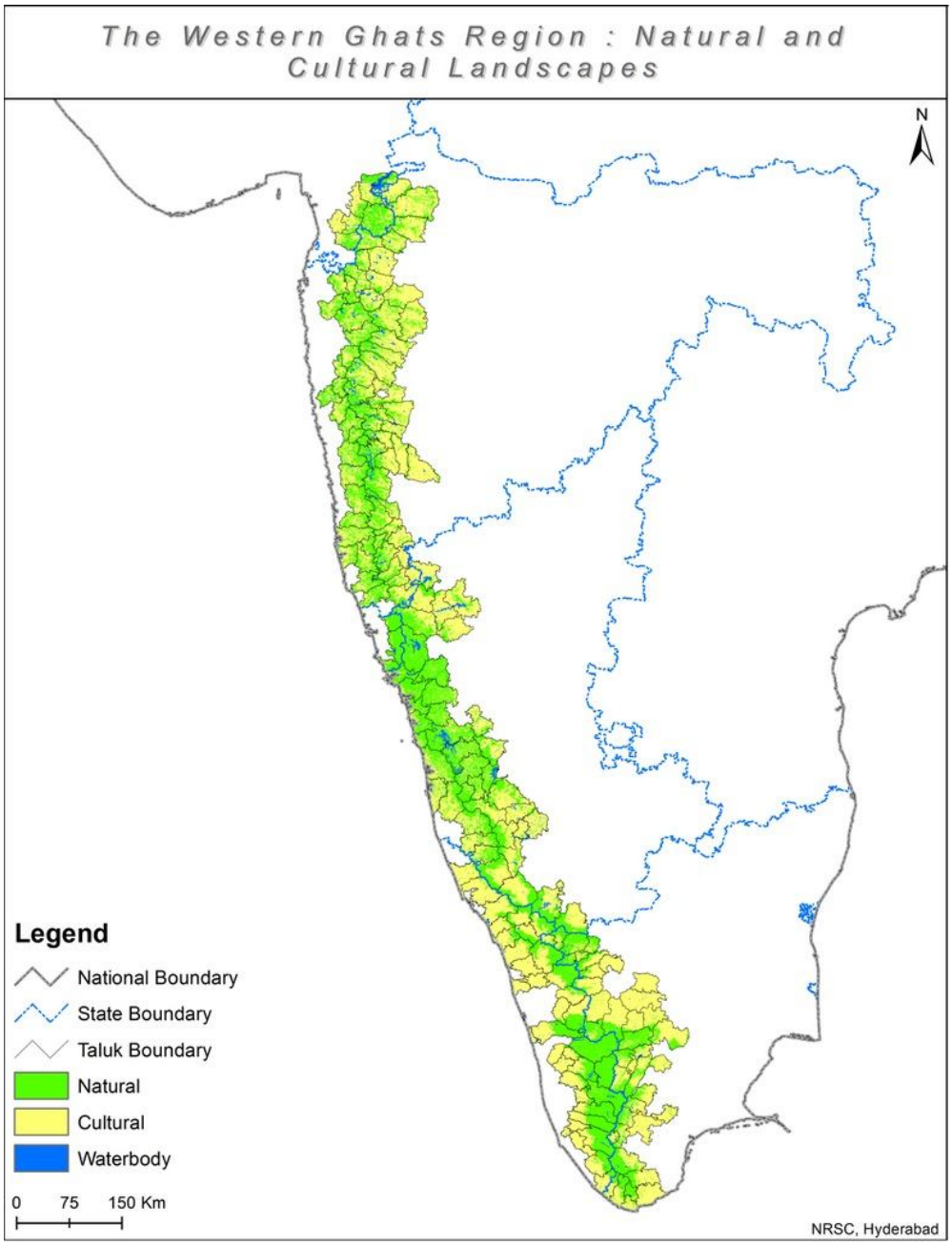

Figure 13: Western Ghats region showing Natural and Cultural Landscapes and water bodies.

Figure 14 illustrates the different levels of biological richness in natural landscape across Western Ghats region. Figure 15 gives pattern of forest fragmentation layer across the Western Ghats region.

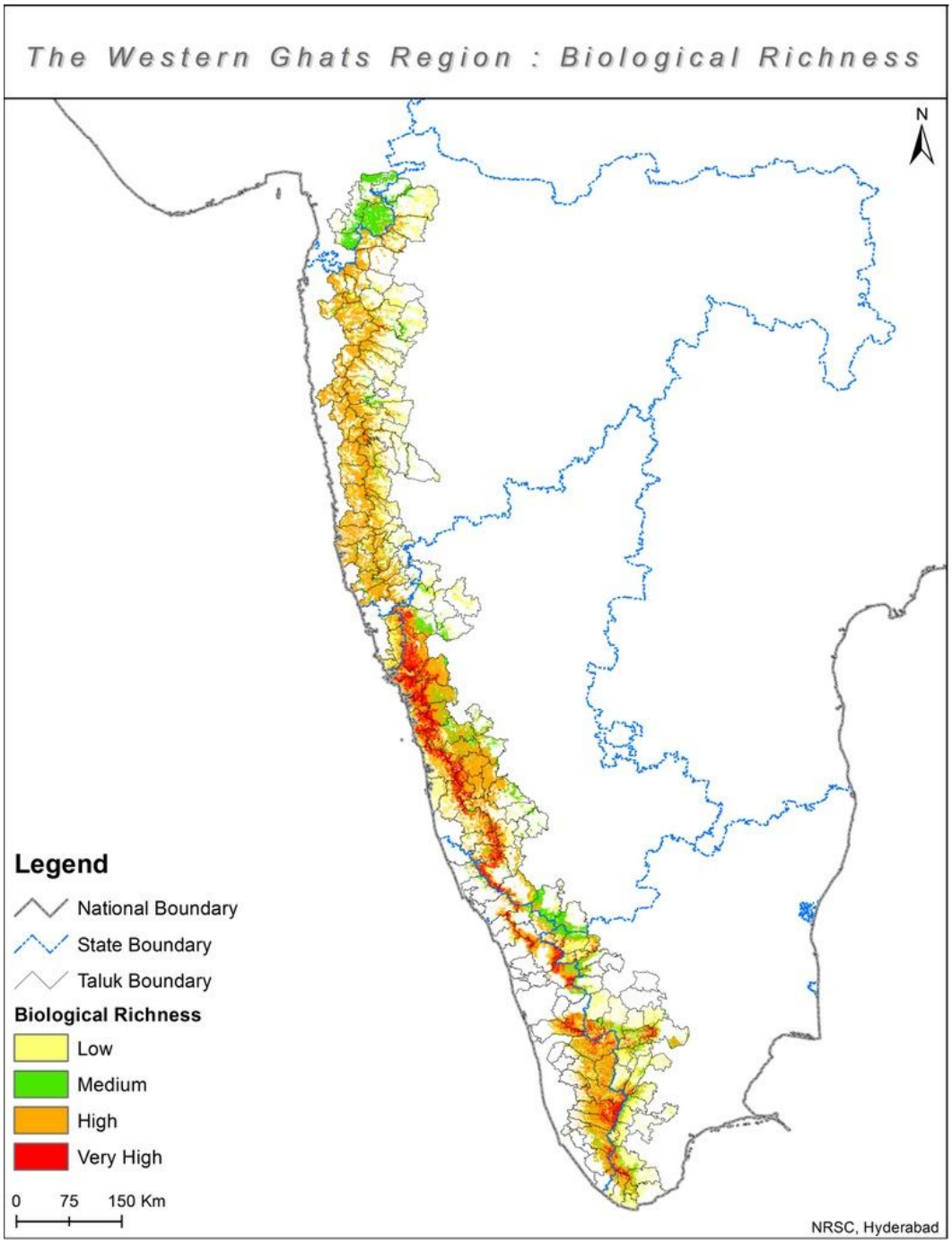

Figure 14: Western Ghats region showing different levels of biological richness in natural landscape.

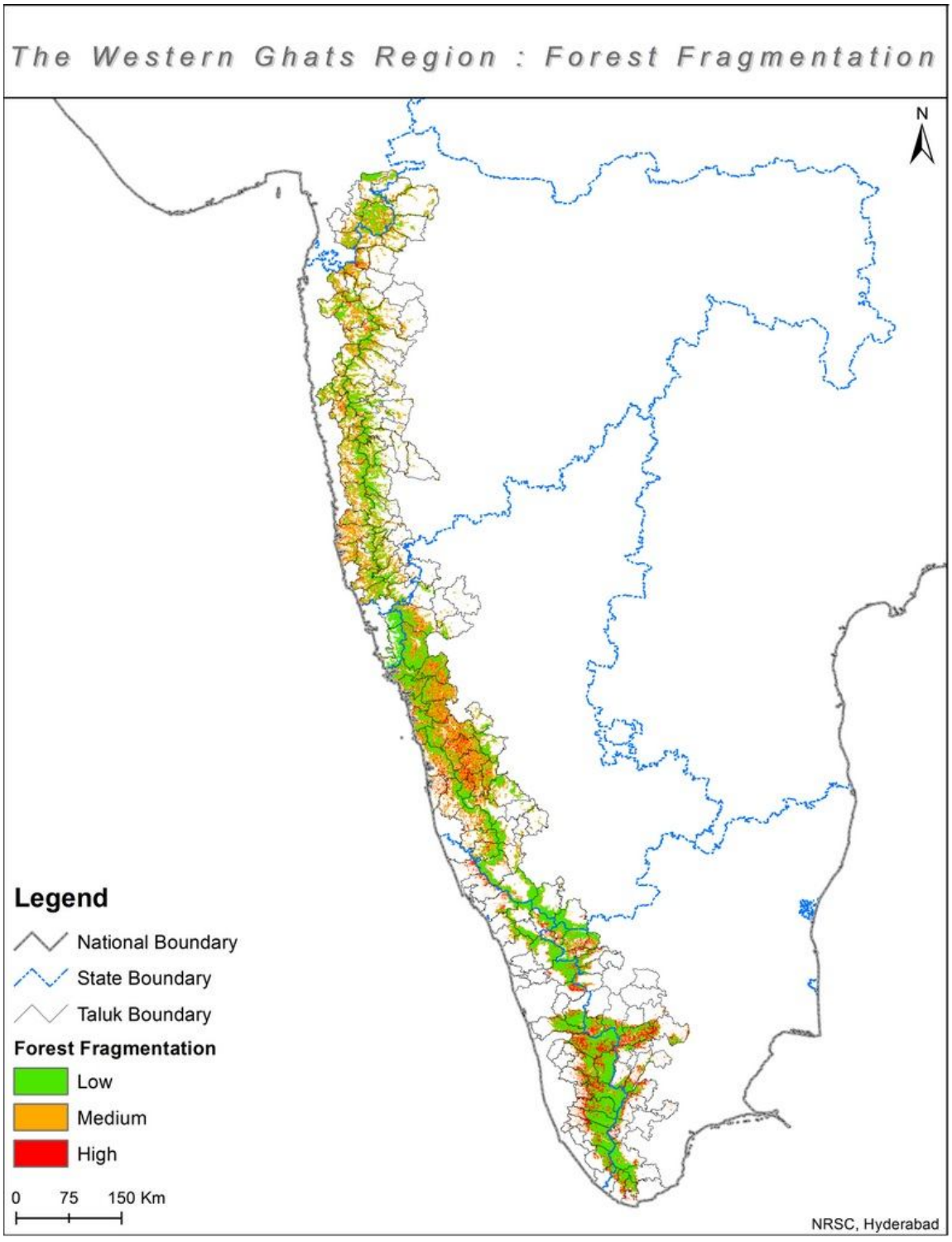

Figure 15: Western Ghats region showing different levels of forest fragmentation in natural landscape.

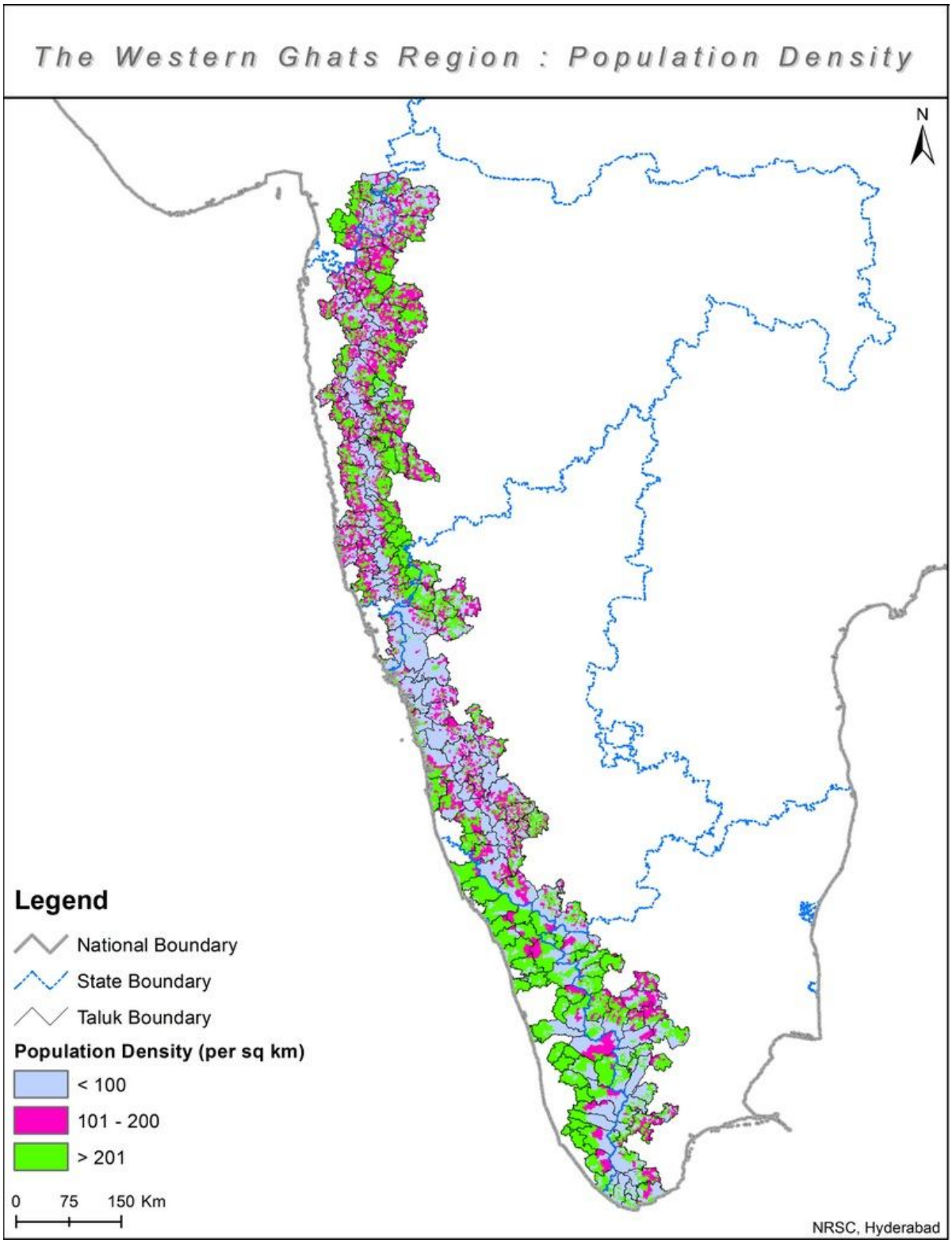

Figure 16: Western Ghats region showing different population densities.

The population densities across the Western Ghats region are given in Figure 16. Table 5 gives the number of villages and population densities in ESA and non-ESA areas. The ratio of village area in ESA to non-ESA is 59,940 km^2 (36.49%) : 1,04,340 km^2 (63.51%). The ratio of population size in ESA to population size in non-ESA is 52,12,244 (10.82%): 429,46,841 (89.18%). The number of villages in ESA to number of villages in non-ESA is 4156 (22.88%): 14009 (77.12%). The ratio of population density in ESA to population density in non-ESA is 86.9: 411.61.

Table 5: Number of villages and population density in ESAs and non ESAs of Western Ghats region

CAT	Village Area	Population Size	Number of Villages	Population Density
ESA	59,940 *36.49%*	52,12,244 *10.82%*	4,156 *22.88%*	86.96
NON ESA	1,04,340 *63.51%*	429,46,841 *89.18%*	14,009 *77.12%*	411.61

The list of villages in ESA is given in Appendix 3 in Volume 2.

5.4.3.2 ESA, PAs, WHSs and Wildlife Corridors in Western Ghats Region

ESA, PAs and WHSs in Western Ghats region are mapped in Figure 17. As indicated in Table 6 the area under ESA (including PAs and WHSs) is approximately 59,940 km^2 (about 60,000 km^2) out of the total 68,271 km^2 of natural landscape. This constitutes 36.49% (about 37%) of the Western Ghats region. Out of 59,940 km^2 ESA, 16,902 km^2 area is occupied by PAs and WHSs (Table 6).

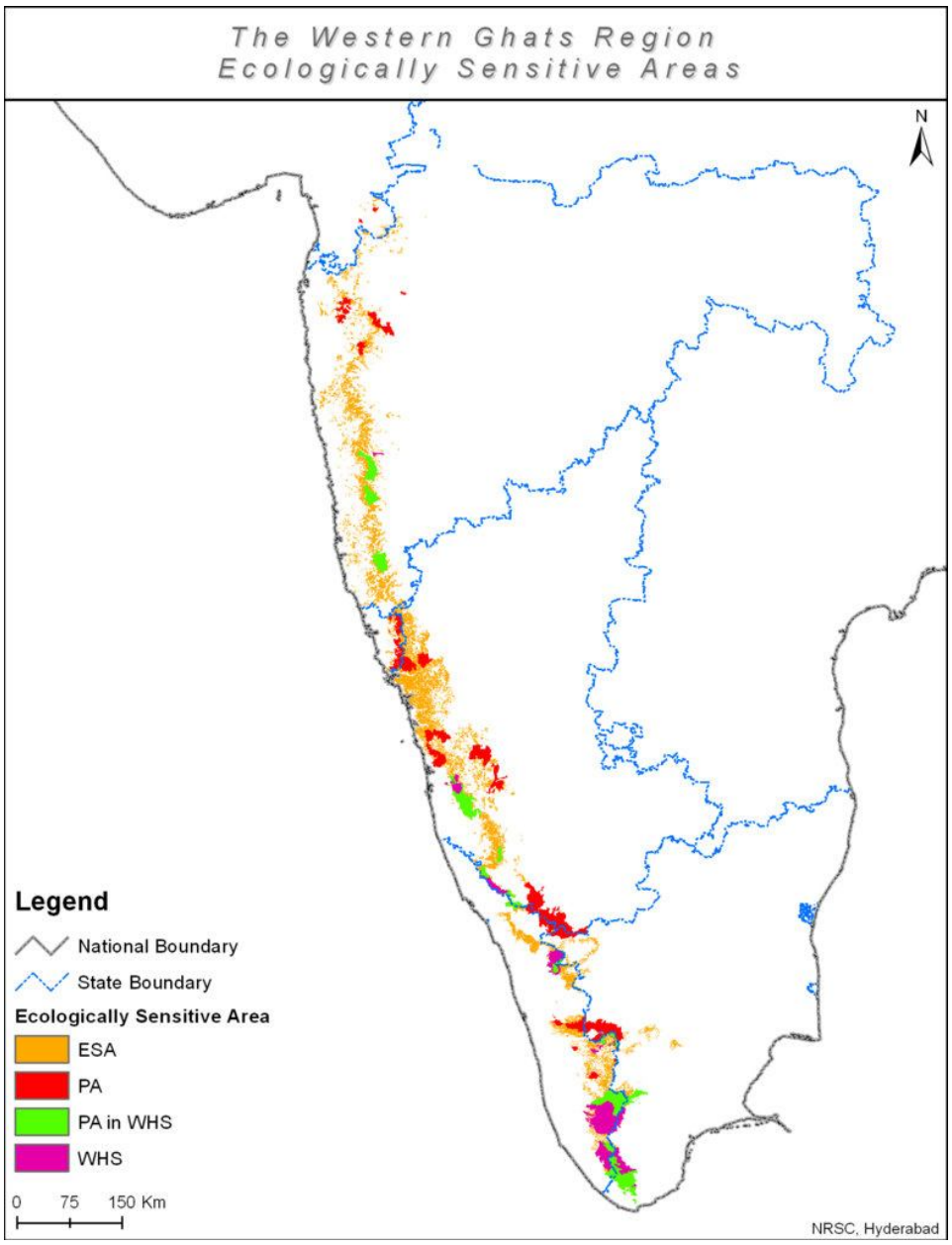

Figure 17: Western Ghats region showing ESA, PAs and WHSs.

The Western Ghats (WG) region includes an extensive Protected Areas network covering about 10% of the geographic area of WG. However, the PAs cannot safeguard viable populations of landscape dependent species such as tiger and elephant over long term, unless they remain connected by habitat corridors. Corridors facilitate movement of individual wild animals amongst PAs so as to minimize the ill effects of inbreeding, genetic drift, demographic stochasticity, and are essential to ensure long-term survival of wild animal populations. This is in tune with the well understood fact that wildlife populations need to be managed as 'metapopulations'.

Wildlife Institute of India (WII) report on the 'Status of Tigers, Co-predators, and Prey in India -2010' identifies important tiger corridors, their spatial context, and potential bottlenecks affecting their functioning. Similarly the Wildlife Trust of India (WTI) has identified elephant corridors.

Tiger and elephant corridors mostly fall in the ESA of the Western Ghats as defined by HLWG in this report. However, some parts of corridors traverse through the cultural landscape in the WG outside ESA. HLWG urges the State Governments to ensure the integrity of the wildlife corridors, and not permit alteration in present landuses in cultural landscape that would make these areas impermeable to the wildlife movement. This can better be ensured by the WG States by devising a workable joint action plan for securing the wildlife corridors especially in cultural landscape.

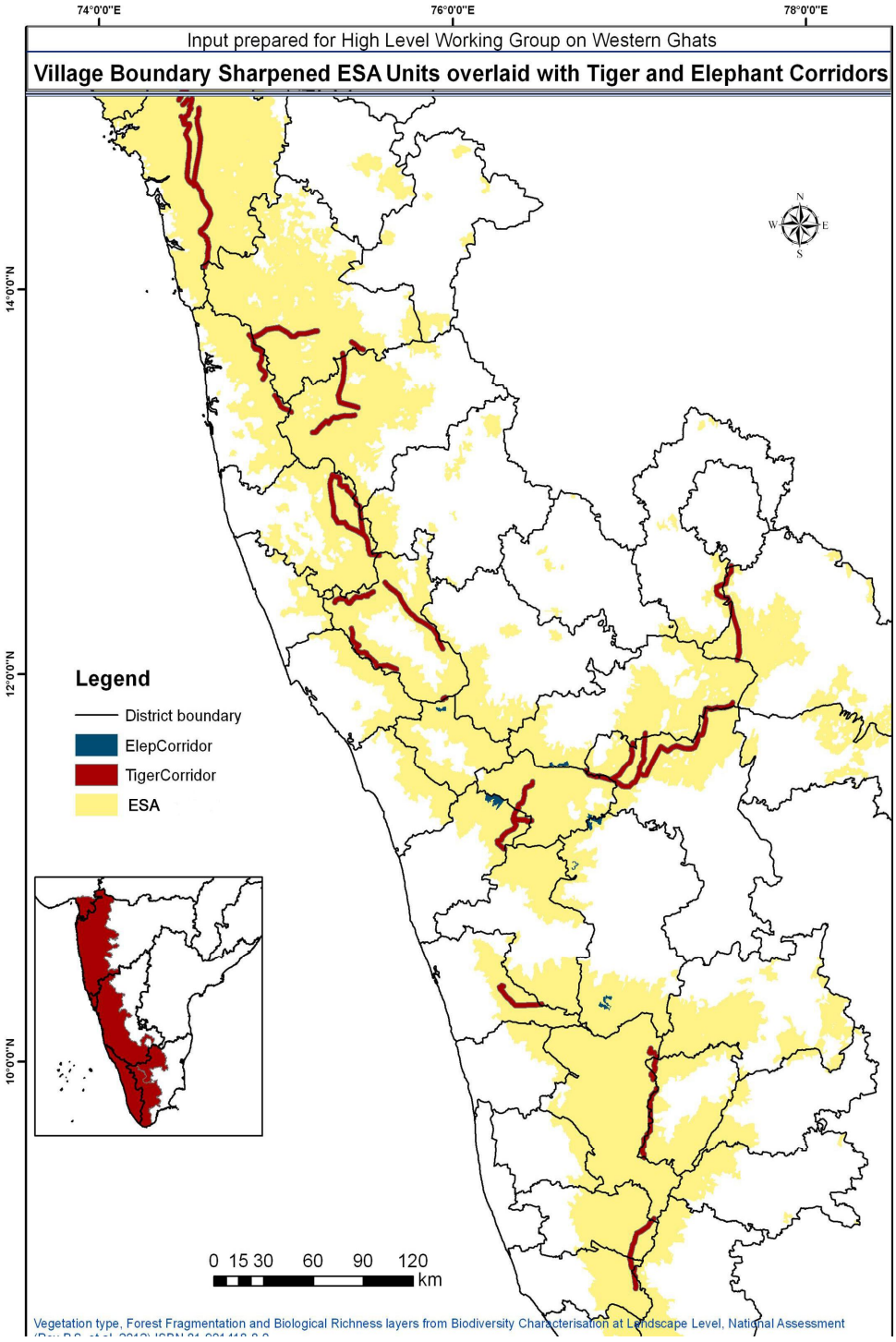

Figure 18: Wildlife corridors (Tiger and Elephant) in ESA of Western Ghats region (Datasets of Tiger Corridor from WII and dataset of Elephant Corridor from WTI were used).

5.4.3.3 Delineation of ESA in each of the Six States of Western Ghats region

For each State of the Western Ghats region, one map depicting natural and cultural landscape and another map showing ESA are provided (Figures 19 to 30). Table 6 gives number of villages falling under ESA and area under ESA in each taluka of Western Ghats region and the districts to which the taluka belongs for each State of Western Ghats region. The list of villages is given in Appendix 3 in Volume 2.

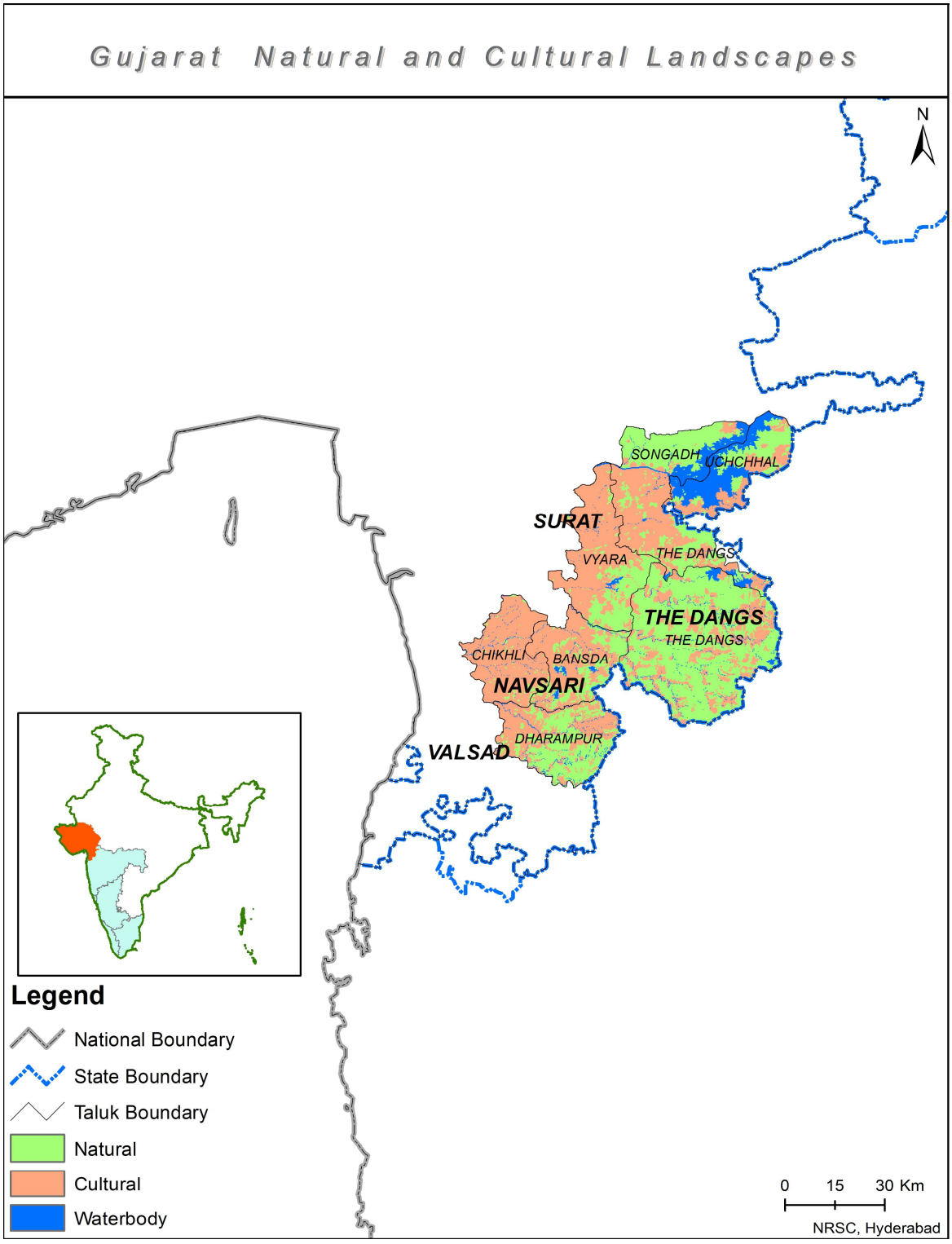

Figure 19: Natural and Cultural landscapes in Western Ghats region of Gujarat.

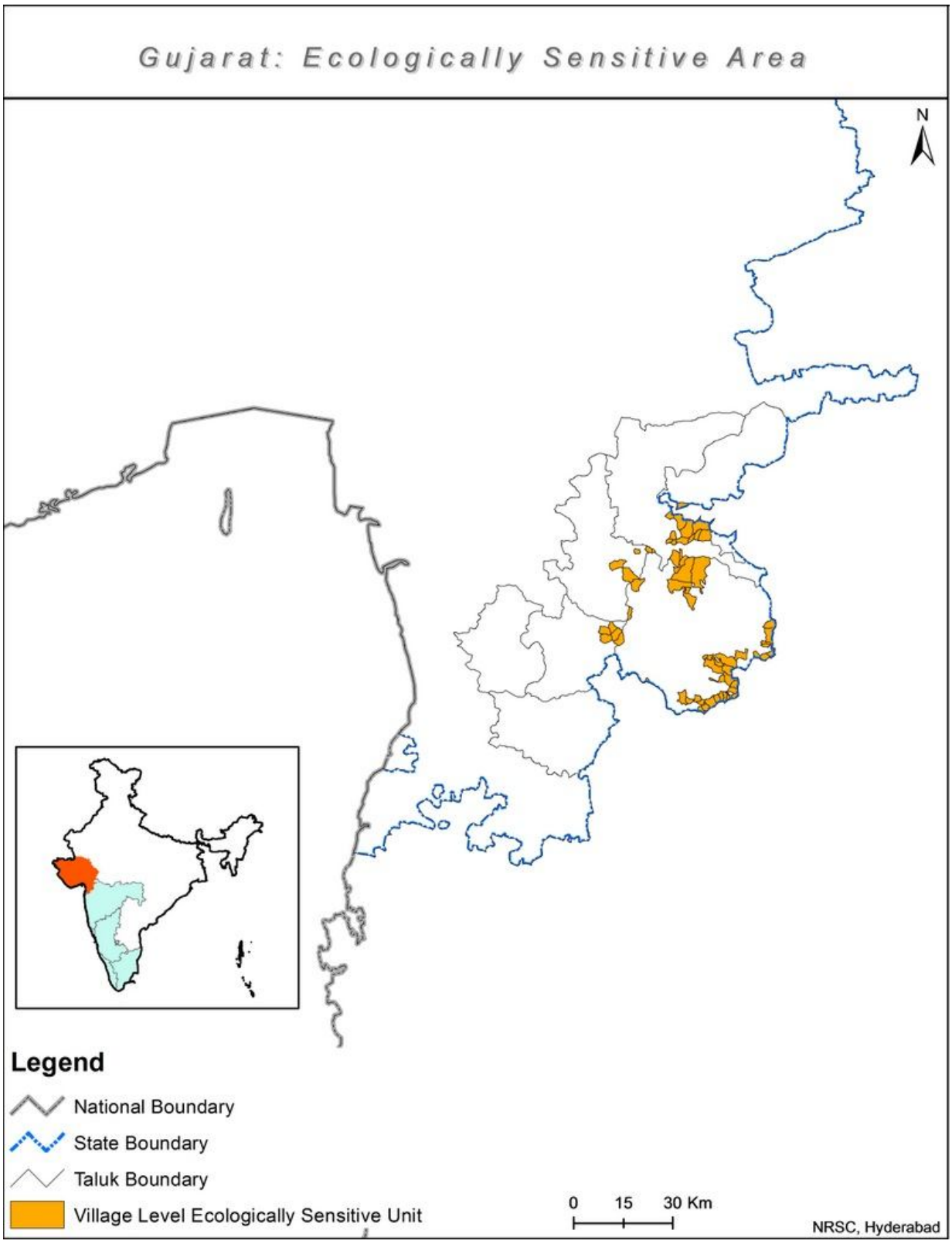

Figure 20: ESA in Western Ghats region of Gujarat.

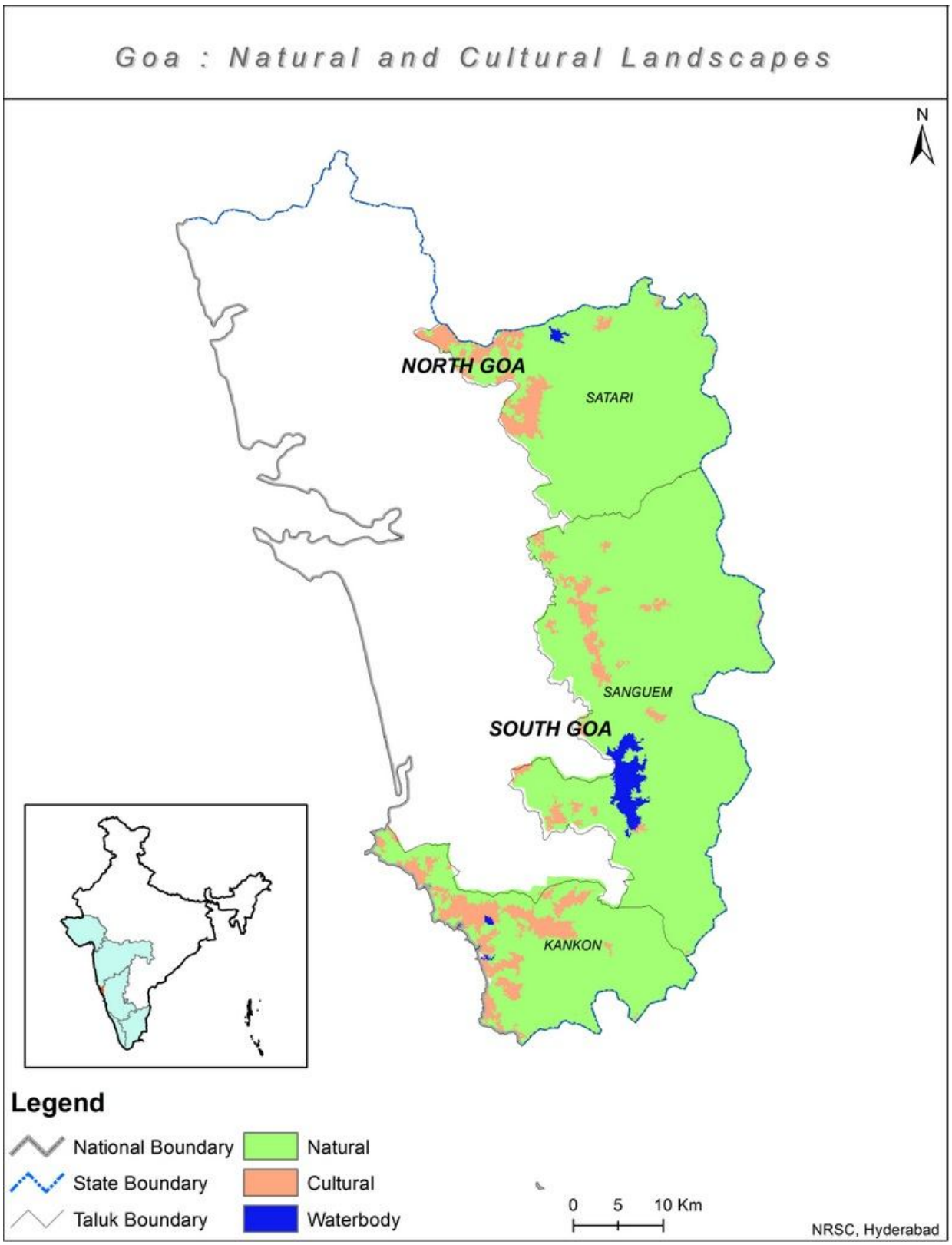

Figure 21: Natural and cultural landscape in Western Ghats region of Goa.

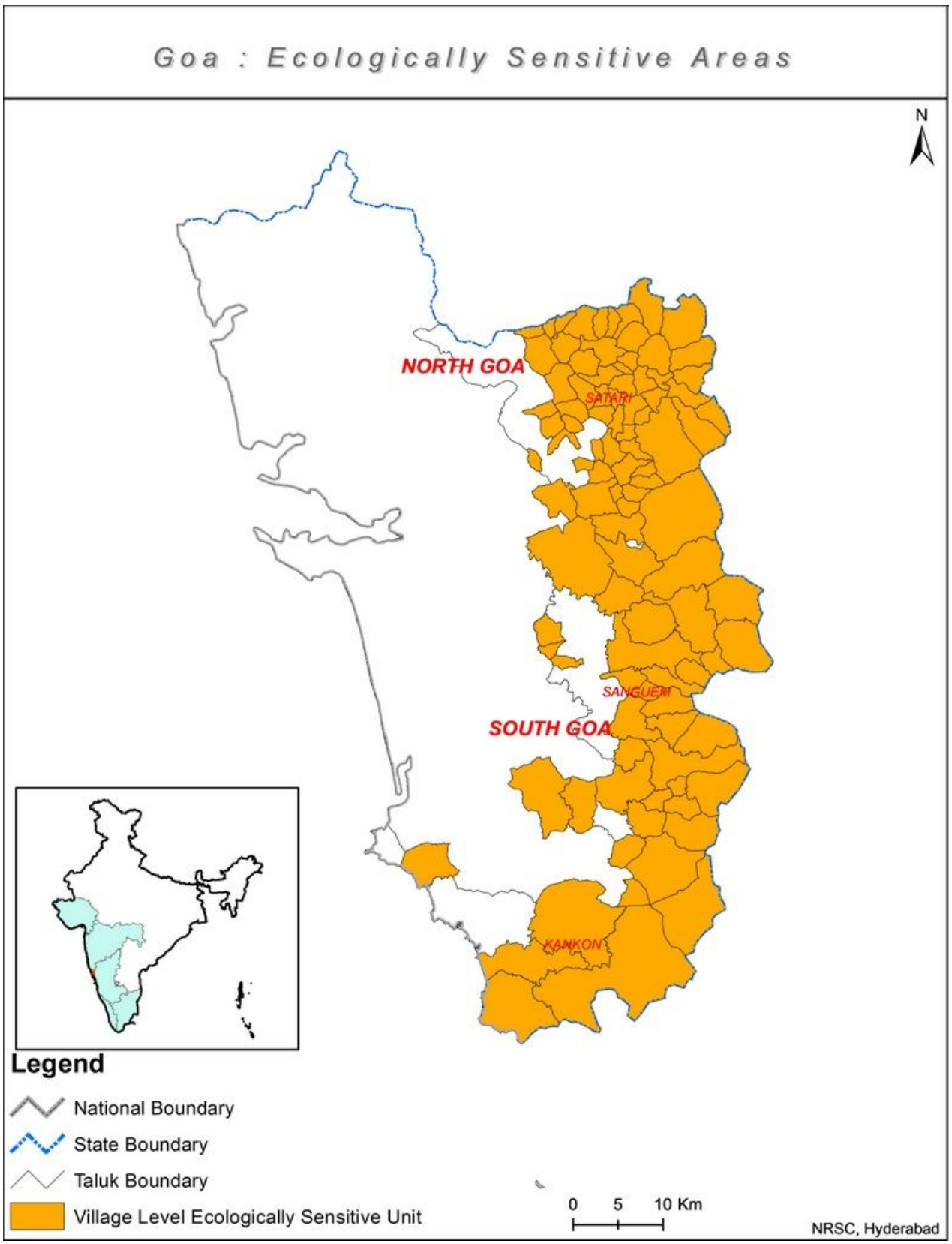

Figure 22: ESA in Western Ghats region of Goa.

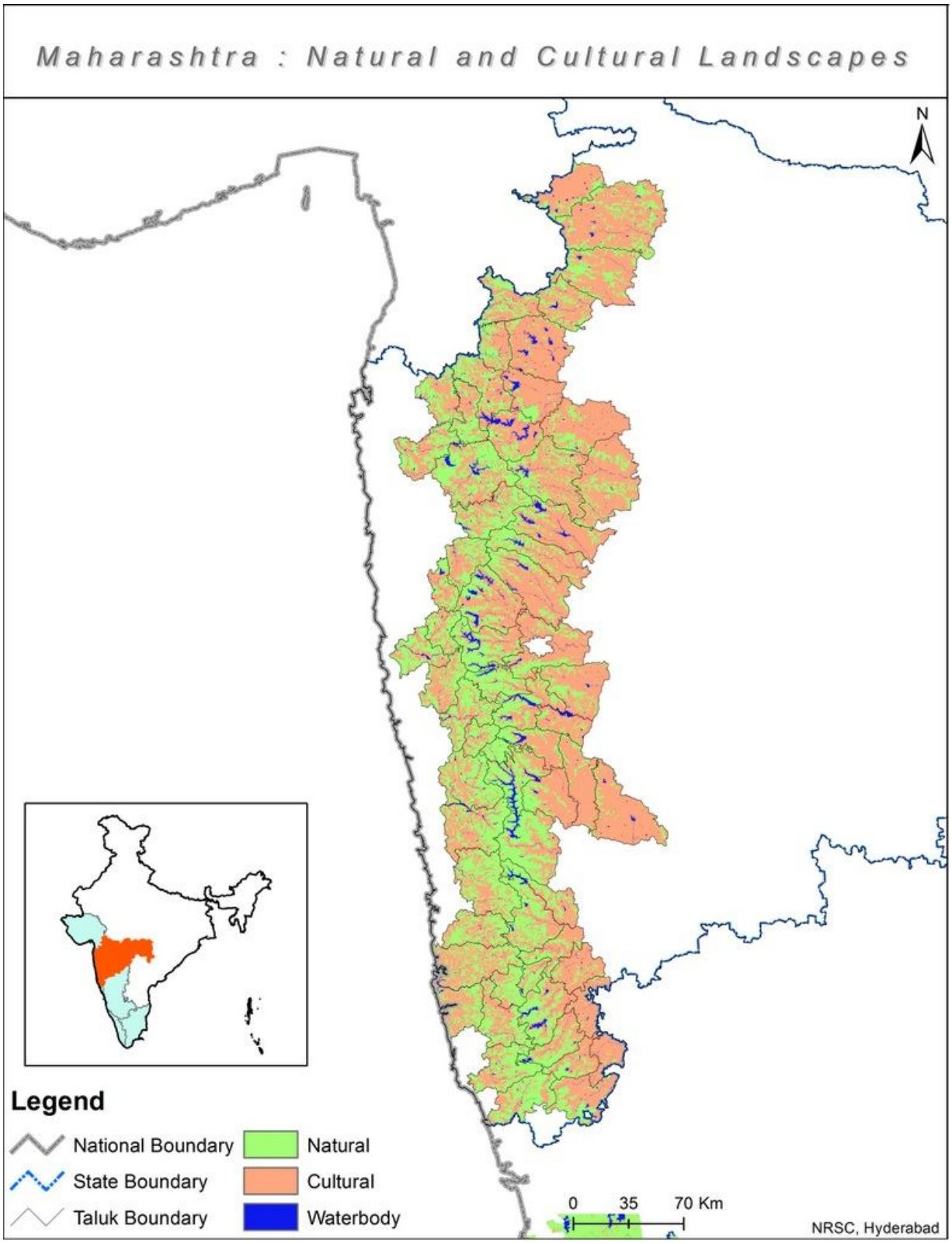

Figure 23: Natural and Cultural landscapes in Western Ghats region of Maharashtra.

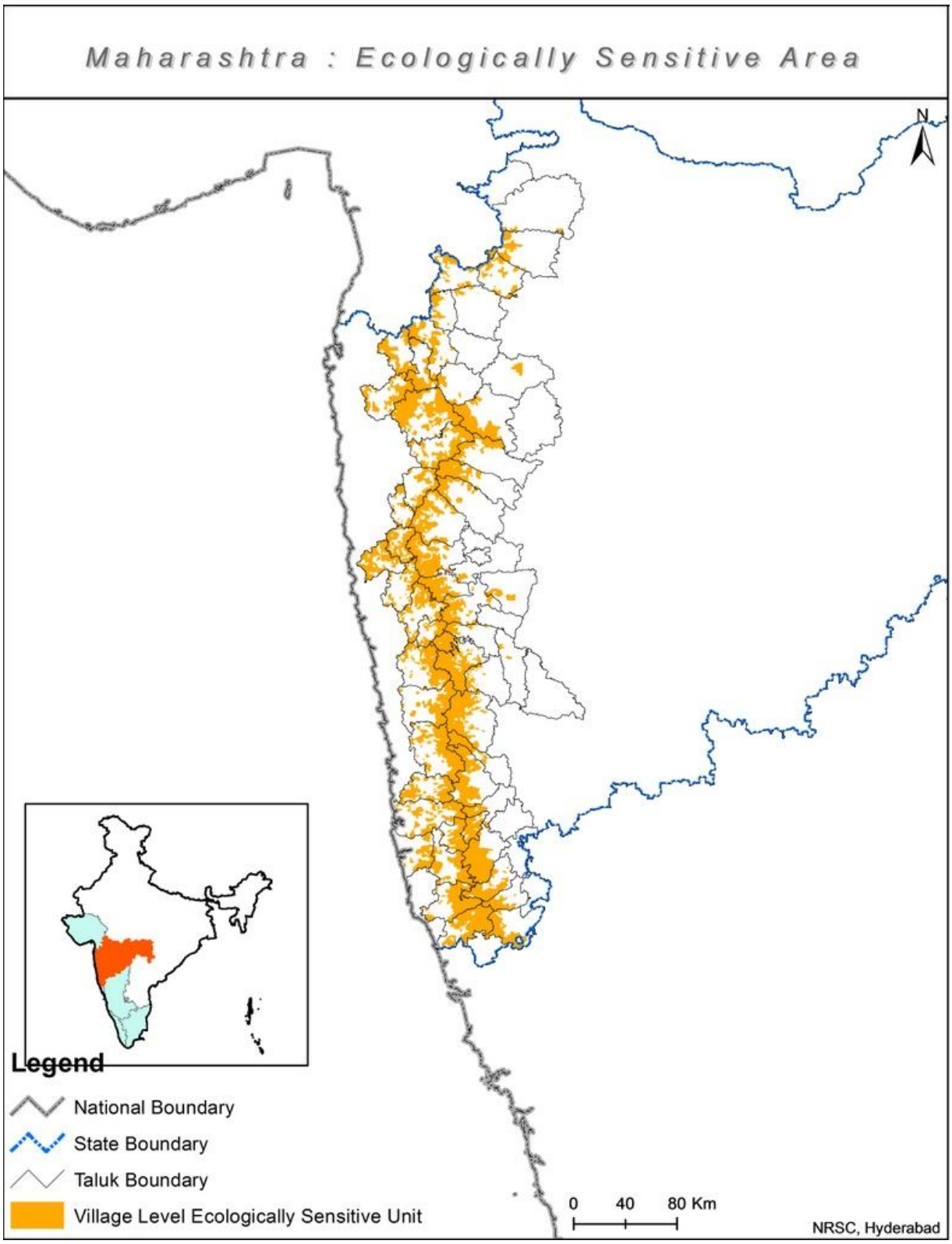

Figure 24: ESA in Western Ghats region of Maharashtra

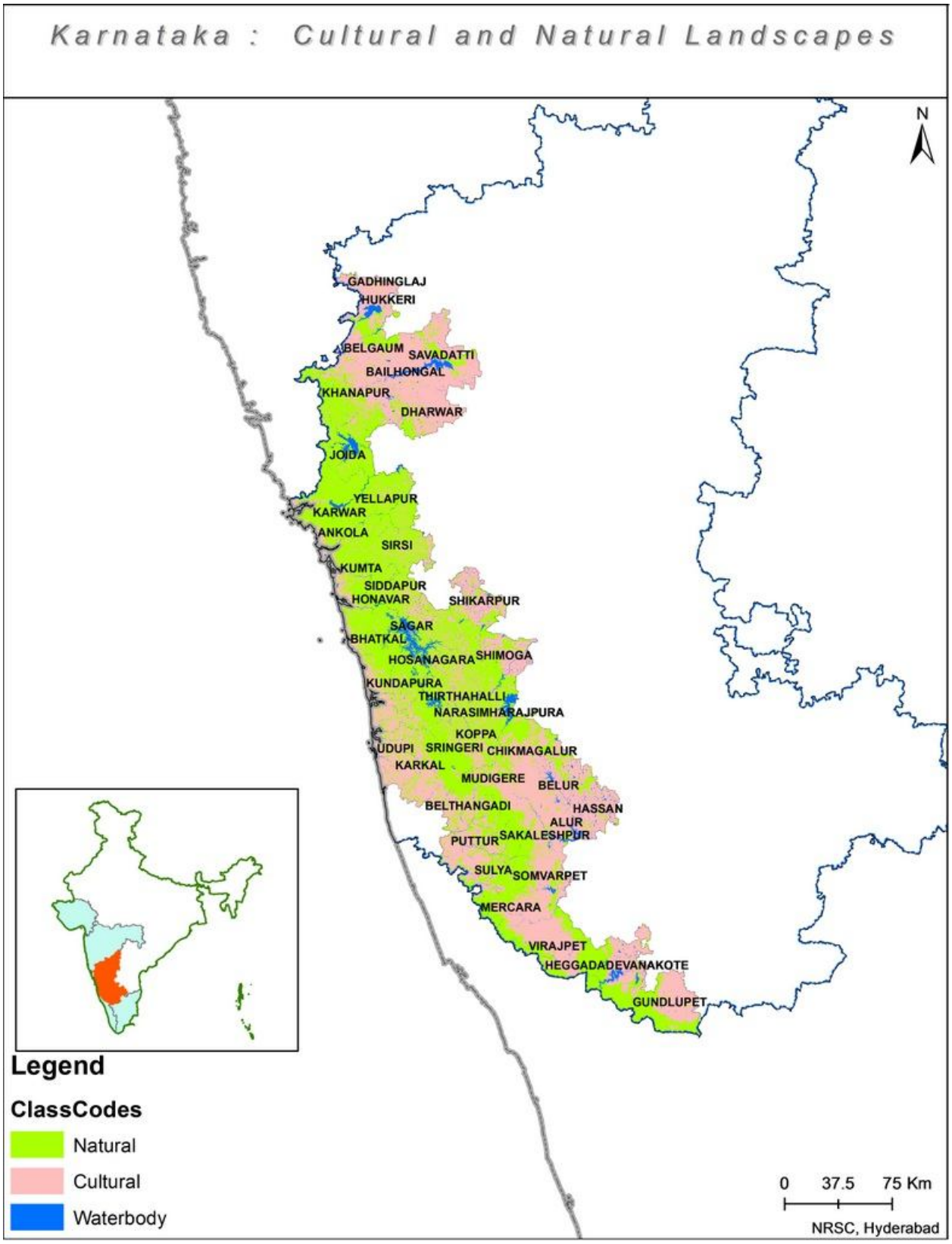

Figure 25: Natural and Cultural landscapes in Western Ghats region of Karnataka.

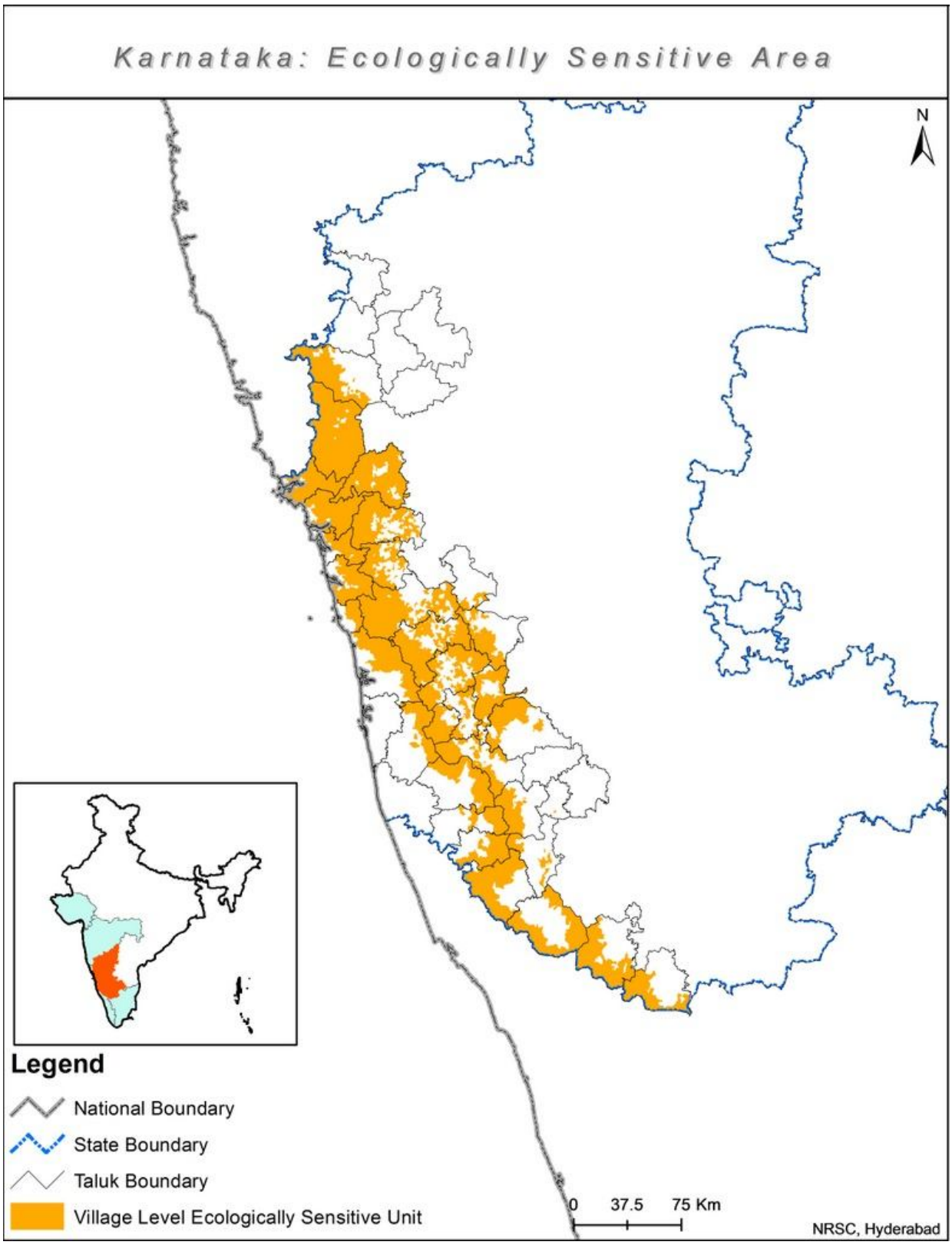

Figure 26: ESA in Western Ghats region of Karnataka.

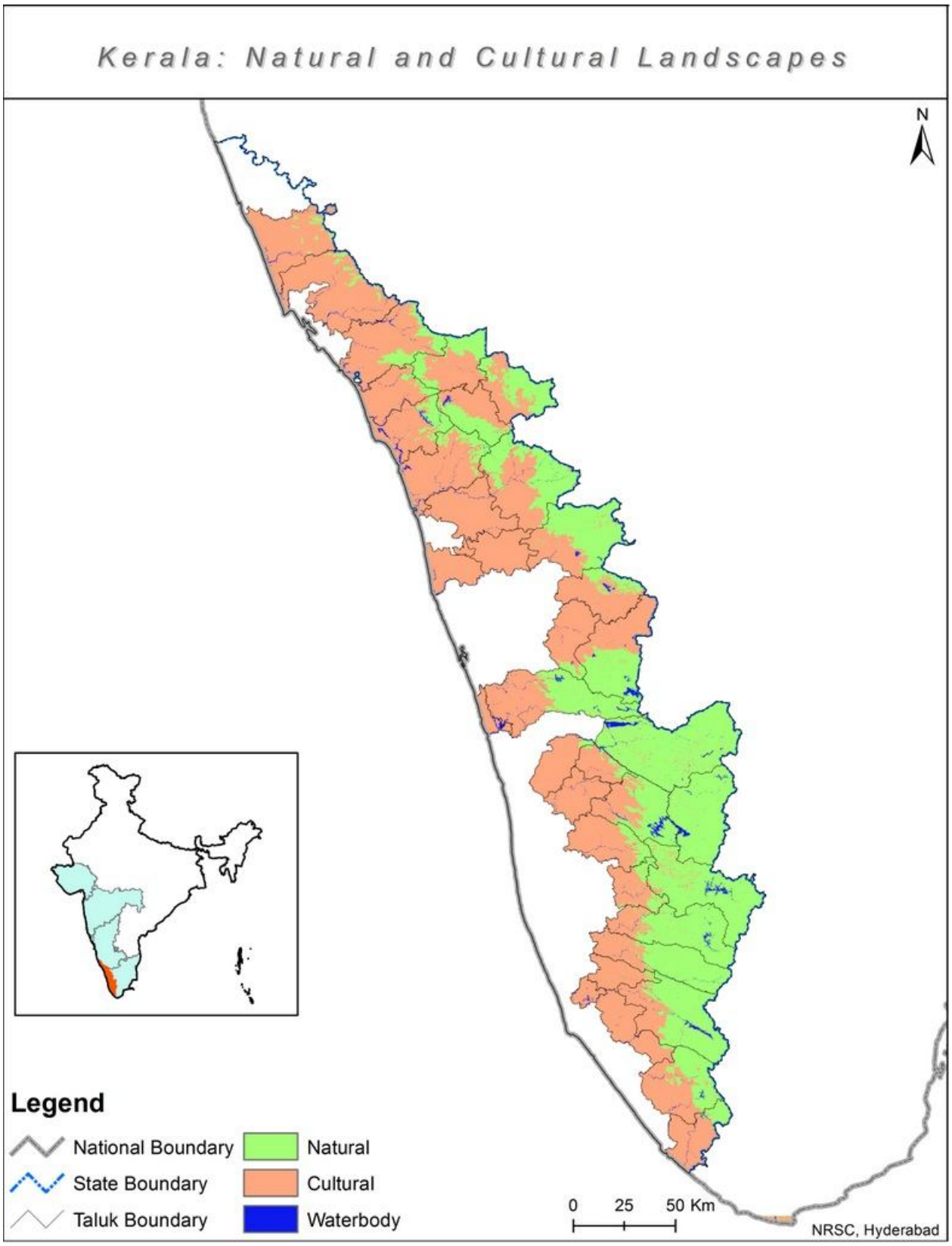

Figure 27: Natural and Cultural landscapes in Western Ghats region of Kerala.

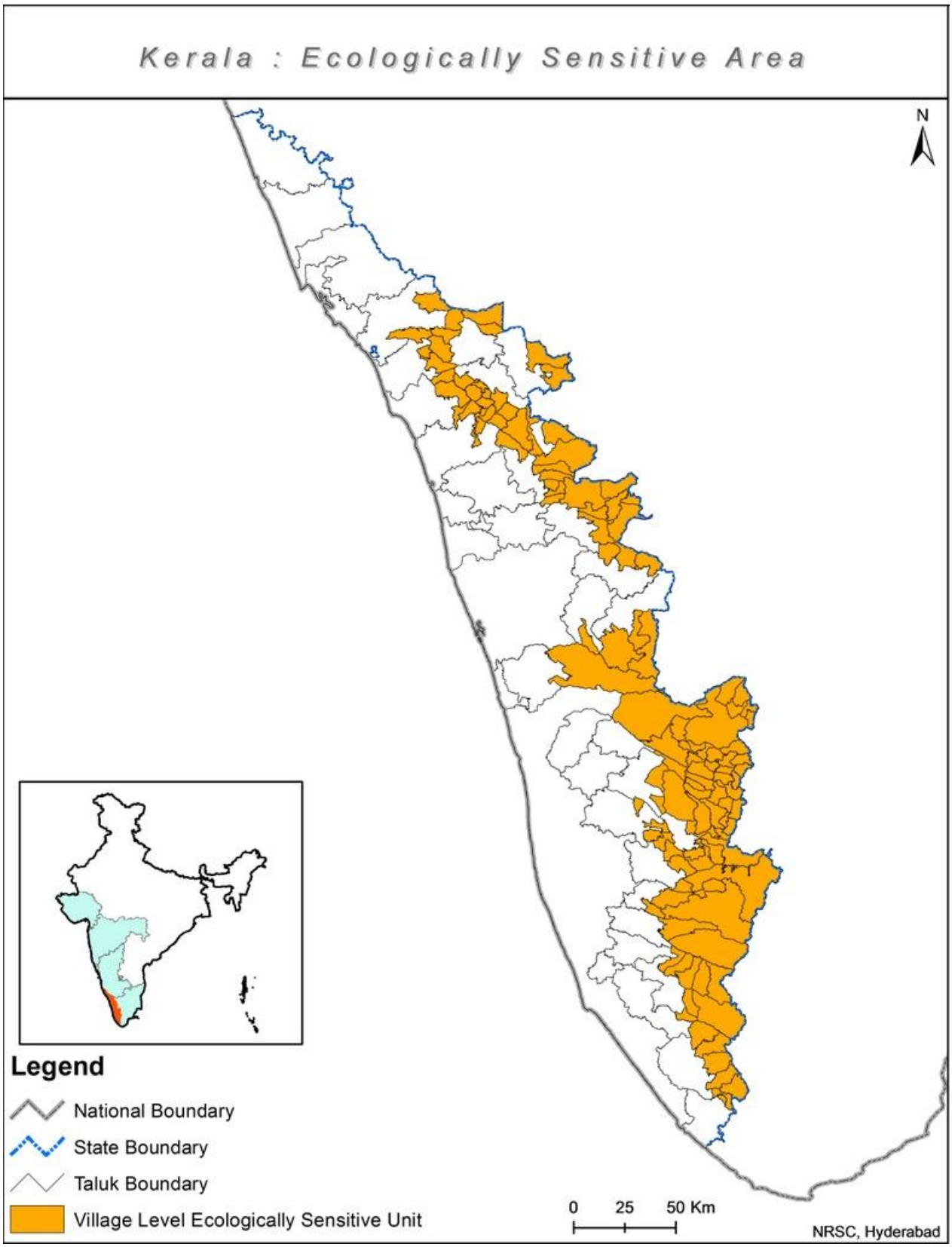

Figure 28: ESA in Western Ghats region of Kerala.

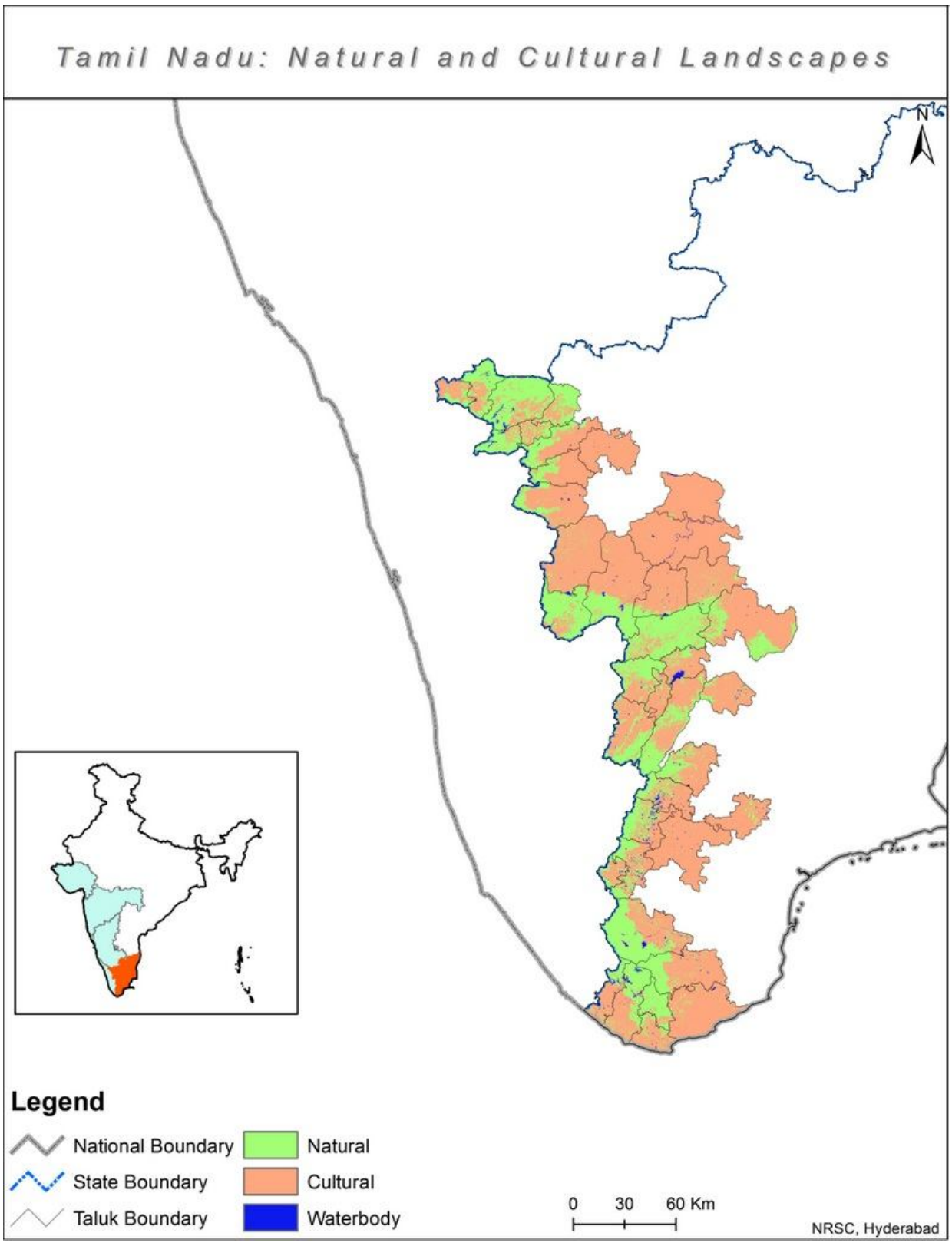

Figure 29: Natural and Cultural landscapes in Western Ghats region of Tamil Nadu.

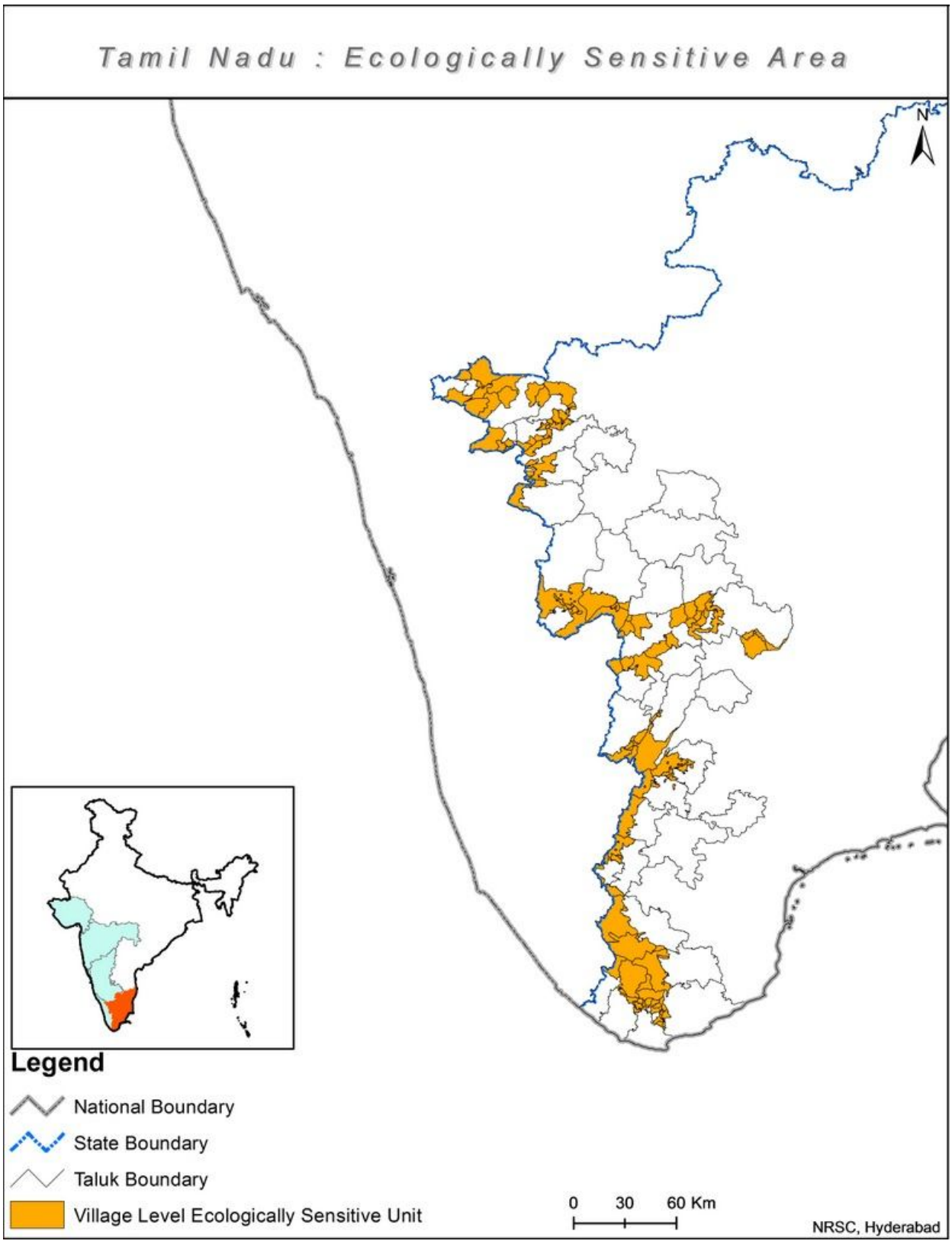

Figure 30: ESA in Western Ghats region of Tamil Nadu.

Table 6 gives statistical data on ESA, PAs+WHSs, natural and cultural landscapes geographical area of talukas falling in Western Ghats region in each of the 6 States of Western Ghats region. The State of Goa has highest percent of ESA (83.57%), of which nearly half of it is under PAs + WHS. The State of Karnataka and Kerala have high percent of area under ESA. Gujarat has least percent of ESA area.

Table 6: Area under Natural and Cultural landscapes, ESA, PAs+WHSs and total area of 'talukas' under Western Ghats region in different States of the Western Ghats region (area in km^2)

State	Total Geographic Area of State	Western Ghats Taluka Area	No. of Villages	Natural Landscape	Cultural Landscape	PA + WHS	Village Sharpened ESA	ESA to WG Taluka
Goa	3,702	1,749	99	1,558	191	655	1,461	83.57%
Gujarat	1,96,024	5,977	64	2,553	3,423	64	449	7.52%
Karnataka	1,91,791	44,448	1,576	21,529	22,919	5,660	20,668	46.50%
Kerala	38,863	29,691	123	12,477	17,214	4,913	13,108	44.15%
Maharashtra	3,07,713	55,345	2,159	21,185	34,161	2,242	17,340	31.33%
Tamil Nadu	1,30,058	27,069	135	8,947	18,122	3,369	6,914	25.54%
Grand Total	8,68,151	1,64,280	4,156	68,249	96,031	16,902	59,940	36.49%

Table 7: Number of villages with ESA in each taluka, the total geographical area of taluka and the area occupied by ESA in a taluka across the States of Western Ghats

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Gujarat	**Navsari**	Bansda	571	35	5
		Chikhli	553		
	Surat	Songadh	1,111	95	13
		Uchchhal	559	5	1
		Vyara	782	30	5
	The Dangs	The Dangs	1,700	285	40
	Valsad	Dharampur	699		
Gujarat Total			**5,976**	**449**	**64**

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Goa	**North Goa**	Satari	515	406	56
	South Goa	Kankon	362	284	5
		Sanguem	872	771	38
Goa Total			**1,749**	**1,461**	**99**

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Maharashtra	**Ahmadnagar**	Akola	1,433	453	42
		Sangamner	1,630		
	Dhule	Sakri	2,333	47	5
	Kolhapur	Ajra	498	165	20
		Bavda	265	208	24
		Bhudragad	651	319	28
		Chandgad	913	340	21
		Gadhinglaj	454		
		Kagal	536		
		Karvir	630		
		Panhala	539	140	14
		Radhanagari	912	558	34
		Shahuwadi	1,008	539	51
	Nandurbar	Nawapur	911	13	2
	Nashik	Baglan	1,400	238	15
		Dindori	1,266	42	5
		Igatpuri	838	92	8
		Kalwan	811	219	28
		Nashik	875		
		Peint	538	145	23
		Sinnar	1,292	53	5
		Surgana	802	262	42
		Trimbakeshwar	889	329	30
	Pune	Ambegaon	987	326	37
		Bhor	863	318	56
		Haveli	1,203	37	4
		Junnar	1,285	281	32
		Khed	1,373	220	22
		Mawal	1,205	511	51

		Mulshi	957	550	66
		Purandhar	1,049	85	9
		Velhe	556	325	60
	Raigarh	Karjat	634	266	45
		Khalapur	395	133	22
		Mahad	796	409	68
		Mangaon	675	238	47
		Poladpur	354	179	36
		Roha	603	383	86
		Sudhagad	444	319	52
	Ratnagiri	Chiplun	1,096	428	43
		Khed	1,026	495	74
		Lanja	744	405	47
		Pajapur	1,190	444	48
		Sangameshwar	1,244	626	80
	Sangli	Shirala	609	201	24
	Satara	Jaoli	831	582	119
		Khandala	488		
		Khatav	1,350		
		Koregaon	877	23	2
		Mahabaleshwar	243	202	40
		Patan	1,312	626	96
		Satara	842	103	25
		Wai	597	108	18
	Sindhudurg	Devgad	760	230	21
		Kankavli	792	409	39
		Kudal	834	475	48
		Sawantwadi	842	613	50
		Vaibhavvadi	414	252	34
	Thane	Jawhar	663	331	29
		Mokhada	563	291	21
		Murbad	930	475	57
		Shahapur	1,489	911	92
		Vada	801	367	62
Maharashtra Total			**55,345**	**17,340**	**2159**

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Karnataka	**Belgaum**	Bailhongal	1,101		
		Belgaum	1,006	15	1
		Hukkeri	960		
		Khanapur	1,700	857	62
		Savadatti	1,536		
	Chamaraja nagar	Gundlupet	1,377	574	21
	Chikmagalur	Chikmagalur	1,586	579	27
		Koppa	568	251	32
		Mudigere	1,139	571	27
		Narasimharajpura	800	566	35
		Sringeri	445	337	26
	Coorg	Mercara	1,441	963	23
		Somvarpet	1,013	193	11
		Virajpet	1,661	926	21
	Dharwar	Dharwar	1,095		
	Hassan	Alur	429	2	1
		Belur	842		
		Hassan	927		
		Sakaleshpur	1,021	408	34
	Karwar	Ankola	905	809	43
		Bhatkal	342	185	28
		Honavar	718	561	44
		Joida	1,861	1,835	110
		Karwar	703	628	39
		Kumta	553	374	43
		Siddapur	851	535	107
		Sirsi	1,300	903	125
		Yellapur	1,293	1,168	87
	Mangalore	Belthangadi	1,387	633	17
		Puttur	1,029	331	11
		Sulya	846	479	18
	Mysore	Heggadadevanakote	1,616	844	62
	Shimoga	Hosanagara	1,406	1,069	126
		Sagar	1,918	1,363	134
		Shikarpur	901	98	12
		Shimoga	1,099	477	66
		Thirthahalli	1,233	853	146

	Udupi	Karkal	1,361	450	13
		Kundapura	1,554	834	24
		Udupi	926		
Karnataka Total			**44,448**	**20,668**	**1576**

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Kerala	**Ernakulam**	Kothamangalam	316		
		Kunnathunad	476		
		Muvattupuzha	449		
	Idukki	Devikulam	1,808	1,808	13
		Peerumade	1,310	1,146	8
		Thodupuzha	888	463	4
		Udumbanchola	1,094	1,094	23
	Kannur	Taliparamba	1,329		
		Thalassery	1,212	304	3
	Kasaragod	Hosdurg	976		
	Kollam	Kottarakkara	571		
		Kunnathur	143		
		Pathanapuram	1,271	942	8
	Kottayam	Kanjirappally	429	51	1
		Meenachil	689	106	3
	Kozhikode	Kozhikode	1,031	234	5
		Quilandy	745	170	2
		Vadakara	580	112	2
	Malappuram	Ernad	816		
		Nilambur	1,383	1,012	10
		Perinthalmanna	511		
		Tirur	418		
	Palakkad	Alathur	578	66	1
		Chittur	1,170	648	3
		Mannarkad	1,226	857	7
		Palakkad	726	272	3
	Pathanamthitta	Adoor	336		
		Kozhenchery	958	616	2
		Ranni	1,097	924	4
	Thiruvananthap*	Nedumangad	957	457	4
		Neyyattinkara	585	165	3
	Thrissur	Kodungallur	150		
		Mukundapuram	1,326	708	1

	Wayanad	Mananthavady	749	364	4
		Sulthanbathery	770	301	2
		Vythiri	619	287	7
Kerala Total			**29,693**	**13,108**	**123**

State	District	Taluka	Taluka Area (km^2)	ESA	No. of Villages with ESA
Tamil Nadu	**Coimbatore**	Avanashi	656		
		Coimbatore north	525	150	4
		Coimbatore south	827	140	2
		Mettupalayam	625	205	10
		Pollachi	1,168		
		Udumalaipettai	1,460	460	7
		Valparai	712	528	7
	Dindigul	Dindigul	1,451	327	5
		Kodaikanal	1,048	500	9
		Oddanchatram	782	70	1
		Palani	711		
	Erode	Dharapuram	1,412		
		Kangeyam	823		
	Kanniyakumari	Agastheeswaram	340	2	1
		Kalkulam	703	286	4
		Thovala	325	298	14
		Vilavancode	378	79	1
	Madurai	Usilampatti	505		
	The nilgiris	Coonoor	199	18	2
		Gudalur	472	413	5
		Kotagiri	400	239	7
		Kundah	309	233	5
		Panthalur	268	92	1
		Udhagamandalam	924	480	5
	Theni	Andipatti	941	311	1
		Bodinayakanur	545	263	3
		Periyakulam	392		
		Theni	250		
		Uthamapalayam	781	167	7
	Tirunelveli	Ambasamudram	1,225	639	5
		Nanguneri	921	272	2

	Radhapuram	1,003		
	Sankarankoil	1,058		
	Shenkottai	210	74	5
	Sivagiri	537	187	1
	Tenkasi	519	149	5
Virudhunagar	Rajapalayam	514	126	5
	Sattur	499		
	Srivilliputhur	654	207	11
Tamil Nadu Total		**27,069**	**6,914**	**135**

5.5 Peer Review on delimitation of ESA in Western Ghats region

A 3-member Peer Review Committee consisting of Dr Y.V.N. Krishnamurthy, Director, IIRS (Chairman), Dr V.B. Mathur, Dean, WII and Dr Subhash Ashutos, Professor, IGNFA was constituted by HLWG to review the geospatial analysis carried out by National Remote Sensing Centre (NRSC) for identification of ecologically sensitive areas in the Western Ghats region and also to provide comments on the draft Chapter 4 (Definition and delimitation of Western Ghats Region) and Chapter 5 (Identification of Ecologically Sensitive Areas in the Western Ghats region)of the Report of HLWG.

The Committee met on 4 April 2013 at the Indian Institute of Remote Sensing, Dehradun. The meeting was also attended by other experts of IIRS in areas of geospatial analysis, forestry and ecology – Dr S.K. Srivastav, Dr S.P.S. Kushwaha and Dr Sarnam Singh. Dr C.S. Jha and Shri G. Rajasekhar from NRSC presented the databases utilized and methodology adopted in identifying the Ecologically Sensitive Areas (ESAs) in the Western Ghats region.

Based on the discussions held in the meeting and information presented in Chapter 5, the Committee made the following comments (Appendix 1):

"It is noted that the primary inputs used for identifying ESAs are taken from DOS-DBT project on "Biodiversity Characterization at Landscape Level" (BCLL), in which different spatial layers, example vegetation type and

landcover, biological richness, forest fragmentation, etc. were generated on 1:50,000 scale using IRS LISS-III images and ancillary data. These inputs are appropriate for identifying the ESAs as they are the best possible seamless datasets available at present with acceptable accuracy. The biological richness and forest fragmentation layers along with population density, village boundary, Protected Area (PA) and World Heritage Site (WHS) maps have been used to identify the ESAs using a suitable decision matrix".

The effort made by the Task team in carefully collating and analyzing the best possible/available datasets for identifying the ESAs is appreciable. The datasets used are adequate and approach followed for geospatial analysis is technically sound in meeting the objective of identifying the ESAs. Further the large area covered for analysis in limited time frame is also commendable.

The Committee also concluded: **"that the datasets used and methodology followed for geospatial analysis within the given timeframe and resources are adequate for identification of ESAs in the Western Ghats region".**

However, the Committee also suggested to provide logic for using certain criteria in the analysis such as: (i) the use of population density of <100 per km^2 as a layer in identifying ESA, (ii) the inclusion of forest fragmentation in biological richness, and (iii) sources of primary and secondary data used in the analysis. They also made some minor corrections in the Chapters 4 and 5 of the Report. These are adequately addressed at appropriate places in Chapters 4 and 5.

The Committee also mentioned that the State Governments: (i) must also ensure protection of wildlife corridors while implementing the programmes for conservation and preservation of ESAs, and (ii) may use forest type map published by Forest Survey of India on 1:50,000 scale for final refinements and prescriptions for conservation of ecological sensitive forest type and rare and threatened endemic species (Appendix 1).

5.6 Conclusions

(i) The total area (1,64,280 km^2)under Western Ghats region as defined by HLWG is higher than that reported by WGEEP. The area under ESA (59,940 km^2) is about 90% of the total area under natural landscape (68,249 km^2); the ESA (including PAs and WHS) constitutes 36.49% of Western Ghats area; The demarcation unit of ESA is the village.

(ii) IRS LISS III derived spatial layers on vegetation type and landscape level indices (with a fine spatial resolution of 24m) were used as the basis for identification of ecologically sensitive areas (ESAs). The LISS-III sensor is a sensor of choice for natural resource management studies at a mapping scale of about 1:50,000. The spectral and spatial resolution of this sensor captures the vegetation types even at small patch size (≈ 1 Ha). Typically this sensor is not used for village/micro level studies; however this sensor was employed for delineation of ecosensitive area because of its compatibility with the scales available for other collatoral data and also given the large area to be covered with a consistent time base.

(iii) The landscape indices (biological richness and forest fragmentation), derived from the geospatial analysis of IRS LISS-III satellite data include details on species richness of vegetation, endemicity, ecosystem uniquness, disturbance indicators, adjacency and patch characteristics. This enabled delineation of ESAs in a objective and scientific fashion at a much finer scale with village as a unit and thus paved the way for actionable and implementable approach for the conservation of ecology and equitable and sustainable development of WG, as envisaged by WGEEP. The model developed in this Report and authenticated by a Peer Review Committee consisting of experts can be replicated elsewhere at the national and regional levels.

(iv) The exclusion of large cultural landscapes enable protection of ecologically sensitive natural landscapes outside PAs and WHS effectively and make them conflict free.

(v) The remote sensing derived vegetation maps are not without limitations. For instance under-story plantations (for eg. cardamom) or naturalized forest

plantations cannot be discriminated. The natural landscape identified, however, are still conservative.

(vi) Wildlife habitats are not explicitly included in the demarcation of ecologically sensitive areas; the forested and natural landscapes are the best available fine resolution and spatially consistent proxies in the absence of high resolution data on faunal distributions. We have added all protected areas and world heritage sites, and the combination of the two data sets account for all habitats. Further, tiger and elephant corridors are also overlaid on ESA.

(vii) The village boundary layer taken from Survey of India and the derived aereal extents are indicative.

(viii) The ESA identified, may be notified by MoEF with development restrictions proposed in Chapter 6.

(ix) It may be noted that PAs and WHSs and Reserve Forest Areas (RFAs) are included in ESAs. These are regulated by the extant provisions of the Indian Forest Act, 1927, Indian Wildlife (Protection) Act, 1922 and the Forest Conservation Act, 1980 and their amendments thereof. Inclusion of these areas under ESA provides additional protection to them.

(x) The State Governments should also ensure consultation with local communities while planning for protection of wildlife corridors.

(xi) The State Governments may also use the recently published forest type map by FSI in 1:50,000 scale for finer refinements and prescriptions for conservation of ecologically sensitive forest types. *(and rare and threatened endemic species)*.

(xii) **The conclusions on the delineation of ESA presented in the Report are based on the best of the contemporary analytical approaches and latest databases. Therefore, there is high confidence in the details used in the demarcation of ESA in WG region.**

CHAPTER 6

The Paradigm for Sustainable and Inclusive Development and the Framework for Governance

6.1 Introduction

The Western Ghats is a biological treasure trove that needs to be protected and regenerated, indeed celebrated for its enormous wealth of endemic species and natural beauty. The analysis of current land-use data, using remote sensing technology at 24-meter resolution, reveals that already close to 60 per cent of the area defined as Western Ghats is under cultural landscape. The cultural landscape – as different from natural landscape – is human dominated land use of settlements, agriculture and plantations (other than forest plantations). Therefore, only 41 per cent of the land area can be currently classified as natural landscape – with different classes of vegetation cover and medium to high biological value.

The biologically rich area, with some measure of contiguity is roughly 37 per cent of the Western Ghats boundary – roughly 60,000 sq km. The HLWG has recommended designation of this identified area as, Ecologically-Sensitive Area (ESA).

The message of this report is serious, alarming and urgent. It is imperative that we protect, manage and regenerate the lands now remaining in the Western Ghats as biologically rich, diverse, natural landscapes. We have reached a threshold, from which we cannot slip further. This has to be the objective of future planning and regulation in this recognized center of biodiversity in our country.

What is also clear is that natural landscapes face unprecedented threats because of development projects and urban growth. HLWG emphasizes a non-tolerance policy with respect to highly interventionist and environmentally damaging activities like mining or polluting industries. The HLWG also proposes to bring specific

recommendations about prohibited activities and those that require high level of scrutiny and assessment before clearance.

HLWG recognizes that the proposed non-permissible activities may not be enough to fully manage the environmental fallout of development. However, it is also clear that management through prohibition and fiat is often detrimental to the interests of the very people and environment policy is aiming to protect. Therefore, we need a balanced and nuanced approach to say no to the most damaging and high impact activities and at the same time working of systems to incentivize environmentally sound development that benefits local livelihoods and economies.

It is important to note that the Western Ghats even in the areas, categorized as natural landscapes, is inhabited. It is not wilderness area, but the habitat of its people, who share the landscape with biological diversity. It is not possible to plan for Western Ghats, only as a fenced-in zone, with no human influence. This is the difference between the natural landscapes of a highly populated country like India, against the wilderness zones of many other countries.

Within the area defined as ESA, there are some 4156 villages. The villages included have 20 per cent of more of ecologically sensitive area within their boundary. The people living in these settlements have undoubtedly built a deep relationship and coexistence with the natural environment. However, these practices need to be supported and incentivized. People living within the rich biodiversity have nurtured nature. They must benefit from conservation. This should be the aim of future programmes.

The area defined as ‘cultural’ has been deliberately identified and segregated from the ‘natural’ landscape. This does not mean that these settlements, plantations or agricultural fields do not co-exist on the biological diversity of the natural area or that these areas have an open license to pollute or degrade the environment. It is for

this reason that HLWG proposed to recommend a higher level of scrutiny and monitoring for projects within 10 km of the ESA.

HLWG also recognizes that this cultural landscape is biologically rich. For instance, the coffee plantation areas of Kodagu have high biological diversity in the cultural landscape. The sacred groves of many settlements are scattered and so not detectable through remote sensing. But these groves are the most abiding symbols of people's belief in the protection of nature. HLWG has recommended policies to incentivize these practices so that growth across the Western Ghats can be environmentally sound.

This is the opportunity for the future. The Western Ghats, are recognizably, one of the world richest regions of biodiversity. The economic growth in these regions comes from natural endowment – the water that irrigates the commercial plantations or rich manure that fertilizes the agricultural fields, the forest wealth that brings industry or tourism that generates jobs. The future lies in working on green growth strategies that build on the natural endowment to create a vibrant economy. This Chapter provides prescriptions for sustainable and inclusive development framework for governance in Western Ghats region.

6.2 WGEEP recommendations for sector level planning and their implications

The WGEEP has recommended guidelines for sector-wise activities, which would be permitted in categorized ecologically sensitive area of the region. In this way, regions with the highest ecological sensitivity would have restricted developmental activities – from a total ban on mining to large hydroelectric projects or inter-basin transfer of water and even plantations. The listing is comprehensive and provides an important direction to what will constitute environmentally sound development in this ecologically rich region. The question is how such a development plan will be implemented. Furthermore, it is also important that environmentally sound development should be incentivized and not only practiced through fiat.

It is also clear that this recommendation of the WGEEP has evoked the strongest criticism from many quarters. There is apprehension that this 'blanket prescription' could be detrimental to economy and livelihoods. For instance, the Kodagu coffee growers and planters association made a strong representation to the High Level Working Group that the district should be kept out of the Gadgil committee recommendations. Their argument was that they have a strong tradition of cultivation of coffee, cardamom and other crops. They practice techniques, which protect the soil, recharge groundwater through ponds and use organic manure. Their way of life is not harmful to the environment.

While WGEEP does not contain a specific reference to plantations in Kodagu, the sector wise guidelines stoke fears of selective interpretation and misuse. In this case, WGEEP specifies that in ESZ1/ESZ2 change in land use would not be permitted from forest to non-forest uses or agriculture, except where it is needed for extension of village populations. It also specifies that even on private lands, there will be no monoculture plantation of exotics like eucalyptus and existing plantations should be replaced by planting endemic species. Therefore, even though, there is no detailed description of the ecological problems of coffee, the implication of this recommendation is that all plantations would have to be replaced with natural forests in the foreseeable future. This is clearly unacceptable to the plantation owners.

It is important to consider that environmentally sound development cannot preclude livelihood and economic options for this region. The role of plantations in the local ecology and economy is critical. The answer will not lie in removing these economic options but in providing better incentives to move the plantations towards greener and more sustainable practices. The plantation owners of Kodagu (as well as the entire region) have challenges – labour shortage is growing and they do not the premium for organic and certified products without expensive

certification. There is also no clear incentive to move towards organic plantations in the domestic market. These issues need to be addressed.

It is also a fact that permit-based regulations are often open for misinterpretation and misuse. A similar issue was raised with the High Level Group on its visit to Maharashtra, when officials explained that there was concern that the WGEEP, if implemented could lead to complete halt of all economic activity. "It would condemn people to live in stone-age". According to them, the guidelines would not allow for any infrastructure development, from renewable energy to inter-basin transfer of water. This would be a problem, they explained, as many regions of the Western Ghats lie in the rain shadow area and need water to be diverted for irrigation and drinking. Clearly, their concern was the impact of the sweeping nature of the recommendations on the region's economy.

It is not possible to design an effective framework for sustainable development based on such an approach. For instance, WGEEP has discussed at length the specific problem of a private windmill project, which was allowed in the Bhimashankar Wildlife Sanctuary. This project was unsanctioned and has had a hugely adverse impact on the rich biodiversity of the sanctuary, which is also home to Maharashtra's state animal, the Malabar Giant Squirrel. The project has lead to large-scale erosion and landslides in the area. This observation has led the committee to recommend that there "should be no large scale wind power projects in ESZ1 and projects after cumulative environmental impact assessment in ESZ2 and ESZ3." It is clear that while the Committee has not recommended a blanket ban, the application is open to misinterpretation. It is obvious that the wind energy projects should be brought under the purview of environment and forest clearance (EC and FC)– which is currently not the case. It is also obvious that wind energy projects should not be allowed in ecologically fragile areas, where there is possibility of irreversible damage. Similarly, it is clear that large -scale water diversion projects, which have impacts on the environment and forests, should not be allowed. However, this recommendation should not imply that all water

diversion would be stopped even without any study or scrutiny about the individual project or cumulative impact of the projects.

What particularly concerns the HLWG is that these rules could easily work against the very communities – poor tribal and agriculturists – whose interest WGEEP is working to safeguard. For instance, WGEEP refers to the confusion created because of the rules issued for Ecologically Sensitive Zones (ESZ) near protected areas. It finds that the rule, no artificial lighting will be used in ESZ has been interpreted by forest department to imply that no kerosene or oil lanterns are allowed inside homes located within 10 km of the protected area. "The only fallout of such a programme is that the poor suffer harassment and extortion while the wealthy and powerful successfully flout the regulations", rightly observes WGEEP. This is what needs to be avoided as far as possible in the regime of management that is implemented for the Western Ghats.

6.3 Sector Level Planning

The HLWG is of the view that the vision of what constitutes environmentally sound and inclusive development is not in dispute. What is in dispute is as follows:

a. How can environmentally sound growth be promoted – what are the policies needed to encourage development that is inclusive and also sustainable and equitable in this ecologically rich region?
b. How can the adverse impacts of development projects be rigorously assessed and regulated. What are the institutions of governance that are required to ensure compliance? Should we agree to set up another institution, which will regulate and permit development in the Western Ghats, modeled on the Coastal Zone Authority (as recommended by WGEEP)? Or should the effort be to strengthen the existing institutions and regulations for effective functioning?
c. How can development be based on decentralized planning and decision-making? In other words, how can local communities including tribals play a

greater role in discussing and deciding on the economic future of the region, which is classified as ecologically sensitive?

HLWG has used high resolution mapping to segregate land use classes in the Western Ghats. This has allowed it to separate the natural landscape from cultural landscape – settlements, commercial plantations and agriculture. The ESA is the presently available medium and high biodiversity region in the Western Ghats. This identified area must be conserved and regenerated and further depletion or degradation must not be allowed. In the Eco-Sensitive Area (ESA), there is a need to maintain integrity of the natural systems. In this region, minimal disturbance will be allowed. It is for this reason that the ESA will not be open to polluting industry, mining or thermal power plants. All other infrastructure development, necessary for the region, will be carefully scrutinized and assessed for cumulative impact and development needs, before clearance.

In this way, HLWG has deviated from WGEEP by not recommending a blanket prescriptive on what constitutes good development, which will be implemented through a prohibitory regime. Instead, HLWG has considered and recommended prohibitory and regulatory regime only for those activities with maximum interventionist and destructive impact on the ecosystem. These activities, as listed below, will be prohibited in the area classified as ESA in this report.

It is our understanding that other economic sectors, such as land use, agriculture or forestry, can best be approached through programmes that provide incentives to change practice. It therefore, recommends that state governments should take into account the need for green growth in the entire Western Ghats during the preparation of regional plans. The regional plan will provide the opportunity to plan for other sectors such as land use, agriculture, water and forestry.

6.4 Development restrictions in ESA

6.4.1 In the area classified as ESA, including its settlements, the following development restrictions will apply:

Mining: Complete ban on mining, quarrying and sand mining in ESA. All current mine areas will be phased out within the next 5 years, or expiry of mining lease, whichever is earlier.

Power/Energy, including hydropower and wind: No thermal power projects will be allowed; hydropower projects must be based on conditions of ecological flow and distance (as provided in section 6.3.2) and will be subject to environment and forest clearance. All projects will require cumulative impact assessments before appraisal.

Industry: All 'Red' category industries will be strictly banned.

Settlements: Building and construction projects of 20,000 sq. m and above will not be allowed. Townships and area development projects will be prohibited.

Other infrastructure and development projects/schemes: Will be subject to environment clearance under Category 'A' projects.

Additional safeguard for forest diversion in ESA: In cases of forest clearance required in ESA, all information of the project, from application stage to approval will be put in the public domain – on the website of MoEF and of the respective forest department of the State. This transparency will add to the scrutiny of the projects, particularly in light of the fact that all information on the ESA will also be in the public domain.

6.4.2 Mining

The mining sector is categorized as 'red' industry and therefore, would be prohibited in the Eco-Sensitive Area of the Western Ghats. It is also clear that this sector has grown without consideration for impacts on the ecology and livelihood

security. The unplanned and unregulated boom in the mining sector have led to protests, which in turn, had resulted in bans and prohibitions in different states. Quarrying and sand mining will also be banned in ESA.

HLWG has received many representations regarding the problems created because of the ban on mining on the availability of laterite stone used for local building purposes in Sindhudurg and Ratnagiri districts of the Western Ghats. HLWG has considered this demand and while it understands the concerns regarding cost of material for housing in this region, it finds that it is unable to make an exception for this material to be mined in ESA. It believes that as the area of ESA has been accurately defined, there will be areas outside which can be used for laterite mining. However, it would recommend that the state government must enforce strictly the guidelines for mining in all cases, including laterite mining.

6.4.3 Power/Energy, including hydropower and wind

Hydroelectric projects, proposed and planned in the forested regions of the Western Ghats have often come in for opposition. It is clear that as much as the country needs hydroelectric power, which is renewable and clean, but it also needs to balance this requirement with the loss of biodiversity in forests and the need for ecological flow in rivers. Both are essential components and policy must determine that these elements are safeguarded. It is also clear that rivers in India play more than just basic ecological functions. These are lifelines for local livelihood, nutrition and water security. The desire to use the river for generating electricity cannot be at the cost of the value of the river. It is this balance that needs to be maintained.

In fact, the potential of hydroelectric power has remained the sole driver for management of the river, particularly in its upper reaches. In the lower reaches, the use of the river for large-scale water diversion projects for irrigation and industrial uses becomes the criterion for development. But these single focus objectives must be enlarged so that the competing – and often the primary needs – can be taken into account at the time of planning and management.

It is also clear that rivers do not know boundaries. Therefore, the conditions for hydropower will be stipulated for the entire Western Ghats and not just for ESA.

HLWG recommends that future hydroelectric projects in the ESA and the entire Western Ghats must only be considered on the basis of the following policies:

a. Hydropower development must be based on the acceptance of uninterrupted ecological flow at 30 per cent level of the rivers flow in lean seasons till a comprehensive study establishes individual baselines. The 30 per cent ecological flow is mandated in Western Ghats keeping in mind the shorter length of rivers in this region. The compliance with this condition will require rigorous and seasonal data collection in upper reaches of rivers to prepare a hydrological mapping of the basin. It is also clear that this hydrological assessment is critical given the changes in rainfall patterns because of climate change.
b. Hydropower projects must be considered only after a cumulative impact assessment on the flow pattern of the rivers and forest and biodiversity loss. Currently, individual projects are planned and executed without consideration of these impacts. The Environment Assessment Committees will only consider proposals for individual projects after cumulative impacts have been studied.
c. Current and future hydropower development in the Western Ghats must be based on clear rules that stipulate distance between projects and that do not allow for over-exploitation of the basin. The minimum distance between projects must be maintained at 3 km in most cases (shorter distance requirement because of the short length of the rivers in Western Ghats as compared to other regions) and not more than 50 per cent of the river basin should be affected at any time. This will require reworking the current projects to provide for optimized energy generation but it is necessary given the need to balance development with ecology.

d. Better and more balanced planning for hydropower will lead correct tariff of energy, taking into account the cost of raw material of water. Energy costs, world over, take into account the cost of raw material. It is imperative that the current subsidies and distortions in raw material supply for energy are minimized. It is in this context that water, as the raw material for generation of hydropower, must be factored in the project design. The ecological, social and cultural health of the river is a price that cannot be discounted at the time of planning for the feasibility of power.
e. There is a need to redesign and reevaluate small hydropower projects – below 25 mw as these often have limited impact on energy generation and can lead to huge impacts on ecology. The rationale for small projects must be considered within a policy framework, which provides for mini-grids and local energy distribution.

Thermal power projects are categorized as 'red' and therefore would not be permitted in the Eco-Sensitive Area.

However, wind energy projects are allowed, conditional to study of environmental impact. HLWG recommends that wind energy should be included in EIA notification and brought under purview of assessment and clearance. It is only when the impacts are understood and efforts made to mitigate damage – both environmental and social – that this sector can grow.

6.4.4 Industry

Under the Water (Prevention and Control of Pollution) Act 1974 and Air (Prevention and Control of Pollution) Act 1981, all industrial and development projects are categorized as red, orange, green. Industries categorized as red or orange have a high pollution load and environmental impact. In the Eco-Sensitive Area of the Western Ghats, red category industry will be completely prohibited.

As the list of industries categorized as 'orange' includes many activities like food and fruit processing there will not be a complete prohibition on this category. But all efforts should be made to promote industries with low environmental impact. The mandatory Consent to Establish (CTE) given by the State Pollution Control Board under the Water, Air Act and Hazardous Waste Rules before a unit can be established must take into account this condition. The proposed Decision Support and Monitoring Centre for Western Ghats will put on its website all industrial units, which have been granted permission to establish and operate in ESA. In case if there is a breach on regulation cases to the CTE condition stipulated for industries with low environmental impact, MoEF may consider imposing ban on orange category industries in the ESA based on the information provided by the proposed Centre.

6.4.5 Settlements

Under EIA notification 2006, there are two levels of regulations for settlements, to ensure that urban growth is managed and is sustainable:

- building and construction projects above 20,000sq. m and below 1,50,000 sq. m, which are categorized as 'B' and require clearance from the State Environment Impact Assessment Authority (SEIAA).

- township and area development projects with built up area of above 50 ha and above 1,50,000sq. m are categorized as B1 and require detailed environmental impact assessment and clearance from State Environment Impact Assessment Authority (SEIAA).

In the ESA, which is well-defined area, emanating from the natural landscape of the Western Ghats, building and construction projects 20,000sq. m and above will not be allowed. Townships and area development projects will be prohibited. Therefore, only projects, which are not currently under the EIA notification and therefore, not considered to have adverse impacts on the environment, will be permitted.

6.4.6 Infrastructure including transport

There is no doubt infrastructure is critical for economic growth and livelihood security in any region. But the question is how impacts can be mitigated and most importantly, how the infrastructure development can be planned so that it is cognizant of the biodiversity value of the ecosystem. The important requirement is to strengthen the public hearing and environmental assessment procedures so that people's concerns are heeded and there is careful scrutiny of impacts.

It is also important that cumulative impacts of the development projects are considered before moving ahead. HLWG recommends that all proposed infrastructure projects, including transport, must be considered only after cumulative impacts are studied and assessed. All these projects will be considered by the Central government under Category A.

Railway projects do not require EIA clearance. It is also clear that railways, while providing an environmentally sound transport option, can have major implications on wildlife, forests and biodiversity. In the recent past, many incidents of accidents involving wild animals because of railways has come to light. It is clear that future planning for railways must be cognizant of environmental safeguards.

6.4.7 Additional safeguard for forest diversion in ESA

Within the ESA, forest landscapes are a key component. It is clear that forest clearance will need careful scrutiny and assessment to ensure that the area under ESA is not decimated or degraded further. The HLWG has already recommended for development restrictions, in which case, no forest clearance can be given. But there will be other cases, such as infrastructure projects, which will need to be considered for approval.

In all these cases of forest clearance required in ESA, all information of the project, from application stage to approval will be put in the public domain – on the website of MoEF and of the respective forest department of the State. This transparency will

add to the scrutiny of the projects, particularly in light of the fact that all information on the ESA will also be in the public domain.

6.5 Incentivizing green growth in Western Ghats

6.5.1 Forest management for inclusive development

The rich ecological diversity of the Western Ghats is intrinsically linked to the forest wealth of the region. Water security of the region is also linked to the forest wealth. Equally importantly, economic and livelihood options are enjoined to forest wealth. Therefore, the imperative to protect, conserve, regenerate and grow forest wealth in this region cannot be underestimated or undermined. The objective has to be to build an effective framework of governance and management, which will allow for this resource to be both protected as well as sustainably utilized for livelihood security. It is clear that regime for forest management will determine the economic future of the region. This is what needs to be reviewed and reworked.

The Decision Support and Monitoring Centre for Western Ghats should study and suggest policies on the following:

Integrate forest accounts, including measurement of the tangible and intangible benefits into state and national economic assessment. It is time to re-position renewable resources like forests in the economic and development discourse of the country. Today the constituency for the protection of forests is shrinking. This is when the forestlands of India are under huge threat. Over time, the infrastructure imperative will take away forests, which are the last remaining common lands in the country. At the very outset it is important to value benefits derived from forests and to incorporate this into state and national accounts. But this valuation must not stop at carbon storage or other important intangible benefits of forests. It must account for the million reasons why forests play critical roles in the current livelihood support of people.

Improve productivity of forests for economic benefits for local communities. It is important to improve the productivity of forests for economic benefits. The region needs to plant, to harvest and then to build economic value-addition from forests, including minor forest produce. But it is also clear that this 'business' of planting trees that survive cannot be successful without people who live in the forest areas. Currently, India's imports of forest produce are increasing – from pulp to timber; revenues from forests are declining in state budgets. State Government's do not value the forest resource as a natural asset, which can be utilized for economic gains in a sustainable and renewable manner. The diversion of forests for uses, considered to be productive and remunerative, becomes the norm. The objective of working plans in forest areas is to improve economic productivity – from timber to non-timber produce –on a sustainable basis. But most importantly, the income from forests must provide benefits to villages living around the forests. It is important the current rules of timber transit, which do not incentivize forest production on private lands and community forestlands, should be reviewed and revised. The Forest Rights Act has brought welcome changes in the categorization of minor forest produce, including bamboo, and these efforts to build forest-based economies should be promoted.

Compute forest ecosystem services to make payment for standing forests in Eco Sensitive Areas/Zones. The ecosystem service fund should go to villages living around the forests. These local communities are taking the burden of conservation – as declaration of ESA/ESZ is reducing their developmental options. This move will build local support for forest protection and local economies. This will also ensure that forests are demarcated in terms of productive and conservation functions.

At the moment the country has a provision to pay the "net present value" once permission has been given for diversion of forestland to non-forest uses. But there is no payment for standing forests. For the past many years, chief ministers have demanded that they be paid to protect forests. Finally, the 12th Finance

Commission, in 2004, agreed that states must be paid for the maintenance of forests—some Rs 1,000 crore between 2005 and 2010. The amount is not substantial, but the principle was established.

In 2010, the 13th Finance Commission reiterated the need to compensate states and enhanced the allocation to Rs 5,000 crore over the next five years. This must be supported. In addition, the 14th Finance Commission should substantially increase the fund and also consider how local communities living in and around forest areas and ESA/EZA should be allocated money directly.

Compute the hydrological service provided by forests and their livelihood benefits on local communities. Unfortunately, there has been little work done to thoroughly assess the role of forests in provisioning and modulating the hydrological cycle that determines the economic wellbeing of the entire region. Yet, we know that without the forests, economic growth will be severely jeopardized. For instance, the city of Mumbai, gets its water supply from the forested watersheds located over 100-110 km away. The city, which is already water stressed, will be in dire straits, if the forests of Western Ghats, are not protected or regenerated. Currently, the city also does not pay for the ecological cost of conservation of the forests. Similarly, irrigation and hydroelectric projects depend on forests to modulate flows and storage. The fact that the hydrological service is not computed ensures that there is little understanding of the role of forests and the necessity for protection.

6.5.2 Promoting sustainable agriculture

The demarcation of Eco-Sensitive Area has taken care to exclude the cultural landscape – agricultural and plantation areas. This is important, as both activities are critical livelihood and economic mainstays of the region. But agriculture cannot be sustained without forests, which provide nutrients and water. It is in the interests of agriculturists and plantation owners to protect and safeguard biodiversity in and around the forests.

HLWG recommends a focused programme to incentivize growers in the Western Ghats to move towards organic cultivation and to build a unique 'brand' for such premium products in the world market. These practices could be built on the 'Kodagu' coffee type plantation, which make best use of local biodiversity protection in economic activity generation could be incentivized. It would also recommend that different agencies – APEDA, Spice Board, Coffee Board etc – should convene a meeting to discuss and resolve the barriers to organic and sustainable production in the region. APEDA's Tracenet programme, which builds an electronic database of all practicing organic farmers and facilitates certification could be used as the basis for further work in this area.

6.5.3 Ecotourism for local benefits

It is clear that tourism, particularly, after the declaration of portions of the Western Ghats as a world heritage site, can be an important source of livelihood and economic growth in the region. But it is equally clear that tourism industry, if not regulated, can be the cause of environmental degradation. The January 2011 report on Tourism in Forest Areas of Western Ghats equations lists the problems created by unplanned and unregulated tourism and urbanization in the ecologically sensitive region. According to this assessment, tourism has been promoted beyond the carrying capacity of the settlements and has led to scarcity of water, increased sewage and solid waste and forest degradation. Clearly, the way ahead is to promote this important economic activity, but in ways, which mitigate damage.

In order to promote sustainable tourism HLWG would recommend:

a. Existing regulatory provisions to assess environmental impact of tourism projects must be strengthened: The Forest Conservation Act and the environment impact assessment under the Environment Protection Act allow for careful scrutiny of projects, before clearance. However, these processes have often being bypassed and certainly been weakened because of poor institutional abilities to assess environment; inadequate consultation with local communities and poor monitoring

of the stipulated conditions for environment and forest management. In future, all projects that fall under the Eco-Sensitive Area must be identified as those require extra scrutiny and assessment. All these projects, before assessment and clearance, must be identified as situated in the Eco-Sensitive Area of the Western Ghats and this information must be available prominently on the website of the Central and state ministries.

b. The tourism policy for Eco-Sensitive Area of the Western Ghats must provide local community ownership and benefits: Key State Governments – Karnataka, Kerala, Tamil Nadu – have ecotourism policies to govern the growth of this sector with responsibility to the environment. The MoEF has also recently issued guidelines for State Governments to develop tourism policies around national parks and sanctuaries to promote conservation, which benefits local communities. In the Eco-Sensitive Area of the Western Ghats, policies must actively promote homestead tourism and ensure that there is a substantial cess imposed on large tourist establishments to pay for environmental management of the fragile region and for local community benefits.

c. All tourism hotspots in the Eco-Sensitive Area will be monitored for compliance and assessed in terms of impact. The proposed Decision Support and Monitoring Centre of Western Ghats will monitor these policies annually and all hotspots of tourism will be regularly audited for compliance. The Centre will also develop benchmarks for good tourism – sustainable and equitable – to check performance and take corrective steps.

6.6 UNESCO Heritage tag for Green Development

In 2012, the UNESCO World Heritage Committee declared specified areas comprising 39 serial sites of the Western Ghats as World Heritage sites of outstanding universal value. Under its declaration, it cited that the “significant feature of the Western Ghats is their exceptionally high level of biological diversity

and endemism. This mountain chain is recognized as one of the world's eight 'hottest hotspots' of biological diversity along with Sri Lanka."

The key criterion for the declaration of the Western Ghats as heritage site was endemicity. In this biodiversity hotspot 54% of tree species; 65% of amphibian species; 62% of reptile species and 53% of fish species are endemic. In addition, a large number of flagship mammals and ecosystems are found in the Ghats.

The nominated sites include 39 hotspots, including 14 important bird areas and 3 Alliance for Zero Extinction sites and a number of forest reserve areas of high conservation value. The IUCN tasked to evaluate the nomination noted that the submitted maps show a number of disturbed areas – including settlements, artificial reservoirs, plantations and agricultural areas, which do not qualify for heritage status. Based on these observations, in May 2012, months ahead of the final committee meeting, IUCN had recommended that Government of India should revise the nominated area by further refining the boundaries to ensure exclusion of disturbed areas and to enhance contiguity (IUCN, 2012). The Government of India satisfied the World Heritage Committee on the observations of the IUCN, and finally succeeded in getting the UNESCO heritage tag for the 39 serial sites.

The UNESCO Heritage Tag provides global recognition of the enormous natural wealth of the Western Ghats. Countries want the heritage tag because it provides for high tourism value – people all over the world want to visit these areas, which have been classified as outstanding.

But the tag also comes with responsibility. Under the Operational Guidelines to the World Heritage Convention, "the state parties are invited to inform the secretariat of their intention to undertake or to authorize major restorations or new constructions, which may affect the outstanding universal value of the property." In addition, there is a provision for 'reactive monitoring', which is done if there is possibility of deletion of any property from the list.

While granting approval World Heritage Committee of UNESCO-WHC stated that the India would:

1. Take into account the outcomes of scientific studies of institutes specialized in the field, and their recommendations,
2. Ensure proactive tourism management in anticipation of increased future visitation, and to ensure that visitation remains within the capacity of the property,
3. Ensure any proposed infrastructure developments are subject to rigorous prior impact assessments, to determine if they are appropriate, including via reporting to the World Heritage Committee in line with paragraph 172 of the Operational Guidelines to the World Heritage Convention,
4. Establish improved coordination and integration between the components, particularly through the preparation and implementation of an overarching management plan or framework for the serial property as a whole.

The HLWG notes that the UNESCO Heritage tag is an opportunity to build global and domestic recognition of the enormous natural wealth that exists in the Western Ghats. The 39 sites are located across the Western Ghats and distributed across the states (Kerala 19), Karnataka (10), Tamil Nadu (6) and Maharashtra (4). The boundary of the sites, are in most cases, boundaries of the legally demarcated national parks, wildlife sanctuaries, tiger reserves and forest divisions and therefore, already accorded with high level of protection. The Eco-Sensitive Area mapping and demarcation done by HLWG also indicates that all sites are within this area. The state government's should view this development and build a plan to protect, conserve and value the resources and opportunities of the region.

6.7 Incentives to individuals, communities and states

Environmentally sound development cannot preclude livelihood and economic options for this region. While some kinds of economic activities have been banned in the ESA, the model for protecting livelihoods of local people includes:

(a) Collection and value addition for non-timber forest products with facilities or small establishments for value addition. Collection and transport from within ESAs with local community involvement may need infrastructural and financial support. This activity should be implemented through a network of community based organizations throughout the Western Ghats with S&T support from organizations like DBT, DST and CSIR.

(b) Eco-tourism as per MoEF guidelines involving local communities as stakeholders as well as making use of the World Heritage tag to which some parts of the Western Ghats now have.

Most of the activities mentioned above will generate household incomes and profit in the long run. In the short run, they may need support, which may be provided *to individuals and communities through the mechanism of "viability gap funding".*

Furthermore, there is a lack of incentives as there is no payment for standing forests. The fact that forests are a part of the natural capital of the country is not built into current financial arrangements. Estimates of the value of forests in all Western Ghats states exist and should be used appropriately to leverage payment mechanisms.

The HLWG recommends that the Western Ghats States should come together to negotiate for a grant-in aid from the Centre. The financial arrangement should be of the nature of a debt for nature swap. This is a mechanism whereby part of the outstanding debt of a state is swapped for new constructive initiatives by it to protect its natural resources. A part of these payments be retained by the state governments and a part be used to finance local conservation trust funds (as in several countries), which disburse grants to community projects for improving forest productivity and ensuring sustainable forest based livelihoods in ESA.

HLWG recommends that there should be arrangements for Payments for Ecosystem Services accruing from ESA and non-ESA regions within the Western Ghats. For example, hydrological services to urban areas. A direct link between urban and rural local governance bodies will need to be created to enable negotiation between them. Further, a part of the budgets of municipalities be set apart for newer initiatives under this head, with provision of disincentives for non-implementation. The HLWG recommends that individual State Governments pursue such initiatives creating possibilities for a dialogue on this issue between municipalities and relevant panchayats within their states.

There is a need for convergence of rural development and conservation. The greening rural development report of the government has enormous relevance for the Western Ghats. The HLWG notes that the convergence of conservation with rural development is now a part of the government's forward-looking agenda. A recent (December 2012) report from the Ministry of Rural Development asks for funding in development programmes funded through MNREGA and other such programmes to promote activities that conserve water and soil and promote organic agriculture. People also demand for such activities.

However, the pervading understanding of 'economic planning' does not extend to an area based ecological planning. The HLWG perceives and recommends that one way forward is to consider extending Entry 20 (Economic Planning) in the Concurrent List, and introduce an appropriate new entry, say 20A, suitably titled, to ensure that developmental projects and activities are undertaken within an overarching environmental and ecological framework.

The Western Ghats Development Programme (WGDP) cell in the Planning Commission co-ordinates the Program. Major activities covered under WGDP are watershed projects, schemes for livelihood, critical gap filling infrastructure projects like foot / hanging bridge, vented Dams, projects for SCs/STs and upliftment of

tribals and forest based programs. During the 11th plan (2007-12) Rs. 533.59 crores were released to the 5 states (175 talukas) covered under the program.

The strategy evolved for the continuation of the WGDP, in the 12th plan include going beyond the Watershed based development, considering the fragility of the habitat, and development needs of the people i.e. a Watershed + approach – an approach which emphasizes conservation, minimal ecological disturbance, involvement of locals along with Sustainable model of economic development and livelihood generation with enhanced allocation.

After a careful consideration of the strategy proposed, the HLWG recommends the following;

a) Continuation of the WGD program with an enhanced allocation of Rs. 1000 crores.
b) Continuation of the special category status to the program i.e. cost sharing of 90:10 Centre and State.
c) Special dispensation by the 14th Finance Commission for the WG based on Ecologically Sensitive area (ESA) in the states.
d) Revival and reconstitution of the High level Committee consisting of CM's of the six States, for monitoring the implementation of the recommendations /suggestions of the HLWG and existing legislations and periodically reviewing the status report of the Decision Support and Monitoring Centre for Western Ghats.
e) Setting up / strengthening of the State WG cell currently functional in the Planning /RD Departments in the states with a mandate to liaise with SPCB, State Department of Forests, SEAC and SBA, and Regional office of the MoEF and service the information and decision support needs of the State Government.

6.8 The Framework for Governance and regulation of ESA

6.8.1 The Eco-Sensitive Area, once identified and demarcated, will need an effective governance framework to ensure that can be protected, regenerated and managed sustainably to meet livelihood needs. We need institutions, which are capable of responding to local concerns and can take timely decisions, to balance people's developmental needs with environmental protection. This, when it is clear that resource management issues are complex, with competing interests and require careful scrutiny and assessment. Furthermore, any system, which is based on a permit and prohibitory regime, needs careful and nuanced decisions, particularly when they impact the poor.

The WGEEP had a specific Terms of Reference to "recommend the modalities for the establishment of Western Ghats Ecology Authority under the EP Act, which will be a professional body to manage the ecology of the region and to ensure its sustainable development with the support of all concerned states." Based on this, the WGEEP recommended a structure, which included a national and state level authorities as well as district ecology committees.

All State governments, who have formally responded to the WGEEP report, have rejected the creation of yet another centralized authority. They have pointed out that the federal system of the country allows states to take decisions and have expressed concern at the attempt to centralize decisions through the creation of this Authority.

HLWG recommends that there is clearly a need to strengthen as well as reform the current system of environmental governance to enhance effectiveness. The HLWG recommends that this be done first before new institutions and authorities are created. Otherwise, the problems of current institutions will continue to weaken decisions in the future as well. Given this situation, HLWG has taken the view that it will recommend a framework for governance and regulation of ESA, which draws on

current regulatory institutions for decision-making, but simultaneously, will strengthen the data monitoring systems and the participation and involvement of local communities in decision-making.

The current environmental management system is either based on a single project-based approach or an area-based approach. Given the scale of interventions and given the urgency for protection and regeneration, HLWG would recommend the need to shift to regional based approaches and cumulative assessments, which determine combined impacts of projects across the region or the river-basin.

6.8.2 Strengthening existing regulatory institutions

It is clear that we need to fix the current institutional system and make it more effective. It is for this reason that HLWG is of the strong opinion that the country must reform and strengthen the current institutions of environmental regulation and management in the country in general and in Western Ghats region in particular.

State Pollution Control Boards:

The State pollution control boards are the foundation of the environmental governance infrastructure. But these institutions lack regular in-service training of personnel, funds, and systems of management that are accountable and transparent. Without attention to these issues of institutional strengthening we cannot move ahead in dealing with the enormous challenges of sustainable resource management and development.

State Forest Departments:

The State Forest Departments of the Western Ghats need to be sensitized towards the importance of biodiversity, ecosystem services and local bioresources. The State frontline staff of Forest Departments needs to be equipped with modern systems of communication and surveillance. Regular in-service training of Forest officials needs to be undertaken in the area of wildlife management.

State Biodiversity Authority:

Establishment of Biodiversity Management Committees (BMC) at the Panchayat level especially in the rich biodiversity areas is a priority. The BMCs so established should take up preparation of Peoples Biodiversity Register in mission mode so as to document local biodiversity, bioresources and traditional knowledge. The BMCs should become a focal point for peoples participation with reference to local ecology and biodiversity. The concerned State Government should provide adequate funds to the State Biodiversity Boards and BMCs.

Environment and Forest Clearance Systems:

Similarly, environment and forest clearance systems both at the Centre and State must be strengthened to deepen the process of public assessment and scrutiny of all projects. In addition, there is an urgent need to build capacity to monitor compliance with conditions set for clearance. The strengthening of monitoring procedures is needed for credible deterrence for non-compliance and for environmental integrity. This agenda is urgent and must get the highest attention.

HLWG recommends that it is important that MoEF should review the functioning of the institutions so that they have necessary powers to ensure compliance. Most importantly, MoEF must direct state governments to complete the process of preparation of zonal plans, with maximum consultation with local people. The ESA mapping should be put in the public domain so that plans are based on current developments, which exist on the ground. It is critical that eco-sensitive area mapping must be sensitive to the livelihood and developmental needs of the poorest. There should be an annual assessment based on the changes in the ESA, which is prepared and presented to the public.

6.8.3 Decision Support and Monitoring Centre for Western Ghats

The HLWG recommends for setting up a “Decision Support and Monitoring Centre” for Western Ghats as a part of Governance of the region. The details on the proposed Centre are given in Chapter 7.

6.8.4 Conclusions

To sum up, the HLWG recommends the following:

1. The Central government should immediately notify the ESA area, as demarcated by HLWG in public interest. It must be noted that there is an urgency to protect and safeguard the remaining biodiversity rich areas of Western Ghats. In 2011, recognizing this imperative, the Central government had set up the Western Ghats Ecology Expert Panel under Professor Madhav Gadgil to recommend how this can be done. The Panel in its deliberations spread over 18 months had large number of public consultations across the different states of the Western Ghats. It recommended the need for effective action to protect the region.
2. The HLWG has also had a number of consultations, particularly with state governments and their agencies. After extensive deliberations and efforts to determine the ESA, it has been found that the natural area of the Western Ghats is 41 per cent and ESA only 37 per cent. The need for action is evident. For this reason, HLWG is recommending for immediate notification, the identified area as ESA. In this notified area, development restrictions as recommended in this report will apply.

3. State Governments will immediately put into place structures for effective enforcement of development restrictions and ensuring sustainable development in ESA. The MoEF will ensure that all projects located in the districts comprising the Western Ghats are required to submit information about distance and proximity to the ESA.

4. The Planning Commission should create a special Western Ghats Sustainable Development Fund, which will be used to promote programmes specifically designed to implement an effective ESA regime and incentivize green growth in the region.

5. The 14th Finance Commission should consider options for ecosystem and other service payments in the Western Ghats as well as allocation of funds to ESA areas. It should also consider how these funds for environmental management would be made available directly to local communities who live in and around Western Ghats ESA.

6. MoEF should set up the Decision Support and Monitoring Centre for Western Ghats, with the mandate to assess and report on the state of ecology of the entire region. The Centre will be hosted by one state and will have joint management of all six states of the Western Ghats. The Centre will have a decision support function in the implementation of ESA. Its reports will be in the public domain.

7. MoEF should put the ESA map in the public domain, which will enable scrutiny and transparency in decisions.

8. All development projects located within 10 kms of the Western Ghats ESA and requiring environment clearance (EC) shall be regulated as per the provisions of the EIA Notification 2006. .

9. The villages falling under ESA will be involved in taking decisions on future projects. All projects will require prior-informed consent and no-objection from the *gram sabha* of the village. The provision for prior informed consent under the Forest Rights Act will also be strictly enforced.

CHAPTER 7
Decision Support and Monitoring Centre for Western Ghats Region

7.1 Introduction

In this chapter, we discuss the rationale for establishing a Decision Support and Monitoring Centre in Western Ghats, to address the multiple dimensions of managing the ecological complexity of Western Ghats landscape. For the sake of completeness we elucidate the broad features of this complex landscape, at the expense of some repetition from earlier chapters.

Western Ghats (WG) are the majestic mountains range that fringes the west coast of India and is one among the seven great mountain ranges in India. It is a unique landscape geologically, biologically and ecologically. The lithology coupled with high rainfall make WG as one of the highly ecologically diversified landscape on earth. WG supports wide range of vegetation types ranging from tropical wet evergreen to grasslands on plateau. It is designated as world's hottest hotspots. The Western Ghats represent unique taxonomic hierarchies, remnant ecosystems and strong endemic associations. The Sholas, Mangroves, Kans, Dry evergreen forests, swamps, reeds and riverine belts etc. represent the unique repositories of diverse genomes. The resource value of this mega diversity center spans from timber-non timber category through wilderness–ecotourism to medicinal-aromatic-food-industrial gene pools. Such luxuriant vegetation compositions have evolved over geological time scale, witnessed various land use practices depending upon the resource demand and ingress of human dimension. This has induced considerable alteration in the Western Ghats biogeography bringing in commercial agriculture, commercial forestry, hydropower, mining and biotic pressures within the forest ecosystems. Mention of human presence and land use practices in WG is found in records >2000 yrs. Trade and cultivation of spices in Malabar and Canara region of WG is due to the unique climatic and ecological setting. This pressure on the WG has been on rise in

modern era. Conservation Planning and Development have often got into conflict due to absence of scientific reliable data base and proper monitoring mechanisms.

7.2 Importance of GeoSpatial Modeling and Analysis

The complexity of a Decision Support and Monitoring Centre arises as the goal calls for an inter-disciplinary understanding of ecological processes in relation to taxonomy, physiology, reproductive biology, conservation biology, forest hydrology, soils as well as socio-economic and climate change dynamics to cite only a few dimensions necessary for a holistic understanding of the natural system. Bringing all the subject experts and the administrators to a common page to have a synoptic understanding of biodiversity and the other ecological settings in the Western Ghats, and the tools through which such processes could be understood is the essence in managing the fragile Western Ghats ecosystem while ensuring economic development to the community at large. The data requirements for such understanding are both of spatial and non-spatial nature and also of various time scales covering multi-thematic domains and terrain characteristics.

This is where the geospatial modeling comes into forefront. This approach integrates the existing geo-databases at relevant scales and in locally meaningful ways to provide informed decision support for adaptive management efforts, linking the ecology, environment and development. Today, it is well recognized globally and in our own country that geospatial technologies provide a viable means to carry out the above monitoring, periodic assessment, and impact analysis which is objective, and replaces the subjectivity from the decision-making process.

7.3 Technology Convergence on Geo-Informatics

Geo-informatics, as it is called, combines the geospatial analysis and modeling, and effectively makes use of the convergence of information and communication technologies, complimenting the efforts on the space and ground segments to provide updated, near-real time information to the decision-makers. Significant

advances made over the past few decades in the geospatial enabling techniques such as satellite-based remote sensing and aerial photography, image processing, Geographical Information System (GIS), Space-based Positioning System like GPS, and photo-grammetry and other cartography services. Further, the advances made due to the advent of disruptive technologies such as internet, location-aware mobile phones, social networking and broadband connectivity as well as development of web portals have made this mechanism widely accessible and affordable as well. Today, with the advances in Cloud Computing with the increasing emphasis on providing 'Geography as a Service', and 'Crowd Sourcing' which ensures active participation from the community through social networks and smart mobile devices, along with the wide availability of Open Source GIS software, geospatial technologies have penetrated all aspects of natural resources, environment management, climate change adaptation studies as well as aspects related to disaster risk reduction. With satellite remote sensing advances reaching to sub-meters with corresponding developments in computational analytical capability to understand relationships among the various processes involved in the interactions of the fragile resources spatially coupled across the landscape, one is in a position to identify scientifically such disturbances, narrowing down the areas to watershed level and even at parcel level appropriately overlaid with administrative units where adaptive management might be most beneficial. For example, due to high relief and terrain complexity, mountainous areas require 3-dimensional information for spatial modeling for management inputs, and it is immensely possible with the type of imaging sensors available from space technology.

7.4 Spatial Decision Support System (SDSS) for Informed Decision-making

Today's technologies in a convergent environment allow spatial information in 2D and 3D, periodically updated, in a seamlessly integrated manner. Such a Spatial Decision Support System (SDSS) with appropriate broadband communication linkages to various stake-holders making available the geo-data bases on the fly, allows the decision-makers to access timely inputs to prioritize efforts and take up

the developmental activities more scientifically without fear of affecting the ecological setting in fragile ecosystems like Western Ghats. It also enables the decision-makers effectively address in a participative manner, the sustainable livelihood concerns, mitigate vulnerability, and helps towards building necessary resilience to the community. In short, it is expected to develop a dynamic, unified scientifically validated knowledge-base which can be accessed by planners, policy makers, conservationists, economists and the social scientists as well as the community itself in their effort to bring in holistic development to Western Ghats. The system also brings the much needed transparency in the decision-making process and thus, helps enhance the confidence of the community in the overall process. The challenge for the scientists and the technologists in developing such an adaptive SDSS is essentially in domesticating the technological advances in such a way that the ultimate delivery system is absolutely user-friendly and less jargonized. The challenge for the administrators is to appreciate the difficulties involved in precise information gathering and effective information sharing in an operational setting involving multiple agencies and stake-holders; and to support such endeavors in all possible manners.

Establishing such a Centre (Fig. 31) would entail among other things:

- Creating a knowledge network comprising of scientific institutions and academia for creating and sharing the scientific knowledge base for conservation and developmental perspective of Western Ghats. The institutions could comprise of NRSC/ISRO, NIO/INCOIS/MoES, SOI/IMD/NCMRWF/IITM/DST, MoEF, CAOS/IISc., State Remote Sensing Centres to name only a few.
- Developing a geospatial data repository and data analytics system with periodic updates. Distributed data centres with broadband connectivity to access the databases on the Cloud with provisions for Crowd Sourcing inputs from community

- Establishing a Spatial Decision Support System (SDSS) using existing and real databases with Open Source Software and validated models. SDSS should provide decision alternatives to enable informed decision-making in consultaion with State Governments, regulatory bodies and implementing agencies.

The different components of the proposed Centre are given in Figure 31.

7.5 Role of the Centre

The Centre will be located within one Western Ghats state, but its mandate will be to assess and monitor changes across the geographical spread of the Ghats. It will provide authoritative, relevant and timely information to governments and to the public about state of environment and ecology of the Western Ghats. The Centre will update and improve upon the current data repository and analysis system to track changes in the ecosystem. The reports of the Centre will be publicly available. The objective of the Centre will be to understand the nature of the challenges that are emerging in this ecologically fragile region, using the best of our scientific and research capabilities. This research must also build upon the traditional knowledge of the region and the unique understanding of its people on how to survive and cope with adverse conditions and build economic futures, which are sustainable.

It will publish an annual report on the state of the ecology of Western Ghats in collaboration with other research institutions and scientists, and it will be placed in the state legislature for discussion and review.

The role of the Centre will be to use the existing and new knowledge to build a vibrant political dialogue in the region as a whole on the need to make shifts in development paradigm, given its particular vulnerabilities. It will do this by facilitating a high-level political dialogue on the Western Ghats, which could be chaired in rotation by different chief ministers of the states and include key

ecologists and researchers. The dialogue will be an important forum to discuss common concerns and ways ahead.

It will also build a repository of all projects in the Western Ghats, including industrial projects and will link with state pollution control boards to build a real time database on monitoring and performance data. Currently, this information is scattered and does not provide for effective decision support systems. The aim will be to network with existing institutions so that changes can be monitored and appropriate decisions taken for mitigating damage.

The Decision Support and Monitoring Centre for Western Ghats will be the decision-support for ensuring the enforcement and regulation of ESA. It will facilitate the process of regional planning; conduct research studies to incentivize green economic growth and set up a monitoring system to track project clearance and monitoring in the ESA.

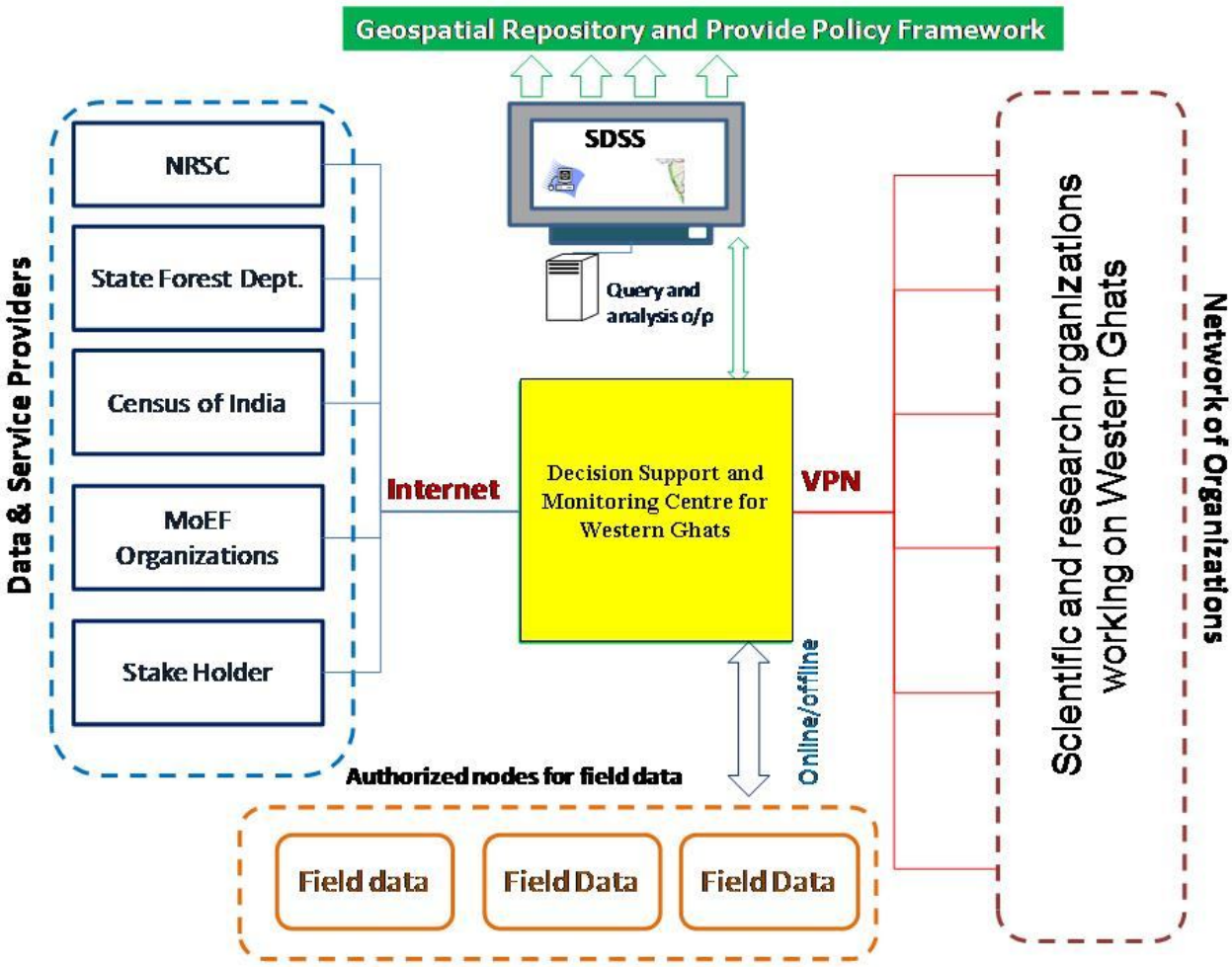

Fig. 31: Components of the Proposed Centre.

CHAPTER 8
Review of Specific Cases

During 2011, MoEF referred four specific cases to the Western Ghats Panel for its observations. These are:

- Athirappilly hydropower project in Western Ghats of Kerala;
- Gundya hydropower project in Western Ghats of Karnataka;
- Moratorium on development projects in Ratnagiri and Sindhudurg District; and
- Mining in Goa

HLWG has reviewed all the four cases, and had extensive discussions and field visits to ascertain the facts. The following are its observations and recommendations.

8.1 Athirappilly Hydropower Project

Kerala State Electricity Board (KSEB) proposed a hydroelectric dam across Chalakudy River in Trichur District to generate 163 MW of power to augment energy requirement of the State and also to provide water for drinking and irrigation. The details of concrete gravity dam are as follows:

- Dam is 23 m in height and 311 m in length.
- Submergible area (water spread area) would be 104 ha.
- Forest area diverted would be 130 ha.
- Water passes through 4.69 km tunnel of 6.4 m diameter from the dam to the power line located northwest of the dam site and above Kannankuzhithodu river into which tailrace water will be emptied and it will join Chalakudy river at a distance of 1.5 km.

The project has been under review for some years now:

- MoEF gave Environmental Clearance (EC) to the project on 20.1.1998 and the project received forest clearance (stage II) on 16.12.1999.
- The High Court suspended the EC, due to procedural irregularities and asked KSEB to conduct public hearing in response to PIL. At the public hearing conducted by KSPCB at Trichur, reliability of EIA prepared by WAPCOS was questioned and was also challenged by Kerala State Biodiversity Board.
- KSEB secured EC again from MoEF with the EIA prepared by WAPCOS. Another PIL was filed in the High Court on the ground that public hearing was not conducted for second modified EIA. The court again questioned the EC issued by MoEF and the court directed KSPCB to conduct public hearing again. At the second public hearing conducted at Chalakudy there was no unanimous decision among the public hearing panel.
- Meanwhile a five member committee of EAC (River valley and Hydroelectric projects) of MoEF visited the site and interacted with local communities and based on the Report submitted by it the MoEF again gave the EC for the project on 18 July 2007.
- Again two PILs were filed against the clearance for the project on the ground that the hydrological data presented in the WAPCOS's EIA are not correct and the impacts of project on ecology and biodiversity are not adequately covered. The court heard the case twice, in 2008 and in 2009 by two Division Benches and the judgment is awaited.

The HLWG along with the officials of Kerala State Electricity Board and Kerala Forest Department visited the Athirappilly Hydropower Project, after hearing the presentations made by Kerala State Electricity Board (KSEB) and also a local NGO (River Research Centre, Trissur). The team visited the dam site, the settlement of Kadar tribes impacted by the dam, rapids and waterfalls and irrigation dam site.

During presentation, the KSEB explained the upstream run of the river hydropower projects - the Sholayar project on the Sholayar river which is tributary of Chalakudy

river, the tail water of which is discharged into downstream that flows into Poringalkuthu project which is on the main river itself, the tail water of which is discharged into downstream of Chalakudy river and is used for the proposed Athirappilly project which is about 40 km away from the backwaters of Cochin. All these projects are run of the river projects and there are no dry stretches of the rivers. If these streams/rivers are not dammed, the excess monsoon run off cannot be stored and enters into sea within 48 hours. The average annual inflow, based on 32 years data at Athirappilly, is 1169.Mm^3. This is confirmed from the flow data of Chalakudy river at Arangals collected by Central Water Commission. The tail water from Athirappilly will be released into Chalakudy via its tributary at Kannankuzhithodu.

The fluctuations in the water flow in different months and the plant load factor were also explained. The issues relating to Kadar tribal families living close to the submergible portion of the dam were explained to HLWG and it was informed that a package has been worked out for their welfare without rehabilitation as the areas inhabited by them does not come under submergible zone.

The NGOs, who met with HLWG, brought to its attention that project would have irreversible impact on the rich biodiversity value of the forest; particularly, along stretch of 7.89 km between dam site and the point where the tail race water joins Chalakudy river. They said that the habitat of the Kadar tribal population would be adversely hit and that people had not yet given their consent. In addition, they said that this project, being built in an area of biodiversity value, would have minimal benefits. The technical feasibility of the project was doubtful with meager amount of power obtained at high cost. In addition, plantation owners and farmer representatives located below the proposed project said it would have adverse impacts on downstream irrigation and drinking water.

The HLWG examined the status of forests, including the riparian forests and submergible slope forest, a small swampy area and the plantations. It is clear that as in all hydropower projects, there is a need to balance the need for energy,

particularly peaking power, water supply and irrigation with the loss of biodiversity, forest habitat, displacement of tribal communities and the need for ecological flow in the river.

HLGW, after detailed deliberations on each of the critical issues, is of the view that while the project's importance for meeting the peaking power requirements of the State cannot be disputed, there is still uncertainty about ecological flow available in the riverine stretch, which has a dam at a short distance upstream of the proposed project. Given the increased variability, in flow from catchments due to unpredictable monsoon rains, the project may be revaluated in terms of the generation of energy and if the plant load factor expected in the project makes it viable against the loss of local populations of some species. Based on this revaluation and collection of data on ecological flow, the Government of Kerala, could take forward the proposal if it so desires with the Ministry of Environment and Forests.

8.2 Gundya Hydropower Project

The Karnataka Power Corporation Limited (KPCL) has proposed a hydroelectric project in the Gundya River basin in the Hassan and Dakshina Kannada district in two phases: Phase I of 1x 200 MW and Phase II of 1x 200 MW. The project is on Gundya river – a tributary of west flowing river of Netravathi; phase I involves pooling of waters by linking Yettinahole, Kerihole, Hongadhalla and Bettakumari and water from these streams will be intercepted by small weirs and will be drawn through a tunnel running from Yettinahole leading to Bettakumari reservoir. From the foreshore of this reservoir, 7.8 km long head trace tunnel takes water to a surge tank and from there to a underground powerhouse. The Phase II will have two tunnels – one tunnel will take water from Kadumanehalla and surrounding areas by 13 km long unlined tunnel and discharge into tunnel that takes water from Yettinahole weir, and another tunnel of 15 km long will take water from Lingath hole and Kumaradhara to Bettakumari reservoir.

The submergible area will be 184.64 ha. An additional 560 ha will be needed for infrastructure. KPCL is not going ahead with the Hongadhalla dam because of the extensive submergible area of 523.80 ha. The project has got necessary clearances from different regulatory agencies; EAC of MoEF has asked KPCL to conduct also public hearing in Dakshna Kannada District, as project area falls in both the districts. The public hearing was conducted at Siribagiln village of Puttur taluka on 25.03.2009. Meanwhile the Malenadu Janapara Horata Samithi made a representation before the subcommittee of EAC during its visit to the site on 5.12.2009. The EAC has recommended clearance but the MoEF has not issued the environmental clearance.

The land required for the project includes forest area of 113 ha, revenue land of 263.63 ha, which also includes forests (though mostly degraded); and 71.5 ha of private land making it a total of 448.13 ha. The site has unique forest types with high biodiversity values (endemic, rare, threatened and new species) and also the cardamom and coffee plantations with scattered forest patches, which will be impacted adversely by land use changes and changes in hydrological regimes in the river basin due to project.

The major impacts of the project would be: (i) submergence of patches of riparian forest, (ii) land degradation/fragmentation of forest patches for tunneling and road construction; (iii) the drying up of down streams of three Yellinahole (with 60.50 km^2 catchment area), Kerihole (27.00 km^2 catchment area), Hongadahalla (8.50 km^2 catchment area) and Bettakumari (35.00 km^2 catchment area) before they join Gundya river, although each of them has small catchments, and a stretch of 34 km of Gundya river; and (iv) the apprehension of shortage of water at Subramanya Swami temple.

HWLG notes that the Gundya hydel project is run of the river project, which must ensure ecological flow in the affected stretch of the river. Furthermore, while the area of the submergible portion of forest is small, the construction of the project and

tunneling in the region will have adverse impacts on both government forests and green areas on private land.

As the Gundya hydropower projects is located in the ESA, HLWG recommends that it must be proceeded upon with extreme caution. It would recommend that the Government of Karnataka should reassess the ecological flow in the downstream areas, based on a thorough evaluation of hydrological regimes in the area. The project should not be given the go-ahead, till such a review and reassessment is made. The Government's review must also assess damage to all forests, which will emanate from the construction work and if at all, this can be mitigated. The HWLG has not proposed a complete ban on the construction of hydropower in the ESA, but it's recommended conditions that balance the needs of energy with environment must be followed.

8.3 Moratorium on Development Projects in Ratnagiri and Sindhudurg Districts

MoEF referred the matter regarding developmental trends in Ratnagiri and Sindhudurg Districts of Maharashtra to WGEEP. MoEF also imposed a moratorium on consideration of projects under the EIA Notification 2006 for ToR and/or EC from these two districts vide O.M. dated 12.08.2010. The moratorium, which was initially made applicable till December 2010, has been extended till 30.04.2013.

As per the WGEEP, only portions (eastern parts) of Ratnagiri and Sindhudurg districts of Maharashtra fall within Western Ghats, as both the districts have plains and coasts on the west which do not constitute a part of Western Ghats.

The WGEEP highlighted a number of environmental issues facing both the districts. Some of them are: (i) local isolated incidents of effluent discharge into rivers, (ii) air and water pollution as reported by local individuals, (iii) failure to comply with EC conditions by industries, and (iv) the lapses on the part of State Pollution Control Board, and the State Government of Maharashtra on the implementation of: (a) Acts

relating to rights of tribal people, (b) Zoning Atlases for Siting of Industries, (c) failure to establish Biodiversity Management Committees (BMC), and (d) not involving Gram Panchayats and Panchayat Samitis in decision making, etc.

HLWG noted that the areas under these two districts fall in three categories; area falling under ESA, area falling outside ESA, but within Western Ghats region and the area outside the Western Ghat region.

HLWG recommends that the moratorium imposed should be lifted with the following conditions. As per the recommendations of this report, in the area of these two districts, which has been categorized as ESA, the sectoral restrictions and regulations will apply. In addition, within 10 km of the ESA, , all development projects that require environment clearance will be regulated as per the provisions under EIA Notification, 2006.

In the remaining area, including the area outside ESA but within Western Ghats, environment and forest processes and regulations will continue to apply. However, in order to ensure that such development projects do not adversely impact the environmental balance of the two districts, MoEF should monitor on regular basis the cumulative impact of projects, which may come up in these districts on regular basis and take policy decisions at appropriate time based on these findings.

8.4 Mining in Goa

A number of public interest litigations have been filed against mining in Goa due to its adverse impacts on agriculture, natural drainage, air pollution and damage to protected areas. It was brought to the notice of the HLWG that the Ministry of Mines, Government of India, vide Notification No.S.O.2817(E) dated 22.11.2010, had appointed a Commission of Inquiry consisting of Shri Justice M.B. Shah, retired Judge of the Supreme Court, for the purpose of making an inquiry into mining of iron ore and manganese ore in contravention of the provisions of various statutes and rules and regulations issued thereunder, in various States including the State of Goa. The

Commission has since submitted its inquiry report relating to illegal mining of iron ore and manganese ore in Goa. Ministry of Mines has laid Action Taken Report (ATR) on the recommendations contained in the Shah Commission report in the Parliament on 7 September 2012.

Following this, the State Government of Goa, vide their order dated 10.09.2012, ordered the suspension of mining operations of all mining leases existing in the State until further orders, apparently with a view to scrutinizing the clearances obtained by the mining lease holders.

Subsequently, MoEF decided to scrutinize and examine the details of each of the mining case and take appropriate decision thereon following due procedure. The Shah Commission, in its report, has mentioned various illegalities and irregularities in respect of 139 mining cases in Goa. Pending detailed scrutinize and action on each of these 139 cases, MoEF on 14.9.2012 issued directions under section 5 of the Environment (Protection) Act, 1986 to keep environment clearance in abeyance for all these cases. The project proponents were directed to submit the documents to the Ministry to show the legality of the ECs issued to them.

In the meanwhile on a writ petition filed by the Goa Foundation in the Supreme Court on Shah Commission's report, the Court, vide order dated 5.10.2012 asked CEC to look into the matter and ordered that till further orders, all mining operations in the leases identified in the Shah Commission's report and transportation of iron ore and manganese ore from those lease areas, whether lying at the mine head or stock yards, shall remain suspended. The CEC has submitted an interim report to the Supreme Court on 7.12.2012. The stay on mining operations in Goa continues.

MoEF has constituted a separate Expert Appraisal Committee to examine the documents in respect of each of the aforesaid 139 mine lease cases and make appropriate recommendations to MoEF for consideration. MoEF intends taking

appropriate view in each of these cases subject to the approval of the Supreme Court in view of the pending litigation.

It was also brought to the notice of HLWG that the State Government of Goa is yet to send their proposal to MoEF for notifying Ecologically Sensitive Areas around notified Wildlife Sanctuaries and National Parks in the State. MoEF has also requested the State Government to use high-resolution imagery and maps, to be followed by ground-survey, to establish the distances, to the best accuracy possible, of each of aforesaid 139 mines from the various notified Wildlife Sanctuaries and National Parks and share the information with MoEF. This information is still to be received from the State Government.

HLWG has recommended that there should be a complete ban on mining activity in ESA and that current lease mining areas in ESA would be phased out within 5 years, or at the time of expiry of the mining lease, whichever is earlier. In view of the fact that the matter is pending before the Hon'ble Supreme Court, the HLWG does not find it appropriate to make any recommendation in the matter.

References

Conservation International. 2013. http://www.biodiversityhotspots.org/Pages/default.aspx. Accessed on 07 January 2013.

Dikshit, K.R. 1981. The Western Ghats: A geomorphic overview. In L.R. Singh's (ed) New perspectives in Geography 1981, and in Memoir Geological Society of India 47 (1): 159-183. 2001.

Franklin, J., Davis, F.W., Ikegami, M., Syphard, A.D., Flint, L.E., Flint, A.L. and Hannah, L. 2012. Modeling plant species distributions under future climates: How fine scale do climate projections need to be? Global Change Biology, doi: 10.1111/gcb.12051.

Gunnell, Y. and Radhakrishnan, B.P. 1967. The Western Ghats of the Indian Peninsula: In Proceedings of the Seminar on Geomorphological Studies in India, Sagar, and in Memoir Geological Society of India 47 (1):133-144. 2001.

Hamlet, A.F., Mote, P.W., Clark, M.P., Letermaier, D.P. 2007. Twentieth-Century Trends in Runoff, Evapotranspiration, and Soil Moisture in the Western United States. Journal of Climate 20: 1468-1486.

IPCC: 2007. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. [Pachauri, R.K. and Reisinger, A. (Eds).] IPCC, Geneva, Switzerland, 104 pp.

NATCOM. 2012. India: Second National Communication to the United Nations Framework Convention on Climate Change. Ministry of Environment and Forests, Government of India, 2012.

Roy, P.S., Kushwaha, S.P.S., Murthy, M.S.R., Roy, A., Kushwaha, D., Reddy, C.S., Behera, M.D., Mathur, V.B., Padalia, H., Saran, S., Singh, S., Jha, C.S. and Porwal, M.C. 2012. *Biodiversity Characterisation at Landscape Level: National Assessment*, Indian Institute of Remote Sensing, Dehradun, India, pp. 140. ISBN 81-901418-8-0.

Rodgers, W.A. and Panwar, H.S., 1988. *Planning a Wildlife Protected Area Network in India*. Ministry of Environment and Forests and Wildlife, Government of India.

Tewari, D.N. 1995. Western Ghats Ecosystem. International Book Distributor, Dehra Dun.

Valdiya, K.S. 2010. Geological Framework and Tectonics of Western Ghats 1-32.

Wadia, D.N. 1975. The Western Ghats in Geology of India (ed. IV) and in Memoir Geological Society of India 47 (1): 87-88. 2001.

Peer Review Report on Geospatial Analysis for Identification of Ecological Sensitive Areas in the Western Ghats Region

- Based on the D.O. letter no. 1-4/2012-RE dated 26th March 2013 from the Joint Secretary, Ministry of Environment and Forests, Government of India, the following three member committee met on 4th April 2013 at Indian Institute of Remote Sensing (IIRS), Dehradun, to review the geospatial analysis carried out by National Remote Sensing Centre (NRSC) for identification of ecological sensitive areas in the Western Ghats region.

  Dr. Y. V. N. Krishna Murthy, Director, IIRS, Dehradun;
  Dr. V. B. Mathur, Dean, Wildlife Institute of India (WII), Dehradun;
  Dr. Subhash Ashutosh, Professor, Indira Gandhi National Forest Academy (IGNFA), Dehradun.

- The draft report consisting of two chapters (Chapters 4 and 5) were provided to the members prior to the meeting. The committee has gone through the draft report and heard the PowerPoint presentations made by Dr. C. S. Jha and Shri G. Rajasekhar from NRSC on 4th April 2013 at IIRS, Dehradun, about the databases utilized and methodology adopted in identifying the Ecological Sensitive Areas (ESAs) in the Western Ghats. The experts available at IIRS in geospatial analysis and forestry and ecology studies, Dr. S.K. Srivastav, Dr. S.P.S. Kushwaha, and Dr. Sarnam Singh, also participated during the presentation and deliberations.

- The members mainly focused on the chapter dealing with geospatial analysis for 'Identification of ecological sensitive areas in Western Ghats region' (Chapter 5).

  It is noted that the primary inputs used for identifying ESAs are taken from DOS-DBT project on 'Biodiversity Characterisation at Landscape Level' (BCLL), in which different spatial layers, e.g. vegetation type and land cover, biological richness, forest fragmentation, etc. were generated on 1:50,000 scale using IRS LISS-III images and ancillary data. These inputs are appropriate for identifying the ESAs as they are the best possible seamless datasets available at present with acceptable accuracy. The *biological richness* and *forest fragmentation* layers along with population density, village boundary, *protected area* (PA) and *world heritage site* (WHS) maps have been used to identify the ESAs using a suitable *decision matrix*.

  The effort made by the task team in carefully collating and analysing the best possible/available datasets for identifying the ESAs is appreciable. The datasets used are adequate and approach followed for geospatial analysis is technically

6/4/2013

sound in meeting the objective of identifying the ESAs. Further, the large area covered for analysis in the limited time frame is also commendable.

- The following observations are made by the members which may be included/taken care while finalising the report.

  (i) While the inputs used in the geospatial analysis are adequate and the references of such data sources are provided, it is felt that a clear description of the primary and secondary data sources including the mechanism, accuracies and constraints is needed as they form the basis for the entire analysis. This may be explicitly mentioned in the report as text and table.

  (ii) For identifying the ESAs, biological richness map and forest fragmentation layer along with population density have been used. While the forest fragmentation layer has been used as one of the several inputs in the geospatial modeling of biological richness, it has also been used again as an independent layer because of its key impact on eco-sensitivity. This point could be highlighted in the report.

  (iii) The population density of <100 persons/km^2 (as per Census, 2001) used as the cut-off for identifying the ESAs in the 'high' biological richness class with 'medium' forest fragmentation, need to be discussed appropriately in the report.

  (iv) The village boundary layer taken from Survey of India and the derived areal extents are indicative. This needs to be mentioned.

  (v) While *protected areas* (PAs), *world heritage sites* (WHSs) have been considered for identifying the ESAs, a remark may be included in the report that PAs, WHSs and *recorded forest areas* (RFAs) are regulated by the extant provisions of the Indian Forest Act, 1927, Indian Wildlife (Protection) Act, 1972, and the Forest Conservation Act, 1980 and their amendments thereof.

  (vi) The process of identifying the ESAs based on ESZs obtained from geospatial analysis needs to be explained in more detail (chapter 5, page 14, para 5 and 6).

  (vii) It is observed that the figures, tables and text on rainfall and elevation (based on ASTER DEM) given in Chapter-4 are not used for defining the boundary of the Western Ghats region and hence may be excluded from this chapter.

6/4/2013

(viii) The inputs used and their sources may also be included in the figures (maps). Other minor suggestions are made in the draft report (two chapters) and have also been discussed with NRSC team during the presentation for appropriate modifications.

The committee concludes that the datasets used and methodology followed for geospatial analysis within the given timeframe and resources are adequate for identification of ESAs in the Western Ghats region.

The following points may be considered while implementing the programmes for conservation and preservation of ESAs by the respective State Governments.

(i) As mentioned earlier, ESAs have been identified based on a 'decision matrix' created using biological richness, forest fragmentation, village layer, PAs and WHSs. The members feel that while PAs and WHSs do help in conserving wildlife, conservation of landscape dependent species, such as tiger, needs the corridors and connectivity areas outside the PA and WHS boundaries to be adequately safeguarded. Recently, the Wildlife Institute of India (WII) has published a report providing detailed information and spatial data on corridors and connectivity areas in the context of tiger. These spatial data could be used by the respective state governments to ensure that permeability required for persistence of wild animal populations for perpetuity is taken care.

(ii) The forest type map recently published by the Forest Survey of India on 1:50,000 scale may also be used by the state governments for finer refinements and prescriptions for conservation of ecologically sensitive forest types and rare and threatened endemic species.

(iii) A sample of ESAs in the fringe villages identified using geospatial analysis may also be validated.

The members thank the Chairman and Members of the High Level Working Group (HLWG) on Western Ghats for giving us the opportunity to peer review the geospatial analysis aspect in identifying the ESAs in the Western Ghats region.

(Subhash Ashutosh) (V. B. Mathur) 6/4/13 (Y. V. N. Krishna Murthy) 6/4/2013

Appendix 2

Approach for Biodiversity Characterization at Landscape Level

1. Data Inputs

Cloud free IRS 1C, 1D and P6 LISS-III Satellite data (23.5 m spatial resolution) for two season (moist- Oct-Dec; and dry Feb-April) have been used for vegetation type mapping. Topographic maps, Climatic maps, Biogeography maps, Socio-economic data, Management Maps/Stock Maps, and Protected Area Network were also used as additional inputs for the study.

2. Vegetation Type Mapping

The vegetation type mapping was carried out using two season (dry and wet period) satellite images of IRS LISS-III data, based on the phenology of the vegetation cover. On screen digitization was adopted for the vegetation type mapping as the delineation of the finer phenological and type variation was possible. The vegetation types were classified according to their separability on the satellite imagery. Climatic and physiognomy based classification principles were used to develop vegetation classification scheme and broadly fits into the existing Champion and Seth's forest classification scheme followed in the Indian sub continent. Tone and texture of the satellite image were correlated with ground based observation and corresponding image chips were made for reference for on-screen digitization. The biogeography and altitude zone maps are also used to define classes. Wherever necessary, field knowledge was used to delineate the locale specific types of ecological significance.

2.1. Landscape Analysis

2.1.1. Fragmentation

Fragmentation was computed as the number of patches of forest and non-forest types per unit area. The forest type map was reclassified into two classes, i.e., forest and non-forest, resulting in a new spatial data layer. A user grid cell of n (e.g., n = 500 m) is convolved with the spatial data layer with a criterion of deriving the number of forest patches within the grid cell. The iteration is repeated by moving the grid cell through the entire spatial layer. An output layer with patch numbers is derived and a look-up table (LUT) associated with this is generated, which keeps the normalized data of the patches per cell in the range from 0 to 10 (IIRS, 2003).

$$Frag = f(n_F, n_{NF}) \quad \text{(Eq. 1)}$$

where *Frag* = fragmentation; *n* = number of patches; *F* = forest patches; *NF* = non-forest patches.

4.4. Disturbance Index

Disturbance is a manifestation of the impact of anthropogenic activities and natural disturbance on the landscape change. The disturbance is manifested in

the spatial extent and distribution of the vegetation cover as well as species composition. In this model for generation of disturbance surface, as a first step, Cumulative landscape metric surface is prepared as a combination of different landscape metrics viz., fragmentation, Juxtaposition, Interspersion, Fractal Dimension, contagion etc. In the next step biodiversity driver surface, which reflect the spatial distribution of the anthropogenic/natural forces on the landscape is prepared using disturbance generating factors viz, proximity to roads, villages, fire intensity, shifting cultivation, mines and disturbance indicator parameters (diversity, invasive species, regeneration potential etc.) using ground based sampling data. Using these two surfaces, we run the model to generate the disturbance surface. A user grid cell of nxn (e.g. n=500 m) is convolved with the spatial data layer with a criterion of deriving a specific landscape metric value within the grid cell. The iteration is repeated by moving the grid cell through the entire spatial layer. An output layer with the specific landscape metric value of a parameter is derived and associated to this a look-up table (LUT) is generated which keeps the normalized data of the landscape metric values per cell in the range of 0 to 10.

$$DI = \sum_{i=1}^{n}\left(Frag_i \times Wt_{i1} + Por_{ji} \times Wt_{i2} + Patc \times Wt_{i3} + Int_i \times Wt_{i4} + BD_i \times Wt_{i5} + Jux_i \times Wt_{i6}\right)$$

(Eq. 2.2)

where DI = Disturbance Index; *Frag* = fragmentation, *Por* = porosity; *Patc* = Patchiness; *Int* = interspersion; *Jux* = juxtaposition; *Wt* = weights.

4.5. Biological richness surface

Biological richness computed as a function of ecosystem uniqueness, species richness, biodiversity value, terrain complexity, and disturbance and depicts the potential for harboring the maximum number of ecologically unique and important species. This helps in assigning conservation priorities to threatened, rare, endemic, and taxonomically distinct species and to different types of habitats or landscape elements on the basis of the richness and significance of threatened species. As a part of this project, the biologically rich areas were spatially identified for the purpose of conservation and saving the existing gene pool from extinction. Since the disturbance index, which is a part of the ecosystem process, is also a function of the biological richness, so the level of stress on the biologically rich areas is also ascertained and adequate remedial measures can be taken while implementing conservation strategies. The biological richness at the landscape level was computed as a function of ecosystem uniqueness, species diversity, biodiversity value, terrain complexity, and Disturbance Index (Roy et al., 2012):

$$BR = \sum_{i=1}^{n}\left(DI_i \times Wt_{i1} + TC_{ji} \times Wt_{i2} + SR_i \times Wt_{i3} + BV_i \times Wt_{i4} + EU_i \times Wt_{i5}\right) \quad \text{(Eq. 2.3)}$$

where *BR* = biological richness, *DI* = Disturbance Index, *SR* = species richness, *BV* = biodiversity value, *EU* = ecosystem uniqueness, and *Wt* = weights.

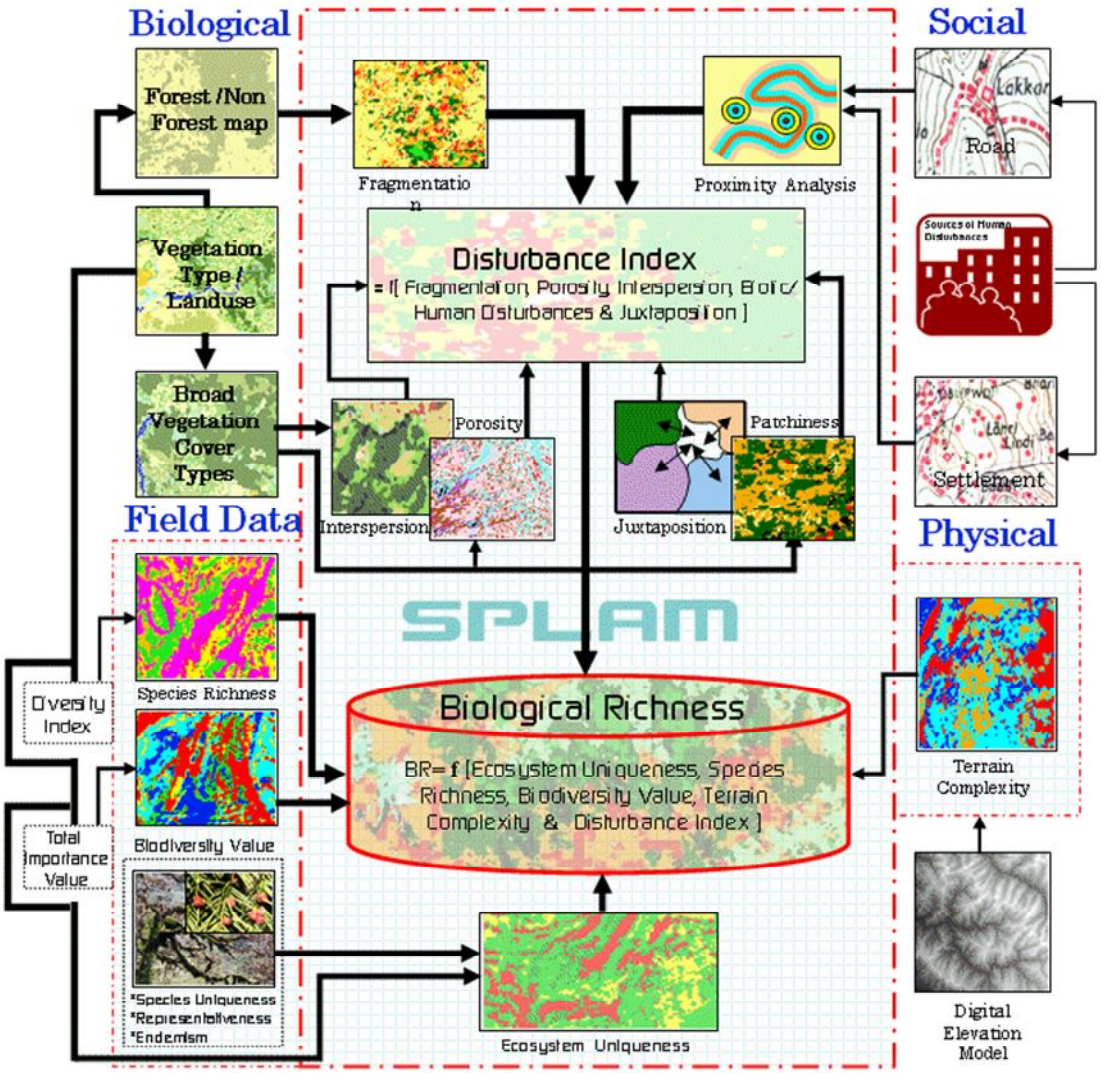

Fig 2: Schematic representation of Spatial Landscape Analysis Modeling (SPLAM) (Roy *et al*., 2005)