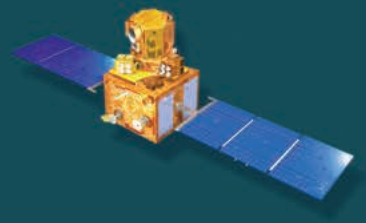

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT

PHASE II (NER STATES)

Central Silk Board
Ministry of Textiles
Government of India
Bengaluru-560068
www.csb.gov.in

North Eastern Space Applications Centre
Department of Space
Government of India
Shillong-793103
www.nesac.gov.in

2018

North Eastern Space Applications Centre
Department of Space, Govt. of India, Umiam, Meghalaya
&
Central Silk Board
Ministry of Textiles, Govt. of India, Bengaluru

Page Layout and Design
Imagic Creatives, Bengaluru

North Eastern Space Applications Centre

Document Control Sheet

Document No	NESAC-SR-190-2018
Security classification	Unclassified
Title	Applications of Remote Sensing and GIS in Sericulture Development (Phase-II) for North Eastern Region
Type of Document	Project Atlas
Number of pages	117
Authors	Project team
Approved by	Project Director/Director, NESAC
Sponsored by	Central Silk Board, Ministry of Textiles, Government of India, Bengaluru
Abstract	The project was taken up as continuation of the previous work carried out for 108 districts representing 24 states of India. Identification of potential sites for mulberry, eri muga and tasar was carried out in 20 selected districts of North Eastern Region (NER) using multi-criteria GIS analysis. Among the states, Assam is found to have maximum suitable areas (149442 ha covering 7 districts) that can be brought under Mulberry Sericulture. This is followed by Nagaland (27648 ha covering 3 districts) and Meghalaya (171208 ha covering 2 districts). Due to limitation of physiographic conditions and climate, Sikkim is having very limited areas (19821 ha in selected 1 district) that can be brought under sericulture activities. Among non-mulberry sericulture, Assam and Meghalaya are having highest suitable areas in terms of Muga in the selected districts (196212 ha and 82524 ha, respectively). The lowest suitable area for Muga was found in Arunachal Pradesh. Similarly, Assam has been found to have the highest areas suitable for Eri (218395 ha) and Meghalaya occupies the second position with 48859 ha suitable areas for Ericulture. The suitability layers/ potential area data-base for all the 20 districts were integrated into Sericulture Information Linkages & Knowledge System (SILKS) web-portal portal which will help all the stakeholders of sericulture industry for better planning and expansion of sericulture in NER.
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APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

Ranjit Dutta
Minister
Handloom, Textiles & Sericulture (including K & VI) &
Welfare of Minorities Departments, Assam

सत्यमेव जयते

B-Block, 2nd Floor
Janata Bhavan, Dispur
Guwahati-781006 (Assam)
Telephone No. 0361-2237058
e-mail : ranjitdutta15@yahoo.com
ranjit.dutta@gov.in
minign99@gmail.com

MESSAGE

Assam is the only State in the World which produces all the four varieties of silk namely Eri, Muga, Tasar and Mulberry. Assam is famous for its scenic beauty embedded with nature's gift of flora & fauna. Like tea gardens in Assam, Muga silk is endemic to Assam which adds to its royalty and uniqueness. Sericulture plays an important role in the economic development of the large section of the rural and semi urban areas of the State. Assam occupies the third position in the country by contributing 90% Muga and 65% of Eri silk production. It also received **"Geographical Indication"** for Muga during 2006 with GI no. 55 which will provide legal protection to GI in India and prevents unauthorized use of GI by others. Approximately 3.10 lakh families of 10,000 villages are directly involved in Sericulture and produce about 3810 MT raw silk during the year 2017-18. At present, the Govt. of Assam has undertaken multifarious schemes/projects to popularize the silk sector not only amongst the rural mass but also amongst the unemployed youths so that the quantum of silk production can be increased many fold higher to meet the demand of silk in the national and international market.

Adoption of sericulture as an alternative to agriculture is possible under suitable agro-climatic conditions all over India and especially in North Eastern Region (NER). However, the potential varies from place to place and needs scientific evaluation of an area before venturing into the practice. Remote Sensing (RS) & Geographic Information System (GIS) has an important role to play in it.

North Eastern Space Applications Centre (NESAC), Umiam (Meghalaya) has taken up the responsibility of executing a programme on "Applications of Remote Sensing & GIS in Sericulture Development" with financial assistance from Central Silk Board (CSB), Bengaluru. A total of 178 districts covering 26 states of the country have been brought under this programme out of which 61 are from NER and 16 are from the state of Assam. Additional potential areas for cultivation of Mulberry, Eri, Muga and Tasar have already been identified in 108 districts from 24 states of the country and 41 were from NER. A web portal called Sericulture Information Linkages & Knowledge System (SILKS) was also developed under the programme to integrate all the data-base generated under the programme.

Site suitability analysis for additional 20 districts of NER including 7 districts of Assam has been completed recently and outputs are published in the form of an atlas and disseminated through SILKS portal. I congratulate the entire project team representing scientists from NESAC, CSB, State Remote Sensing Application Centres (SRSACs) and officers from the State Department of Sericulture of NER for successful completion of the programme.

Ranjit Dutta

Guwahati
October 12, 2018

(Ranjit Dutta)

सत्यमेव जयते
रजित रंजन ओखंडियार, भा.व.से.
सदस्य-सचिव व मुख्य कार्यकारी अधिकारी
RAJIT RANJAN OKHANDIAR, I.F.S.
MEMBER SECRETARY & C E O

केन्द्रीय रेशम बोर्ड Central Silk Board
वस्त्र मंत्रालय Ministry of Textiles
भारत सरकार Govt. of India

FOREWORD

The Central Silk Board (CSB), Ministry of Textiles has placed greater emphasis on improving the productivity at all stages of silk production to ensure higher returns to the stakeholders. Realizing that the space technology has the potential to provide valuable inputs to the sericulture development, CSB and the Department of Space (DOS) have been pursuing in applications of Space technology since 1990s.

With the increasing pressure on the land and water resources, there is challenge to further increase the areas under silkworm host plants. Traditional areas under sericulture are in a state of saturation and there is a need for expanding the sericulture activities to non-traditional areas including those in NE states. There is also need for detailed information at sub-district level and a mechanism to disseminate information and advisory services to reach the far-flung areas of the country including the North-east. With this background, a project was jointly implemented by CSB and North Eastern Space Applications Centre (NESAC), Department of Space, Govt. of India for identifying potential areas for expansion of sericulture using RS & GIS techniques. The outcomes of the first phase of the project have been appreciated by Govt of India, various State Government and stakeholders throughout the country. In the second phase potential districts, not covered in the earlier phase including NE States, have been selected for assessment and finding suitable areas for introducing sericulture in the non-traditional States. The efforts made by CSB, NESAC, State Remote Sensing Applications Centres and State Sericulture Departments in generating targeted information are appreciable.

The present publication is an outcome of the same and is expected to provide critical inputs to the policy makers, State departments and other agencies to take up further expansion of Sericulture in respective States.

11-10-18

Rajit Ranjan Okhandiar, IFS

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

कार्यालय : केरेबो कांप्लेक्स, बी.टी.एम लेआउट, मडिवाला, बेंगलूरु -560 068, भारत
Off : CSB Complex, B.T.M Layout, Madiwala, Bengaluru-560 068, India
दूरभाष कार्यालय/ Phone Off: 080-26680190/26282500, फैक्स: 080-26681511, 26680723
ई-मेल: ms.csb@nic.in E-mail: ms.csb@nic.in

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उमियम-793 103, मेघालय
दूरमाष : 0364-2570140, 2570012,
2570141, 2908814, 2908812
फैक्स : 0364-2570139

NORTH EASTERN SPACE APPLICATIONS CENTRE
Government of India, Department of Space
Umiam-793 103, Meghalaya
Tele: 0364-2570140, 2570012,
2570141, 2908814, 2908812
Fax: 0364-2570139

PREFACE

North Eastern Space Applications Centre (NESAC) is taking the lead in applications of geospatial tools in Sericulture development in the country by successfully implementing a national level project on Applications of Remote Sensing and GIS in Sericulture Development funded by Central Silk Board (CSB), Ministry of Textiles, Govt. of India. The first phase of the project has successfully been executed in 108 districts from 24 states of the country covering all four types of sericulture (Mulberry, Eri, Muga and Tasar) in collaboration with State Remote Sensing Application Centres (SRSACs), State Sericulture Departments and other partner Institutes.

Now the 2nd phase of the project is being implemented in 70 priority districts in the country covering 25 states, out of which 20 districts have been selected from North Eastern (NE) states. Mapping of potential areas for sericulture development in these priority districts of NER has been completed and the database have been integrated in the SILKS (Sericulture Information Linkages and Knowledge System) geoportal developed as a part of the project which is hosted live at http://silks.csb.gov.in.

Maps and statistics on the potential areas identified in 20 selected districts from NER have been brought out in this form of an Atlas and this will help all the stakeholders of sericulture community for better planning and expansion of sericulture in NER.

I complement the entire project team for their sincere effort in completing the project work for NER and bringing out the Project Atlas. I Hope that the Atlas will serve as reference for all who are associated sericulture and further accelerate its growth.

(PLN Raju)
Director, NESAC
& the Project Director

ACKNOWLEDGEMENTS

The project team would like express sincere gratitude to Central Silk Board (CSB), Ministry of Textiles, Government of India for recognizing the capability of NESAC and entrusting NESAC to carry out the project on Applications of Remote Sensing & GIS for Sericulture Development" for additional 70 districts of India, out of which 20 districts are from North Eastern Region (NER). The project team extend heartiest thankfulness to Shri Rajit Ranjan Okhandiar, IFS, Member Secretary of CSB and Dr. H. Nagesh Prabhu, IFS, Former Member Secretary of CSB for their keen interest and whole hearted support.

We are grateful to Dr. K. Sivan, Chairman Indian Space Research Organization (ISRO) & Secretary Department of Space and Shri A.S. Kiran Kumar, former Chairman, ISRO and Dr. P.G. Diwakar, Director EDPO and Former Director of NESAC for their support and encouragement.

Sincere thanks to Director, NESAC and Project Director of the project for his continuous support and guidance in successful implementation of the project.

The project team is thankful to Central Muga Eri Research & Training Institute (CMERTI), Jorhat, Central Sericultural Research & Training Institute (CSRTI), Mysore, CSRTI, Berhampur, Central Tasar Research & Training Institute (CTRTI), Ranchi, Regional Office of CSB, Guwahati and other regional centres of CSB for providing non spatial data-base for integration into Sericulture Information Linkages & Knowledge System (SILKS) web portal.

We are also thankful to the Department of Sericulture of all the NER states for providing technical and logistic support in executing the programme. The active support of all the State Remote Sensing Application Centre (SRSAC) of NER is also whole heartedly acknowledged for actually carrying out the site suitability analysis work for their respective states.

B.K. Handique
Project Coordinator

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

PROJECT TEAM

Project Director
Shri P.L.N. Raju

Project Coordinator
Dr. Bijoy Krishna Handique

Methodology development, database generation & Quality assurance
Smt. Pratibha T. Das
Dr. Jonali Goswami
Shri Chandan Goswami

SILKS portal development and database integration
Shri Puyam Subhash C. Singh
Shri Pranjal Saikia

Project assistance
Shri Gautam Borah
Shri Ashu Negi

Project management from CSB, Bengaluru
Dr R K Mishra, Director (Tech), CSB Bangalore
Dr C M Bajpeyi, Scientist-D, CSB Bangalore
Dr V K Rahmatullah, Scientist-D, CSB, Bangalore
Shri Sekhar Reddy DS, Asstt. Supdt (Tech), CSB, Bangalore

Project Monitoring Committee

Chairman
Member Secretary, CSB, Bengaluru

Members
Director, Uttarakhand Space Application Centre, Dehradun
Director, Maharashtra Remote Sensing Application Centre, Nagpur
Director, Jharkhand Space Application Centre, Ranchi
Head, Agriculture Group, National remote Sensing Centre, Hyderabad
Director, Central Muga Eri Research & Training Institute, Jorhat
Director, Central Sericultural Research & Training Institute, Mysore
Director, Central tasar Research & Training Institute, Ranchi

Convener
Director, North Eastern Space Applications Centre

Project team of state wise project execution

State Remote Sensing Application Centre, Arunachal Pradesh
Dr. Harekrishna Dutta
Shri Saumitra Deb

Nagaland Science, Technology & Environment Council
Shri Ditho Katiry
Shri Thsope Medo

Tripura Space Applications Centre
Shri N. Dutta
Shri Abhijit Roy

Assam Remote Sensing Application Centre
Dr. C.R. Deka
Shri Ranjit Sarma
Dr. Kalyanjit Sarma

Mizoram Remote Sensing Application Centre
Dr. R.K. Lallianthanga
Shri Robert Lalchhanhima Sailo
Shri H. Lalhmachhuana
Smt. Hmingthanpuii
Shri R. Lalfamkima
Kum. Vanlalmuansangi

Sikkim State Council of Science & Technology
Shri D.G. Shrestha
Shri N.P. Sharma
Shri Benoy Kr. Pradhan
Shri Baichung Lepcha

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Abbreviations

AFS	Agro-forestry Systems
AWS	Automatic Weather Station
CDP	Catalytic Development Programme
CSB	Central Silk Board
CSC	Common Service Centre
DEM	Digital Elevation Model
FAO	Food and Agriculture Organization
GIS	Geographic Information System
ICT	Information Communication Technology
IMD	India Meteorological Department
IMSD	Integrated Mission for Sustainable Development
IRS	Indian Remote Sensing Satellite
ISRO	Indian Space Research Organization
IT	Information Technology
LAN	Local Area Network
LGP	Length of Growing Period
LULC	Land Use Land Cover
MSL	Mean Sea Level
NBSS & LUP	National Bureau of Soil Survey and Land Use Planning
NRDB	Natural Resources DataBase
NRIS	Natural Resources Information System
NRSC	National Remote Sensing Centre
NWIP	National Wastelands Inventory Project
NWUM	National Wastelands Updating Mission
NWUP	National Wastelands Updation Project
PET	Potential Evapo-Transpiration
RS	Remote Sensing
SEZ	Special Economic Zone
SHG	Self Help Group
SILKS	Sericulture Information Linkages & Knowledge System
SLUSI	Soil and Land Use Survey of India
SPAARS	Survey of Potential and Actual Area with Remote Sensing
SRSAC	State Remote Sensing Application Centre
SRTM	Shuttle Radar Topographic Mission
VKC	Village Knowledge Centre
VRC	Village Resource Centre

EXECUTIVE SUMMARY

Sericulture is a source of livelihood and provides gainful employment in the rural areas, especially for the women. The Central Silk Board (CSB), Ministry of Textiles has placed greater emphasis on improving the productivity at all stages of silk production to ensure higher returns to the stakeholders. Realizing that the space technology in the past has provided valuable inputs to the sericulture development, CSB has requested the Department of Space (DOS) to suggest appropriate inputs for expansion of sericulture activities particularly in the non-traditional sericulture states with a special emphasis on NE states.

North Eastern Space Applications Centre (NESAC) took the lead on behalf of DOS and came up with the project proposal titled Applications of Remote Sensing and GIS in Sericulture which has two major components: i) Identification and mapping of potential areas on 1: 50,000 scale for development of silkworm host plants covering selected districts in all 7 North Eastern States. iii) Development of a network of Sericulture Information Linkages and Knowledge System (SILKS) for the selected districts. The first phase of the project has successfully been implemented in 108 districts from 25 states in the country. Based on the success of the first phase of the project, a second phase of the project is being implemeted in 70 priority districts in the country, where 20 districts are selected from 7 states of NER. This Atlas contains the maps and statistics of potential areas identified in the selected 20 districts.

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

Among the NE states, Assam is found to have maximum suitable areas (149442 ha) in the selected 7 districts that can be brought under Mulberry Sericulture. This is followed by Nagaland (27648) and Meghalaya (171208 ha). Due to limitation of physiographic conditions and climate, Sikkim is having very limited areas (19821 ha) in the selected district.

In Assam the highest suitable area was found in Sivsagar district covering an area of 39022 ha, followed by Kamrup and Baksa having 26871 Ha, 26760 ha respectively. Further, the mulberry suitability among remaining districts are 26760 ha, 23023 ha, 11151ha, 2849 ha in Dhemaji, Kokrajhar, Goalpara and Morigaon district respectively. For non mulberry sericulture, Goalpara is having the highest suitability area of 132747 ha, 86184 ha respectively for Eri and Muga.

Out of the selected three districts in Arunachal Pradesh, West Siang district is having the highest mulberry suitable areas of 25221 ha. This is followed by East Siang and Siang districts with areas of 7342 ha, 4427 ha respectively. Among non mulberry suitability areas, suitable areas under Eri was maximum in East Siang with an area of 9955 ha.

In Nagaland the highest area under mulberry suitability is found in Paren district (2328 ha) among the 3 selected districts. Paren district is followed by Dimapur (4420 ha). Among non mulberry suitability area again Paren district is having the highest suitable areas. Among the two selected districts of Meghalaya, Jaintia Hills district is having the highest mulberry as well as non-mulberry suitable areas, the mulberry suitability area found to be 151386 ha .

The Koilasib district of Mizoram is highly suitable in Mulberry having an area of 61050ha and Non mulberry (Eri and Muga) suitability areas are also highest in Koilasib district with areas of 37402 ha, 24768 ha respectively. In Tripura Gomati district is having highest mulberry suitable area of 18259ha followed by Sepahijila district having area of 9268ha. In Sikkim only one district was studied, which is west sikkim which is having a mulberry suitable area of 19821ha.

All these information have been integrated in the SILKS (Sericulture Information Linkages and Knowledge System) portal developed as a part of the project and has been put in the public domain under the domain name http://silks.csb.gov.in. SILKS is a single window, ICT-based information and advisory services system for the farmers, sericulture extension workers, administrators and planners working in the field of sericulture development.

1. INTRODUCTION

1.1. Background

Silk is the most elegant textile in the world with unparalleled grandeur, natural sheen, and inherent affinity for dyes, high absorbance, light weight, soft touch and high durability and appropriately called as the “Queen of Textiles”. Production of silk provides livelihood opportunity to millions owing to high employment oriented, low capital intensive and remunerative nature of its production. Sericulture is one of the important sectors of economy in India and plays an important role in programmes of poverty alleviation. Silk industry provides employment to approximately 8.25 million persons in rural and semi-urban areas in India during 2015-16. Of these, a sizeable number of workers belong to the economically weaker sections of society, including women. Compared to agricultural crops, sericulture provides more employment all round the year and fetches higher income for rural farm families. Sericulture allows commercialization and diversification of farm enterprises.

India has the unique distinction of being the only country producing all the five known commercial silks, namely, mulberry, tropical tasar, oak tasar, eri and muga, of which muga with its golden yellow glitter is unique and prerogative of India. India is the second largest producer of silk in the world. Among the four varieties of silk produced in 2015-16, Mulberry accounts for 71.8% (20,434 MT), Tasar 9.9% (2,818 MT), Eri 17.8% (5,054 MT) and Muga 0.6% (166 MT) of the total raw silk production of 28,472 MT. Mulberry sericulture is mainly practised in five states namely, Karnataka, Andhra Pradesh, West Bengal Tamil Nadu and Jammu and Kashmir. North Eastern Region (NER) of India produces four varieties of silk viz., Mulberry, Oak Tasar, Muga and Eri. Overall NE region contributes 18% of India's total silk production in the country.

The demand for superior quality bivoltine silk is increasing in India for domestic consumption as well as value added silk products for the export market. The Ministry of Textiles Government of India and Departments of Sericulture in various states provide technical and financial assistance for enhancing the bivoltine silk production. Sericulture is the functional area under the Ministry of Textiles. The ministry has taken a number of policy initiatives to promote sericulture in the country. Sericulture is included as agriculture allied activity under Rastriya Krishi Vikash Yojana (RKVY). This enables the sericulturists to avail the benefits of the scheme for the entire sericulture activities up to reeling. Forest Conservation Act has been amended to treat non mulberry sericulture as forest based activity enabling the farmers to undertake Vanya silkworm rearing in the natural host plantation in the forests. The in initiatives of CDP-MGMREGA (Catalytic Development Programme-Mahatma Gandhi Rural Employment Guarantee Act) convergence will help sericulture farmers to avail assistance from MGNREGA scheme.

1.2. Space Technology inputs in sericulture related studies

Sericulture production is still limited to a few pockets in our country and the current production (about 29 thousands tones) is not adequate to meet the demand for silk in the country. The same time there is tremendous scope for improving the production and quality of silk through improved method of information collection, processing and dissemination, in addition to use of biotechnology. Central Silk Board (CSB) and Indian Space Research Organization (ISRO) in collaboration with the concerned States Sericulture/Textiles Departments applied the technology of remote sensing (RS) and geographical information system (GIS) for mulberry acreage estimation, garden condition assessment and for finding suitable areas for introducing sericulture in the non-traditional States. ISRO and CSB had carried out another large area project, called National Survey of Potential and Actual Area under Sericulture through Remote Sensing (SPAARS), in which large scale application of the RS and GIS technologies were tried. Satellite based estimates of area under mulberry and a comparison of these estimates with that of the State Sericulture Department showed drastic reduction in the acreage under mulberry in some districts like Mysore and Bangalore rural districts of Karnataka State. SPAARS also had carried out district wise assessment of area suitable for sericulture development on 1:250,000-scale mapping. The database generated under this project is available at the five Regional Remote Sensing Centres (RRSCs) under ISRO, Department of Space. SPAARS in some way served as a mechanism of evaluating the National Sericulture Project funded by World Bank.

Although many organizations are involved at various stages of silk production in different states, reliable information on the potential area suitable for silkworm host plants is not available at the district level and the extension machinery is not able to reach the far-flung places in the region. In the non-traditional States like Punjab, Haryana, Madhya Pradesh, etc. there is urgent need for diversification of agriculture, to protect the soils from degradation, to raise surplus income in the hands of farmers and to attain ecological/economic security of the traditionally wheat-rice ecosystem of our country. It is in this context, sericulture has to be seen as an alternative to agriculture. Adoption of sericulture as an alternative to agriculture is possible under suitable agro-climatic conditions all over India and especially in NER. But the potential varies from place to place and needs scientific evaluation of an area before venturing into the practice. It is here that the satellite technology has an important role to play. CSB entrusted the responsibility of executing a national level project entitled “Applications of Remote Sensing & GIS in Sericultural Development’ covering 108 districts from 24 states of the country to North Eastern Space Applications Centre (NESAC), under Department of Space, Govt. of India in collaboration with State Remote Sensing Centres with the following objectives-

i) To identify potential areas for mulberry and non-mulberry sericulture development in 108 priority districts representing 24 states of India and

ii) To develop Sericulture Information Linkage & Knowledge System (SILKS) for the selected 108 districts.

The project has successfully completed with the mapping of potential areas for mulberry and non-mulberry sericulture development in 108 priority districts representing 24 states of India and developed a SILKS geoportal, which is now available in public domain under domain name https://silks.csb.gov.in.

Based on the success of the project, CSB approved the implementation of a second phase of the project in additional 70 priority districts from 25 states, out of which 20 districts were selected from NER. Selection of these districts was based on the recommendation of the State Sericulture Departments of the concerned states. The project work in 20 districts from NER has been completed and database of these project has been integrated in the SILKS portal. Maps and statistics on the potential areas identified in these 20 selected districts from NER have been brought out in this form of an Atlas and are expected to help all the stakeholders of sericulture industry for better planning and expansion of sericulture in NER.

1.3. User Perspective

The beneficiaries of the project output include sericulture extension officials, farmers/ sericulturists at the grass-root level Self-Help Groups, financial institutions like Banks and Co-operative Societies, State Sericulture Directorates, Regional Development Offices and Central Research Laboratories/ Institutes of Central Silk Board (CSB).

1.4. Districts/areas covered in NER

A total of 20 districts are being covered from NER, details of which are given below:

State	Selected Districts
Arunachal Pradesh	East Siang, Siang, West Siang
Assam	Baksa, Dhemaji, Goalpara, Kamrup Rural, Kokrajhar, Morigaon, Sivasagar
Meghalaya	Jaintia Hills (Undivided), West Garo Hills (Undivided)
Mizoram	Kolasib, Serchhip
Nagaland	Dimapur, Kohima, Paren
Sikkim	West Sikkim
Tripura	Gomati, Sepahijala

1.5. Implementation Guidelines / operational modalities

The project is being implemented by the North Eastern Space Applications Centre (NESAC) located at Shillong, Meghalaya serving as the nodal agency for the project. The State Remote Sensing Application Centres (SRSAC) of all the selected 7 states and the Dept. of Sericulture/Textiles of the respective states participated as collaborating centres. Responsibilities of various organizations participating in the project are as given below.

1.5.1. Central Silk Board, Ministry of Textiles

- Project monitoring, linkage establishment with State Directorates/ Departments of Sericulture/ Textiles, mid course corrections and guidance.
- Financial Support and yearly sanctions effecting smooth flow of funds.
- Facilitate co-operation from the Central Research laboratories and Regional Stations under their administrative control.
- Arrange to provide technical data, scientific inputs, and feed-back.

1.5.2. North Eastern Space Applications Centre (NESAC)/ Department of Space

- Nodal agency and overall responsibility for project implementation
- Methodology standardization, classification scheme/legend development and drafting of manuals/handbook.
- Expert Centre for identification of suitable areas for sericulture development in the NER States.
- Development of SILKS.
- Coordination with Central Silk Board, Ministry of Textiles, Bangalore.
- Linkages with the State Sericulture/Textiles Departments and SRSACs.
- Progress reporting on physical and financial targets.
- Submission of utilization certificates.
- Structuring of training course and preparation of training material.
- Orientation training of State officials and on-the-job training.

1.5.3. State Remote Sensing Applications Centers

- Responsible for analysis and interpretation of satellite data identification of suitable areas for sericulture development in their respective States.
- Providing agro-meteorological data and soil map on 1:50,000 scale (if available).
- Ground truth, field validation and ancillary data collection.
- Liaison with State Directorate/Department of Sericulture/Textiles.
- Logistic support during field visits and field validation.
- Submission of progress reports and utilization certificates (UCs).

1.5.4. State Directorates/Departments of Sericulture/Textiles

- Cooperation and logistic support during ground truth collection.
- Supply of agro-meteorological data.
- Participation in the interpretation/analysis of satellite data either at NESAC/SRSACs.
- Sponsoring/identification of officials for on-the-job training and project participation.

1.6. Deliverables of the project

- District-wise estimates of area suitable for developing silkworm food plants. This will be accompanied by a set of maps on 1:50,000 scale.
- Reports summarizing the area estimates and names of villages/Panchayats/blocks suitable for sericulture in each district.
- SILKS for 20 districts NER will be developed and integrated to silks.csb.gov.in

1.7. Monitoring and Evaluation

A Project Monitoring Committee (PMC) with the Member Secretary, Central Silk Board as the chairperson, members representing NESAC, State Remote Sensing Application Centres, State Directorates of Sericulture/ Textiles and Project Director as its convener, would provide overall project management and monitoring. PMC will review and recommend yearly release of funds. PMC ensures organizational linkages for the successful implementation and completion of the project as scheduled.

2. MATERIALS AND METHODS

2.1. Identification of Potential Areas for Silkworm Food Plants

The methodology for identification of potential areas for sericulture development involves evaluation of land and water resources requirements for growing silkworm food plants as well as rearing of silk worms. Mulberry *(Morus spp.)* is the only food plant for silk worm *Bombyx mori.* Silk produced by *Philosamia ricini* is called Eri silk. The food plants of Eri silkworm mainly consist of castor *(Ricinus communis)* and other alternatives like *Heteropanax fragans, Manihot utilissima, Earica papaya, Ailanthus sp., Plumeria acutifolia*. For the extraction of tasar silk three species of silkworm *Antherea* are used in India. They are *Antherea mylitta*, *A. perniyi* and *A. royeli*. This silkworm is reared on trees of *Terminalia tomentosa, Terminalia arjuna*. Tropical tasar silk worm *(Anthracea mylitta)* feeds on the leaves of *Terminalia tomentosa (Asan), T. arjuna, Shorca robusta (Sal), Lagerstromca parviflora (Senna), Zizyphus martiana,* etc. The silk produced by Antherea assamensis is called Muga. This silkworm prefers feeding on Som *(Machilus bombycina)* and Soalu *(Litsaea polyantha)*. The temperate tasar *(A. proylei J)* feeds on *Quercus serrata, Q.incana and Q. Semicarpifolia*.

The assessment of suitability of land for sericulture involves evaluating the land qualities for the requirements of the silkworm food plants (FAO, 1976; Sys, 1985, Sys et al., 1993) and silkworm rearing. It needs interpretation and integration of climatic parameters, physiographic conditions, soil parameters and land use/ land cover etc. using GIS (Handique et al., 2016). Land use land cover map at 1: 50,000 scale for the period 2015-16 generated by National Remote Sensing Centre (NRSC) in collaboration with State Remote Sensing Application Centres (SRSAC) will be updated by visual image interpretation using Resoursat-2 LISS-IV imagery for identification of culturable wastelands for mulberry and forest fringe areas for non-mulberry food plants.

2.1.1. Identification of Potential Areas for mulberry

2.1.1.1. Evaluation of site suitability based on landscape and soil characteristics

Soil characteristics (soil depth, pH, texture, stoniness, soil drainage, etc.) were integrated while assessing the soil site suitability. Soil characteristics were obtained from the soil map prepared at 1:50,000 scale under the different projects such as Natural Resources Census (NRC)- Soil Resource Mapping (SRM), Natural Resources Data Base (NRDB) project, etc. Slope map will be derived from Carto-DEM/ SRTM-DEM. Information on ground water availability will be obtained from ground water prospect map already prepared under NRDB project or under Rajiv Gandhi National Drinking Water Mission. The slope map will be reclassified based on plant requirements. Different thematic layers will be generated in GIS environment for each of the land characteristics (Table 2.1) and will be

compared with the requirements of silkworm food plants (Table 2.2). Degree of limitation ranging from 1 (suggesting no or slight limitation) to 4 (suggesting very severe limitation) will be assigned and final maps will be generated (FAO, 1976a).

Table 2.1: Soil site parameters considered for land evaluation

Soil site characteristics	Related land quality
Climate (c) during crop growing period - Total rainfall (mm) - Mean maximum temperature (°C) - Mean minimum temperature (°C) - Mean relative humidity (%) - Length of growing period (days)	- Available moisture
Topography and landscape (t) - Slope - Erosion	- Landscape position - Resistance to erosion
Wetness (w) conditions - Drainage - Ground water availability	- Available moisture/ soil aeration - Landscape position - Deficiency and toxicity of nutrients
Physical condition (s) of soil - Texture - Depth	- Water availability/ soil aeration/ soil structure - Available space for root development
Soil fertility (f) - pH	- Availability of plant nutrients

2.1.1.1.1. Soil mapping using remote sensing data (where soil map at 1:50,000 scale is not available)

Soil mapping using remote sensing and GIS technique was carried out where soil map at 1:50,000 scale is not available. The existing soil maps (1:2,50,000 scale) for the culturable wastelands and other area of interest were updated with limited field survey by studying soil profile and collecting soil sample for laboratory analysis. Soil maps were prepared by considering the factors of soil formation, such as rock type, physiography, vegetation cover, slope and climate. The methodology consists of 4 steps (i) image interpretation and selection sampling sites, (ii) field survey for profile study, soil sample collection for analysis, (iii) laboratory analysis of soil samples and (iii) map preparation.

The image interpretation involves onscreen interpretation of satellite data along with the available secondary data and spatial maps for preparation of land use/ land cover map which will give information on vegetation type. The slope and aspect map were derived from DEM (Carto-DEM). Lithology and geomorphology map prepared under different projects like NRDB or Rajiv Gandhi National Drinking Water Mission were used to get information on types of parent materials and physiography, respectively. Each map represents the factors which influence soil formation. All these maps were transferred to GIS environment and overlaid and used as base map for the survey. Based on variations of these factors, sites were selected for detailed morphological study of the soil profile.

The basic procedure involved in the field survey is to establish the relationship between observed image elements and soil properties along with their physiographic setting. Detailed field investigations were carried out by studying the soil profiles, mini pits or auger bores. The soil profiles were studied in the sample sites selected on the physiographic base map upto a depth of about 1.5 meters or upto lithic or paralithic contact. Each soil profile was examined for depth, texture, drainage, flooding, coarse fragments (%) and will be recorded following standard procedure (AIS&LUS, 1970, Schoeneberger et. al., 2002). Soil samples were collected for determination of soil pH and texture in the laboratory following standard procedure.

Table 2.2: Criteria or limitation rating for evaluation of soil site suitability for Mulberry

Soil-site characteristics		Degree of limitation & Suitability class			
Limitation	Unit	0-1 None to slight	2 Moderate	3 Severe	4 Very severe
Suitability		S1 (Highly suitable)	S2 (Moderately suitable)	S3 (Marginally suitable)	N (Not suitable)
Topography and landscape					
Slope	(%)	0-5	5-15	15-33	>33
Erosion		e1	e2	e3	e4
Soil characteristics					
Drainage	Class	Well	Moderately well	Imperfect	Poor/Excessive
Ground water	Availability	Good	Fair	Fair to moderate	Poor
	Quality (EC mmohs/cm)	Very good < 2000	Fair to good 2000 - 3000	Moderate 3000 - 4000	Poor > 4000

Texture	Class	Clay loam–gravelly clay	Fine loamy	Coarse loamy	Sandy fragmental
Depth	Cm	>100	75-100	50-75	<50
pH		6.5-7.5	5.5-6.5 7.5-8.5	4.5-5.5 8.5-9.5	<4.5 >9.5

Soils vary in their properties in a natural setting. A distinctive, relatively homogenous soil cover develops on each physiographic unit. Two distinctively different physiographic units typically support soil covers that are significantly different from each other in appearance and behavior. Once, the soil landscape relationships are determined in an area, the soil cover will be inferred by examining the landscape. Based on soil landscape relationship, soil boundaries were delineated on the physiographic base map. Finally soil maps were prepared by assigning the information collected during field survey and soil sample analysis. The entire sequence of steps of soil mapping is illustrated in figure 2.1.

2.1.1.2. Evaluation of site suitability based on climatic parameters for silkworm food plants

Climate is an important parameter, which determines the growth of plant species, as the extreme climatic conditions are detrimental for plant growth. The suitability of climate for a given crop can be described in terms of: (i) minimal length of growing period, (ii) temperature, (iii) water supply (rainfall). The weather data, collected from the class-I observatories of IMD or the Automatic Weather Stations (AWS) were analyzed for rainfall, maximum and minimum temperature, Potential Evapotranspiration (PET) and length of growing period (LGP) for the silkworm food plants.

Estimation of LGP

LGP or moisture availability period for crop growth is the period (in days) when precipitation (P) exceeds 50 percent of the PET. Shorter LGP (less than 120 days for mulberry and 90-120 days for castor) may not suitable for cultivation of silkworm food plants.

Monthly potential evapotranspiration (mm) has to be calculated for all the stations by Thornthwaite method (1948) as illustrated below:

PET = 16xCx(10xT/I) a for T≤26.5°C eq.2

PET = C×(-0.43253×T^2+32.244-415.85×T) for T >26.5°C eq.3

Where

PET= Potential evapotranspiration (mm/month)

T = Mean monthly temperature (^{0}C)

I = annual heat index for 12 months in a year (I = ∑i)

i = Monthly heat index {i = (T/5)1.514}

a = $6.75\times10^{-7}\times I3^{-7}.71\times10^{-5}\times I2\times1.792\times10^{-2}\times I\times0.49239$

C = Correction factor for each month where C = (m/30) × (d/12) table 2.3 shows the value of C for geographical location at 27^{0}N

m = No of days in a month, d = Monthly mean daily sunshine duration in hour

Table 2.3: Correction Factor C for 27 ˚N

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
0.9	0.8	1.0	1.0	1.1	1.1	1.1	1.1	1.0	0.9	0.9	0.9

It is suggested to calculate monthly PET and 0.5 PET for all the raingauge stations.

Based on climatic characteristics, limiting levels such as highly suitable, moderately suitable, marginally suitable and unsuitable were decided by matching the requirements of silkworms food plants (Table 2.4) and suitability class will be assigned to each polygon. Thus a climatic limitation map was generated.

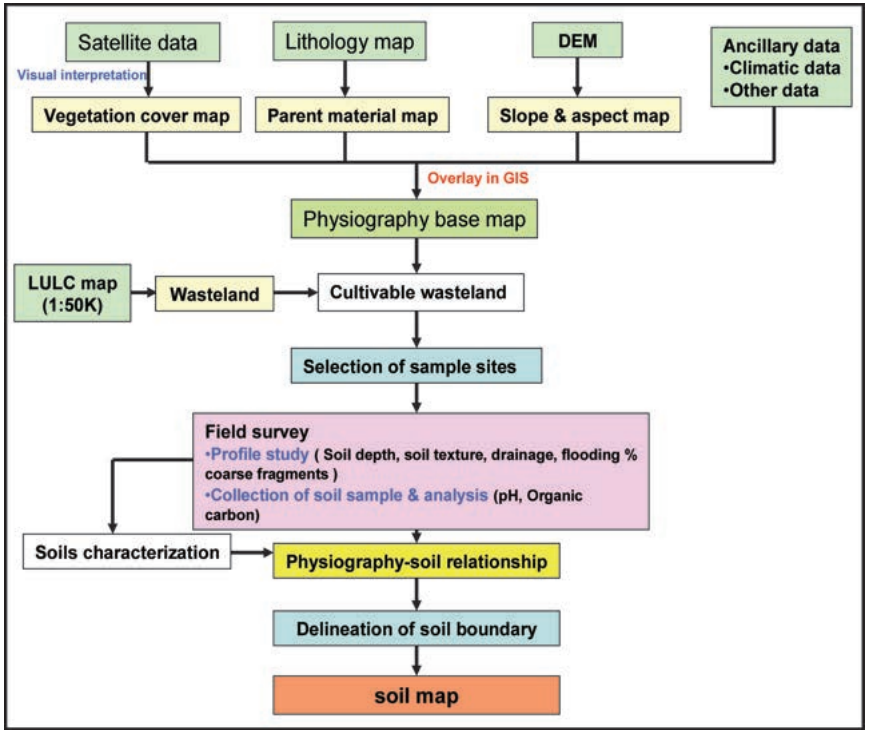

Figure. 2.1: Flow chart of methodology of soil mapping for evaluation of soil site suitability

Table 2.4: Evaluation of climatic site suitability for Mulberry

Climatic characteristics	Suitability classes			
	Highly suitable (S1)	Moderately suitable (S2)	Marginally suitable (S3)	Not suitable (N)
Sericulture food plant :Mulberry				
Mean temperature in growing season (^{0}C)	20-30	30-37	30-37	<15, >37
Total rainfall (mm)	500-750	750-2000	2000-3400	<500, >3400
LGP(days)	>120			<120

2.1.1.3. Evaluation of suitability for silkworm rearing

2.1.1.3.1. Suitability for Mulberry Rearing

Silkworms are delicate and very sensitive to environmental conditions. Among the various environmental factors, the most important are atmospheric temperature and humidity prevailing at the time of rearing. Temperature has indirect correlation to the growth of the silkworms and excessive fluctuations in temperature are harmful and should be avoided. The combined effect of both temperature and humidity largely determines the satisfactory growth of the silkworms. The growth of the worm is better under higher temperature and higher humidity condition followed by lower temperature and lower humidity condition during their life cycle. Humidity also influences directly the physiological functions of the silkworm.

Table 2.5: Suitability of Mulberry Rearing based on limiting condition of climatic parameters

Season/ Crop	Limiting Temperature (°C)			Limiting Average Relative Humidity (RH%)
	Max Temp	Min temp	Average	
Jan-Feb	23	15	20	55
March-April	28	22	25	55
may-Jun	30	25	28	70
Jun-July	29	24	28	85
Aug-Sept	28	24	27	85
Oct	29	23	26	85

The optimum temperature and relative humidity ranges are 20-28°C and 70-85%. The temperature above 30°C directly affect the health of the worm. The temperature below 20°C worm becomes too weak and susceptible to disease. But in hilly regions (Limiting condition derived taking Mizoram condition as standard), the minimum temperature and relative humidity will be 15°C and 55%, respectively.

2.1.1.3.2. Suitability for Muga Rearing

The optimum temperature and relative humidity ranges are 24-25°C and 75-80%, respectively. For commercial crop minimum temperature requirement is 16-20°C. The above given requirements are the range of temperature and humidity upto which they can sustain. For winter crop *(Jarua)* minimum temperature should not go below 7°C. (FAO, 1976).

Table 2.6: Suitability of Muga Rearing based on limiting condition of climatic parameters

Crop	Season	Limiting Temperature (°C)			Average Relative Humidity (%)
		Max	Min	Av.	
Jarua	Jan-March	29	13	21	81
Jethua	May-Jun	34	21	28	84
Aherua	June-July	33	26	30	86
Bhadiya	July-Aug	34	26	30	84
Kotia	Oct-Nov	30	19	25	83

2.1.1.3.3. Suitability of Temperate-Tasar Rearing based on limiting condition of climatic parameters

Climatic requirements are different for different species as rearing seasons are different. Rearing season for A. prolei is March to May and July to September whereas for *A. Yamamai and A. pernyi* it is June-July and August-September. Optimum temperature for *A. proylei* is 25-26°C and become restless above 28°C and inactive below 15°C. For *A. pernyi,* optimum temperature is 18-22°C and above 28-30°C and below 8-10°C are not suitable. The early stages require higher relative humidity (80-90%) than the advanced stages (70-80%) (FAO, 1976).

2.1.1.3.4. Suitability of Eri Rearing based on limiting condition of climatic parameters

Eri silkworms are reared throughout the year in both the plains and the hills at temperature ranging from 15°C in winter to 35°C in summer and from 50% to 100% relative humidity. However, the optimum range of temperature and relative humidity are 24-26°C and 75-85%, respectively. The larval span varies from 20 days in summer to 50 days in winter (FAO, 1976).

2.1.1.4. Integrated evaluation of soil and climatic suitability for silkworm food plants and sericulture development

The limitation maps generated for climate (i.e. temperature, rainfall and length of growing period), landscape and soil characteristics (i.e. slope, soil drainage, texture, depth and pH) and socio-economic parameters such as silkworm rearing habit of the population, approachability of the area, access to market etc. were spatially overlaid in GIS environment to produce a composite layer. Based on number and the intensity of limitations suitability classes were decided and graded as highly suitable (S1), moderately suitable (S2), marginally suitable (S3) and not suitable (N) as given in Table 2.7 (FAO, 1976a). The entire sequence of steps in this method is illustrated in figure 2.2. The methodology described here was modified based on availability of data on soil and climatic parameters favorable for the silkworm and its food plants.

2.1.2. Identification of Potential areas for Non mulberry (Tasar, Eri and Muga) silkworm food plants

There are varieties of non mulberry food plants for tasar and muga, which are mostly associated with forest ecosystems. Mostly the forest fringe areas are used for rearing these silkworms. Table 2.8 gives an overview of Vanya silks of India. The food plants of Eri silkworm mainly consist of castor *(Ricinus communis)* and other alternatives like *Heteropanax fragans, Manihot utilissima, Earica papaya, Ailanthus sp., Plumeria acutifolia*.

Table 2.7: Criteria for determination of land suitability classes

Land classes	Criteria
S1: Highly suitable	Land units with no or only 4 slight limitations
S2: Moderately suitable	Land units with more than 4 slight limitations and/or not more than 3 moderate limitations
S3: Marginally suitable	Land units with more than 3 moderate limitations and/ or one or more severe limitation
N: Not suitable	Land units with very severe limitation

Most of these plant species come under the moist deciduous or semi-evergreen forest type. Experience shows that identification of individual trees of these plants may be difficult but as a plant community they can be delineated from the forest types. Areas suitable for sericulture development in these forest ecosystems are those which are up to 1 Km from periphery of forest areas (accessible zones).

Table 2.8: Vanya silkworm verities and their food plants

Silkworm Variety	Entomological Name	Primary Food Plants		Distribution
		Local Name	Botanical Name	
Tropical tasar	*Antheraea mylitta D.*	Arjun Asan Sal	Terminalia arjuna T. tomentosa Shorea robusta	Central India and Southern Plateau Region
Oak tasar	*Antheraea. proylei J.* *A. roylei Mr.*	Uyung	Quercus serrata Q. incana Q.semicarpifolia	Sub Himalaya Region and North Eastern India
Muga	*Antheraea assamensis Ww.*	Som Sualu	Machilus bombycina Litsaea polyantha	North Eastern Region

Moreover, socio-economic parameters such as silkworm rearing habit of the population, approachability of the area, access to market etc. are also considered while selecting the potential sites. Steps involved in delineating potential areas for expansion of tasar, muga and eri are described in figures 2.3 and 2.4.

2.2. Ground Truth Collection

The preliminary interpretation are checked for the quality and before collecting ground truth. The idea is to improve the quality of ground truth in light of the knowledge of interpreter about sericulture. The ground truth points were collected from identified suitable areas and also from existing plantations of mulberry and other sericulture food plants. The ground truth collection includes collection of information on geographical location along with geo-tagged photographs covering all four direction of the location.

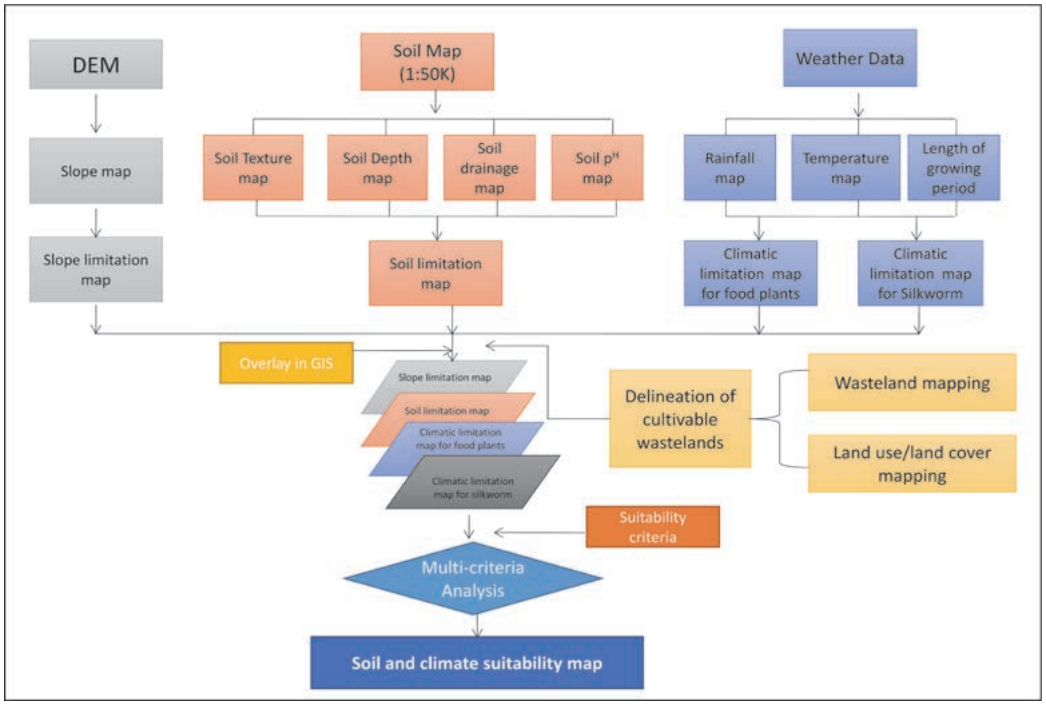

Figure 2.2: Integrated methodology of finding out suitable areas for sericulture food plants

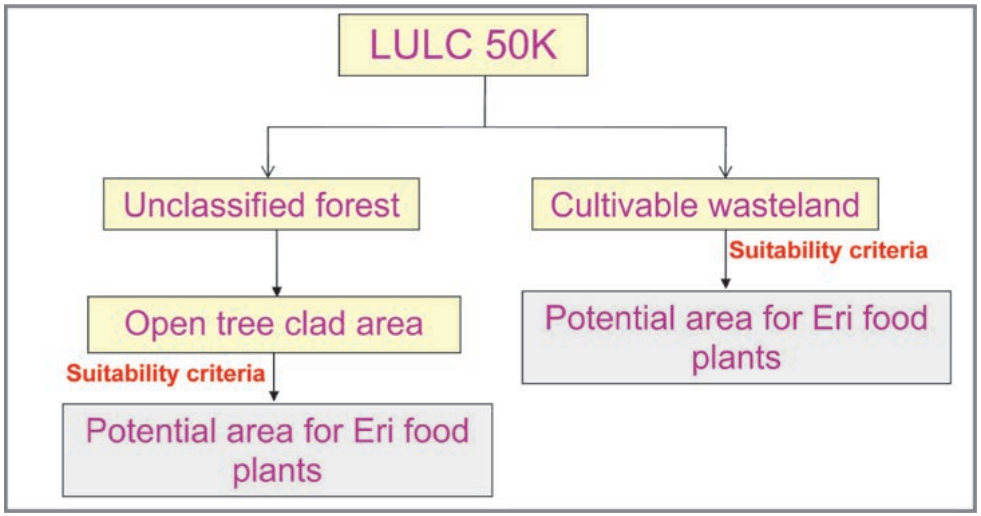

Figure 2.3: Methodology for mapping of potential areas for eri silkworm food plants

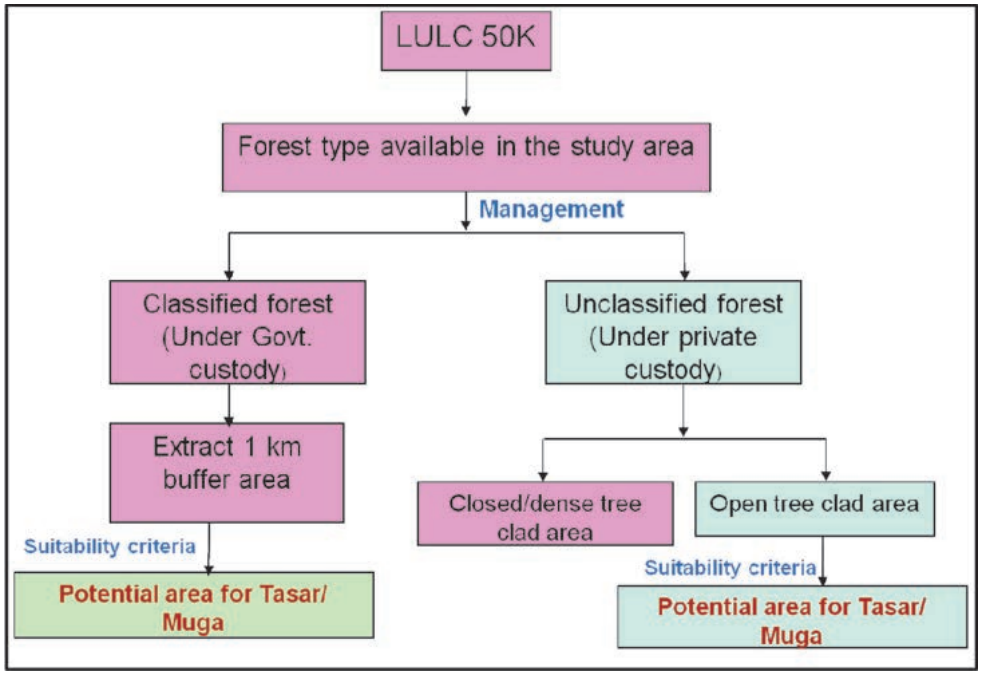

Figure 2.4: Methodology for mapping of potential areas for tasar and muga silkworm food plants

2.3. Output and Statistics Generation

From the maps of potential sites for silkworm food plants, area statistics are generated for highly, moderately and marginally suitable classes at district/block level.

2.4. Output Products Including Metadata

The seamlessness of an output map with adjacent maps need to be checked carefully. The check is to be carried out for both continuity of the mapping using and thematic accuracy. To assess the quality, a 3' x 3' grid are overlaid on the output data and required number of random points will be generated in each of the grid. The thematic accuracy are visually assessed at these pints and all the results of all these points are summed-up for assessing the quality of the output.

2.5. Quality assurance

The second phase of the project envisages mapping of potential sites for silkworm food plants at 1:10,000 scale. Since the project is being carried out for 25 states of the country, seamless data generation plays an important role for effective utilization of output. So, for quality of the output, quality check is required at various stages of project. Quality assurance are in the line of LULC 50K Project of NRSC/Dept. of Space.

A two-fold quality assurance mechanism is suggested that involves internal quality audit as well as external quality audit. The collaborating centres should identify members for internal quality check whom should not be included in the mapping and vice versa.

The NNRMS standards finalized for Natural Resources Repository (NRR), Department of Space will be adapted in this project. Quality checks will be carried out at various stages in a systematic manner. The remarks of the Internal Quality Audit Team (IQAT) should be recorded in the prescribed format with specific recommendations of quality team leader. Once the IQAT clears the outputs the External Quality Audit Team (EQAT) will evaluate the quality assurance of the product. EQAT will select a minimum of 10% of the products at random for quality assurance and evaluation. The products whose samples do not meet the quality standards will summarily be returned for incorporation of necessary corrections as suggested by EQAT. If the quality is not met in these randomly drawn areas, the entire lot will be rejected. Only those outputs meeting the accuracy standards will be cleared for incorporation in the geo-database.

2.6. Development of sericulture information linkage & knowledge system (SILKS)

As in the first phase of the project, all the project outputs in the form of site suitability maps, relevant inputs layers, and all other relevant

information for expansion of sericulture were integrated in the form of sericulture information linkage & knowledge system (SILKS). SILKS is a single window, ICT-based information and advisory services system for the farmers practicing sericulture. The objectives of SILKS is to i) provide computerized information storage, value addition, and supply sericulture knowledge to the farmers, ii) Provide planning and advisory services in formats and language appropriate for the local sericulturists, and

Briefly, the steps involved in developing SILKS are:

- Users' need assessment of sericulturists in the traditional and non-traditional districts.
- Collection of existing data and information and gap assessment district-wise for the 50 intensive sericulture practicing districts in the country.
- Additional data collection through remote sensing and other methods.
- Data base design and network configuration.
- Creation of geospatial data of potential areas for sericulture development in GIS environment and non-spatial sericulture knowledge and best practices information from the CSB's research and extension institutes.
- Organizational linkages for updating and maintenance of the database.
- Web-enabling and dissemination of information and advisory services.

Each SILKS have modules of information on the natural resources potential of a group of villages, their suitability for sericulture, agro-climatic conditions, package of best practices of sericulture, cocoon and silk marketing information, etc. The meteorological data collected by the network of Automatic Weather Stations (AWS) being established all over India and a few in the R&D laboratories of CSB form an important source of data for value added services from SILKS. Information modules of SILKS are categorized broadly under three main classes of information viz., natural resources information, planning services, other services and farmers' services. Implementation of the overall SILKS following the design specifications has been carried out judiciously after selecting a testing environment. Testing was required for each component of SILKS framework that was implemented both in the database and application coding levels. The SILKS has been hosted live at http://silks.csb.gov.in. There are two instances of database running in parallel– PostgreSQL is used to store and maintain all the geospatial related data for all 20 districts. Mapserver is the core of entire applications and hold important Mapfiles for each district-wise SILKS. The portals are available in 12 local languages in India to attract more users with diverse background.

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DETAILS OF STATE LEVEL INFORMATION WITH MAPS AND STATISTICS

ARUNACHAL PRADESH

Arunachal Pradesh, "the land of dawn-lit mountains" is one of the 29 states of India and is the northeastern-most state of the country. It is also known as the Orchid State of India or the Paradise of the Botanists. Arunachal Pradesh borders the states of Assam and Nagaland to the south and shares international borders with Bhutan in the west, Myanmar in the east and is separated from China in the north by the disputed McMahon Line. Itanagar is the capital of the state. It is situated between latitude 26˚30'N and 29˚30' N and longitude 91˚30'E and 97˚30' E. The state is inhabited by 25 major tribes and 110 sub tribes. The department of Textiles and Handicrafts, Govt. of Arunachal Pradesh is encouraging sericulture activities in a big way in all the sericulture practicing area in the districts. Through various developmental schemes sponsored by state as well as centre, Arunachal Pradesh has potential to be a hub for various sericulture activities in near future in the context of Look East Policy (North East Vision document, 2020) unveiled by the Govt. of India. Three districts viz., East Siang, Siang and West Siang were selected for the second phase of the project, brief introduction of the districts are given below-

East Siang

East Siang is an administrative district in the state of Arunachal Pradesh in India. It is located at 28°06'34''N latitude 95°08'35''E longitude. The district headquarters are located at Pasighat. East Siang district occupies an area of 4,005 square kilometres. According to the 2011 census West Siang district has a population of 112,272. The district has a population density of 13 inhabitants per square kilometre.

Siang

Siang District is the 21st district of Arunachal Pradesh State, India. This district was created by bifurcating West Siang and East Siang districts of Arunachal Pradesh in 2015. The name of the district is derived from the mighty Brahmaputra River, which in Arunachal Pradesh is known as the Siang river. It is predominantly inhabited by Adi tribe of Arunachal Pradesh. Geographically, Siang District is located almost in the centre of the Siang belt of Arunachal Pradesh. It is located at 28°13'16''N latitude 94°59'37''E longitude.

West Siang

West Siang is an administrative district in the state of Arunachal Pradesh in India. It is located at 28°10'17''N latitude 94°47'56''E longitude. According to the 2011 census West Siang district has a population of 112,272, roughly equal to the nation of Grenada. The district has a population density of 13 inhabitants per square kilometre.

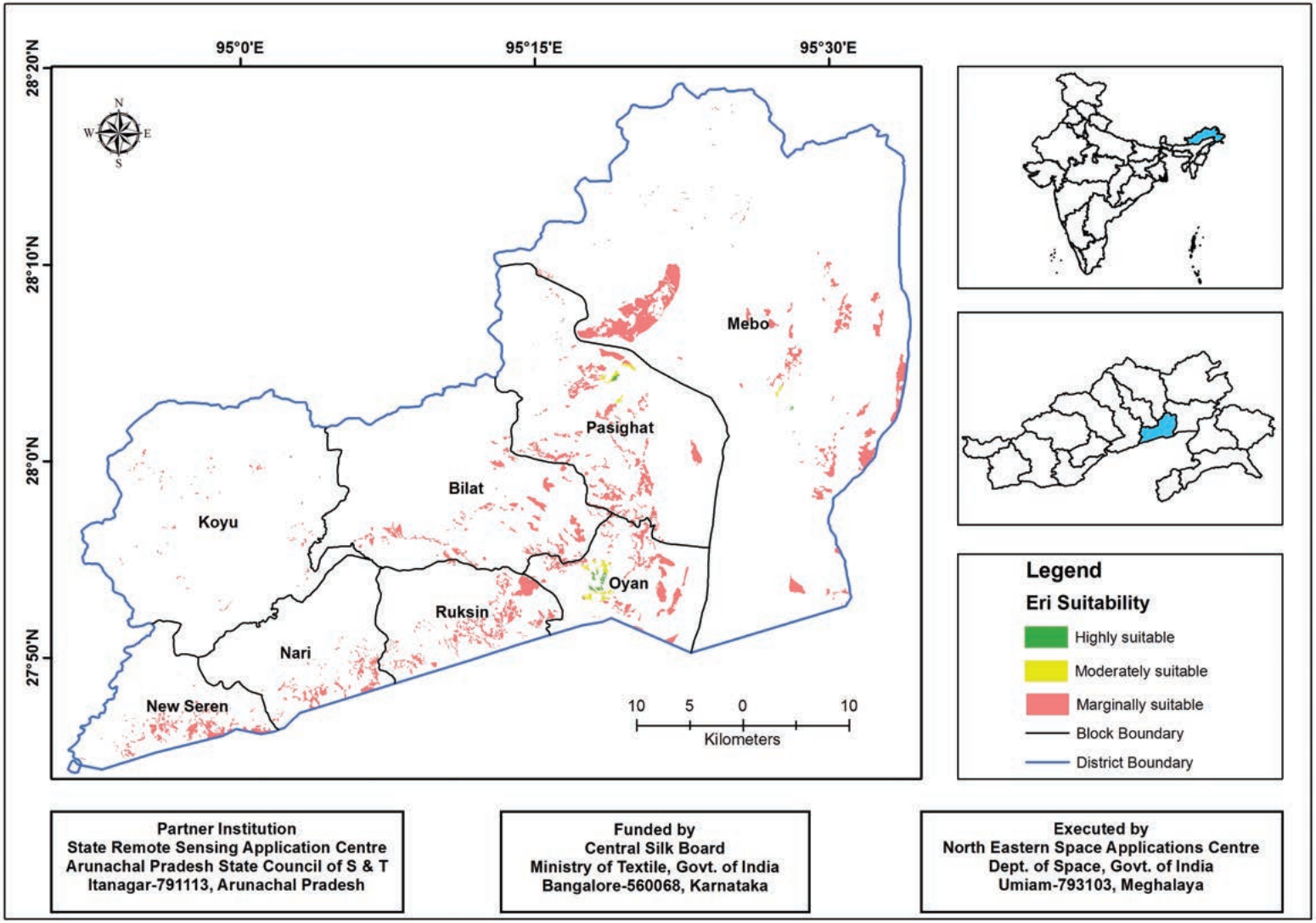

Fig 4.1.1: Suitable areas for Eri in East Siang district of Arunachal Pradesh

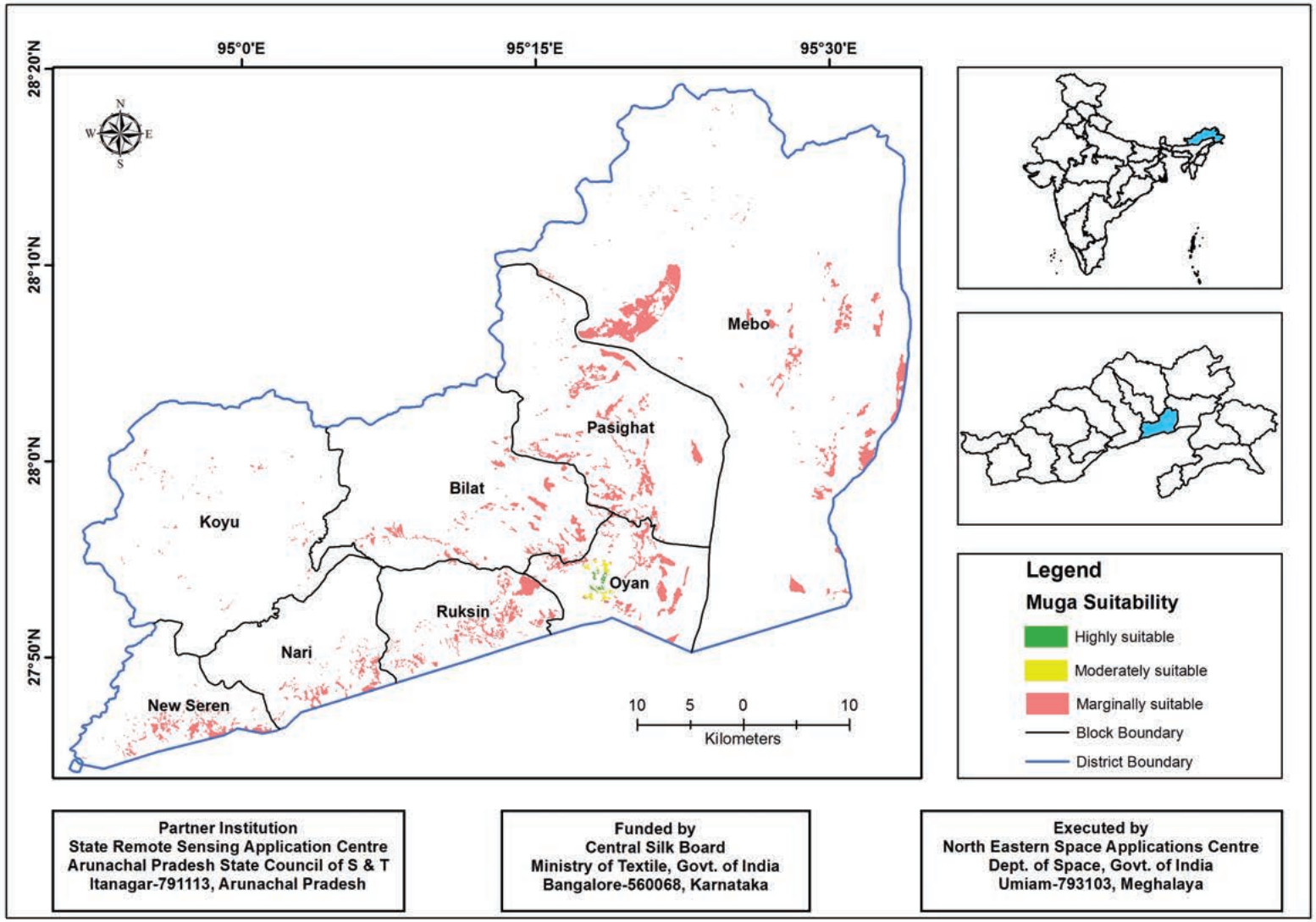

Fig 4.1.2: Suitable areas for Muga in East Siang district of Arunachal Pradesh

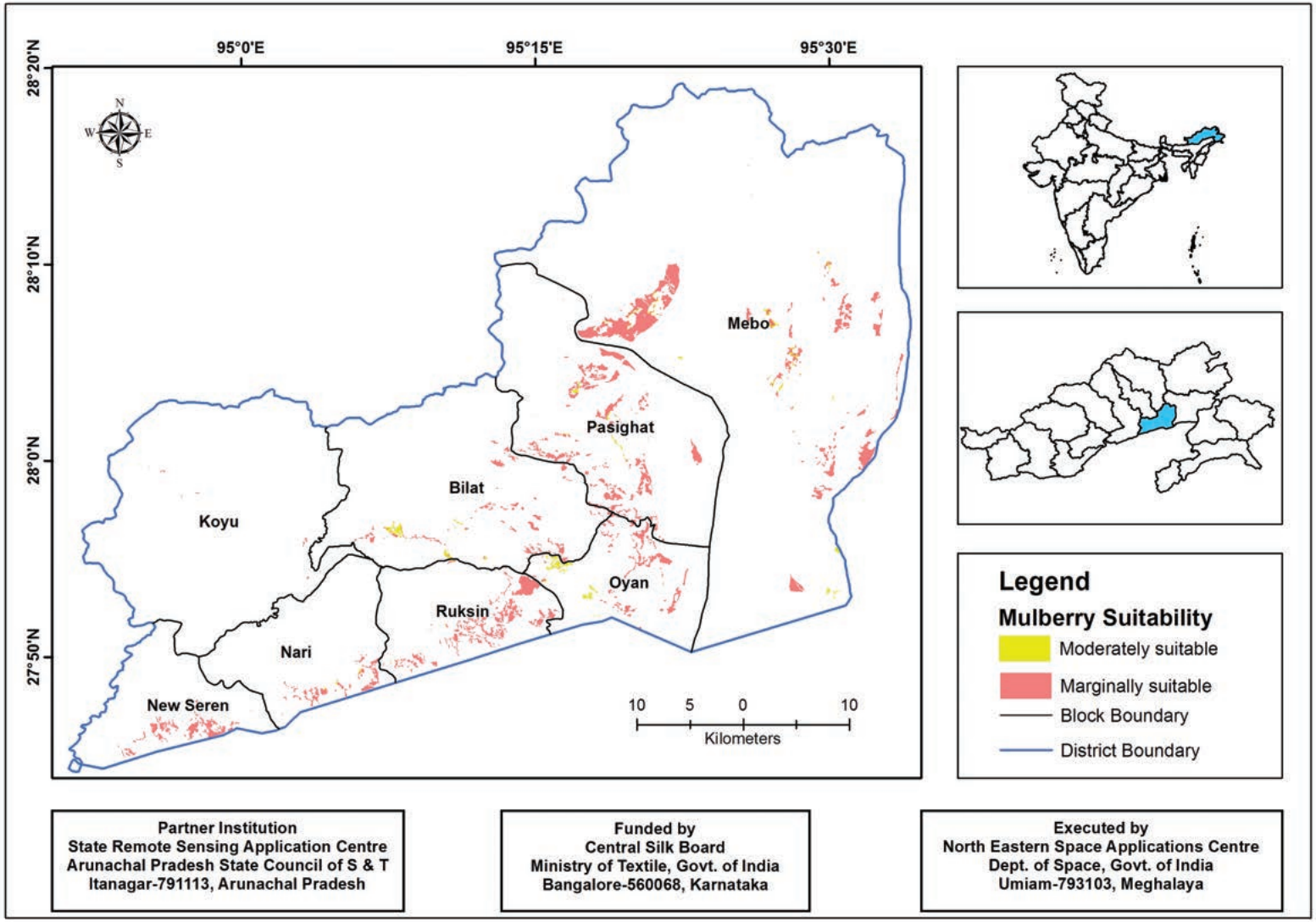

Fig 4.1.3: Suitable areas for Mulberry in East Siang district of Arunachal Pradesh

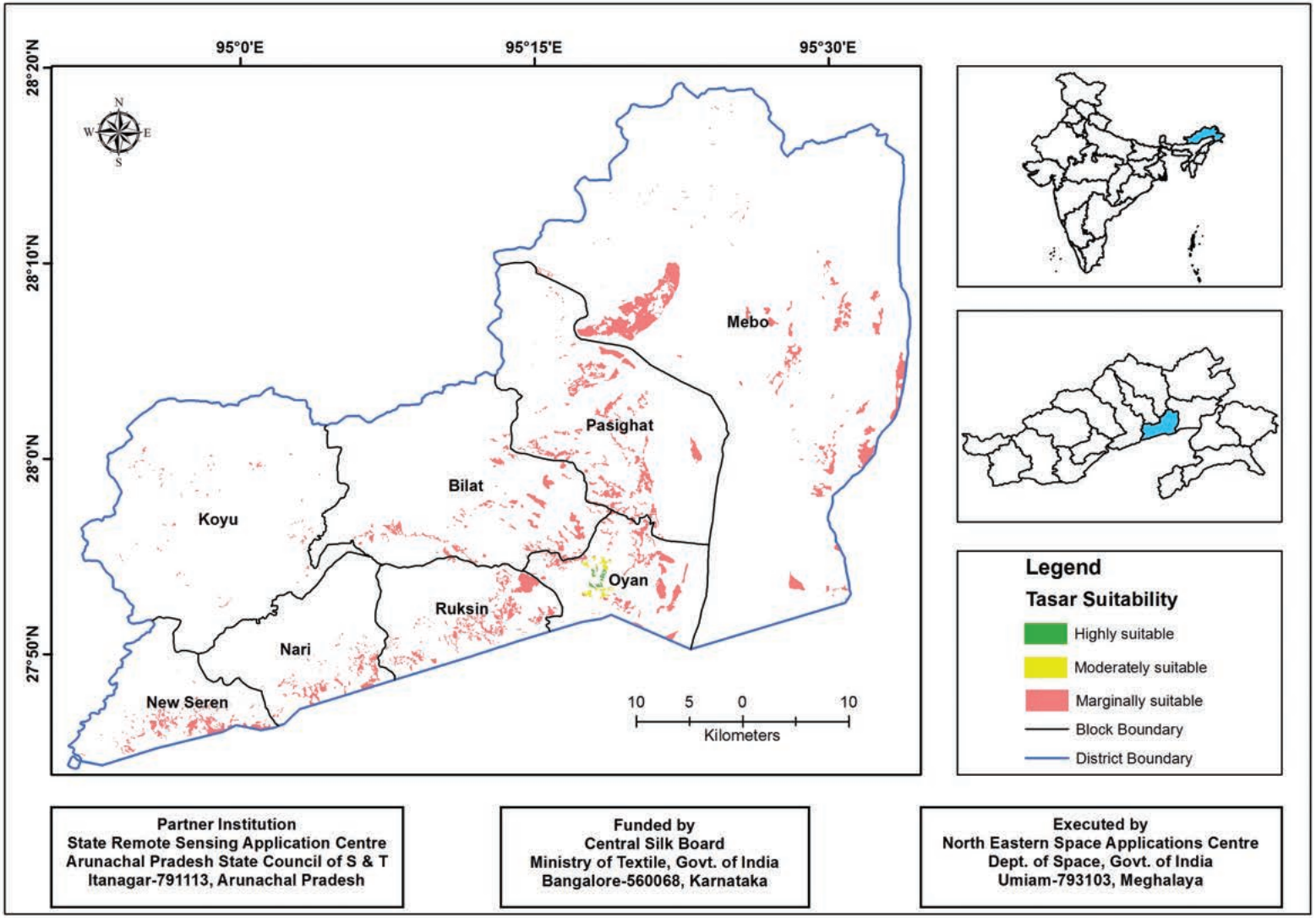

Fig 4.1.4: Suitable areas for Tasar in East Siang district of Arunachal Pradesh

Table 4.1.1: Suitable Areas for Eri in East Siang of District of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Bilat circle	-	-	1088.82	1088.82
Koyu circle	-	-	152.36	152.36
Mebo circle	5.32	18.37	3286.19	3309.88
Nari circle	-	-	522.17	522.17
New seren circle	-	-	706.86	706.86
Oyan circle	61.88	144.39	1067.08	1273.35
Pasighat circle	17.9	88.42	1654.5	1760.82
Ruksin circle	-	-	1141.17	1141.17
Total	**85.1**	**251.18**	**9619.15**	**9955.43**

Table 4.1.2: Suitable Areas for Muga in East Siang of District of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Bilat circle	-	-	1088.82	1088.82
Koyu circle	-	-	152.36	152.36
Mebo circle	-	-	3309.88	3309.88
Nari circle	-	-	522.17	522.17
New seren circle	-	-	706.97	706.97
Oyan circle	61.88	144.39	1067.09	1273.36
Pasighat circle	-	-	1760.85	1760.85
Ruksin circle	-	-	1141.17	1141.17
Total	**61.88**	**144.39**	**9749.31**	**9955.58**

Table 4.1.3: Suitable Areas for Mulberry in East Siang of District of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Bilat circle	-	111.11	507.59	618.7
Koyu circle	-	-	21.4	21.4
Mebo circle	-	183.26	2530.17	2713.43
Nari circle	-	12.95	307.69	320.64
New seren circle	-	-	466.67	466.67
Oyan circle	-	151.86	578.72	730.58
Pasighat circle	-	63.23	1387.47	1450.7
Ruksin circle	-	11.83	1007.68	1019.51
Total	**-**	**534.24**	**6807.39**	**7341.63**

Table 4.1.4: Suitable Areas for Tasar in East Siang of District of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Bilat circle	-	-	1088.82	1088.82
Koyu circle	-	-	152.36	152.36
Mebo circle	-	-	3309.88	3309.88
Nari circle	-	-	522.17	522.17
New seren circle	-	-	706.97	706.97
Oyan circle	61.88	144.39	1067.09	1273.36
Pasighat circle	-	-	1760.85	1760.85
Ruksin circle	-	-	1141.17	1141.17
Total	**61.88**	**144.39**	**9749.31**	**9955.58**

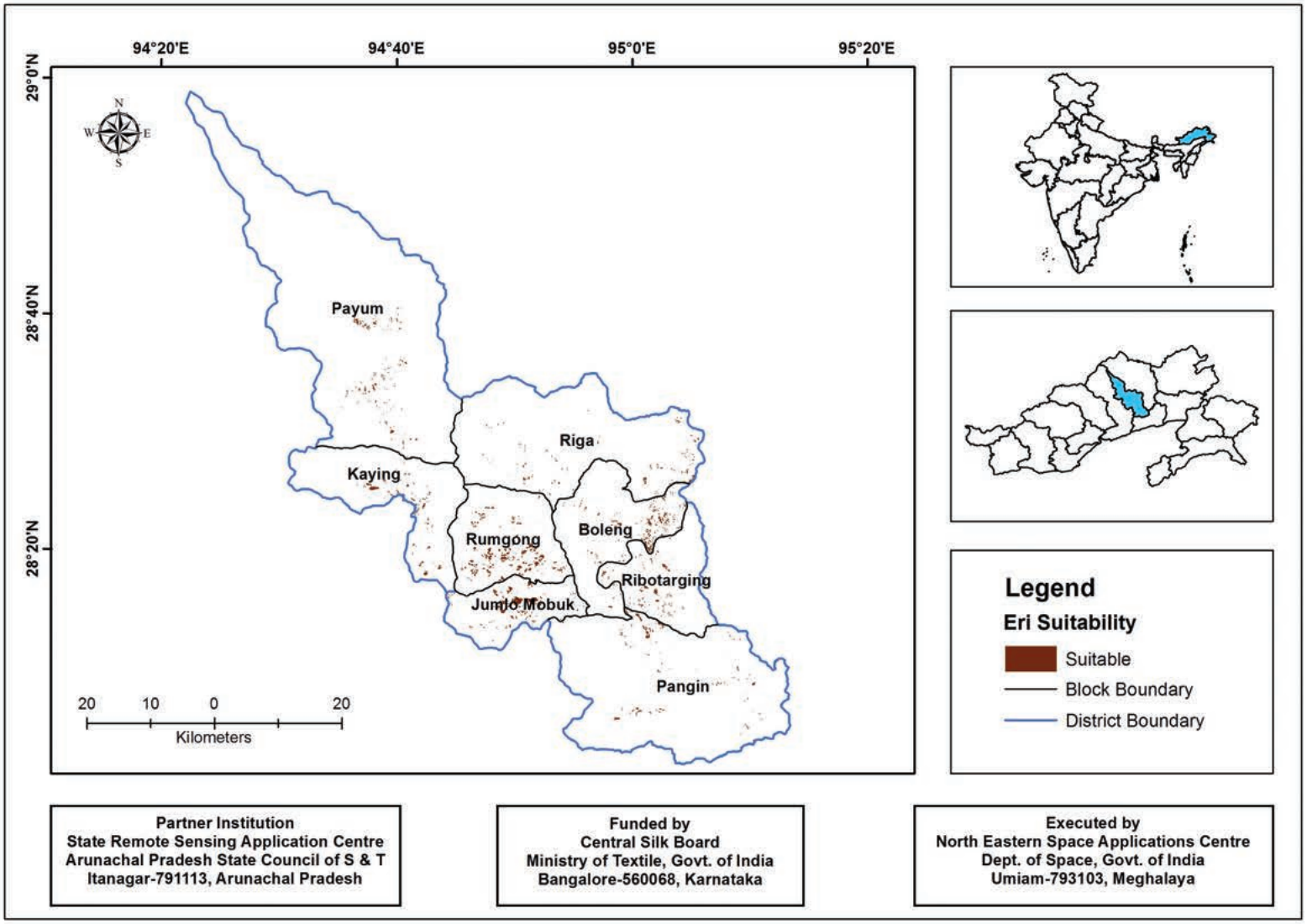

Fig 4.1.5: Suitable areas for Eri in Siang district of Arunachal Pradesh

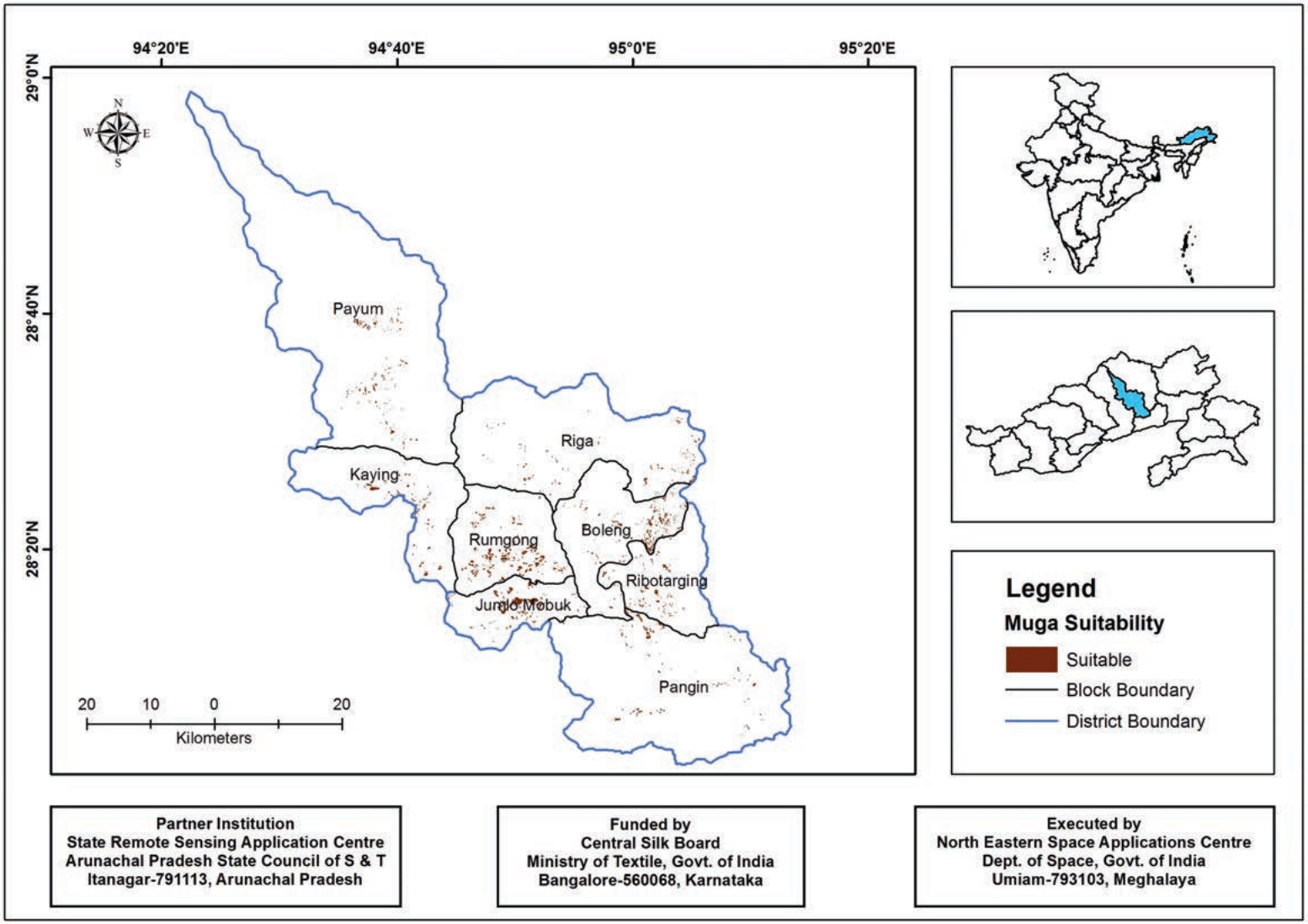

Fig 4.1.6: Suitable areas for Muga in Siang district of Arunachal Pradesh

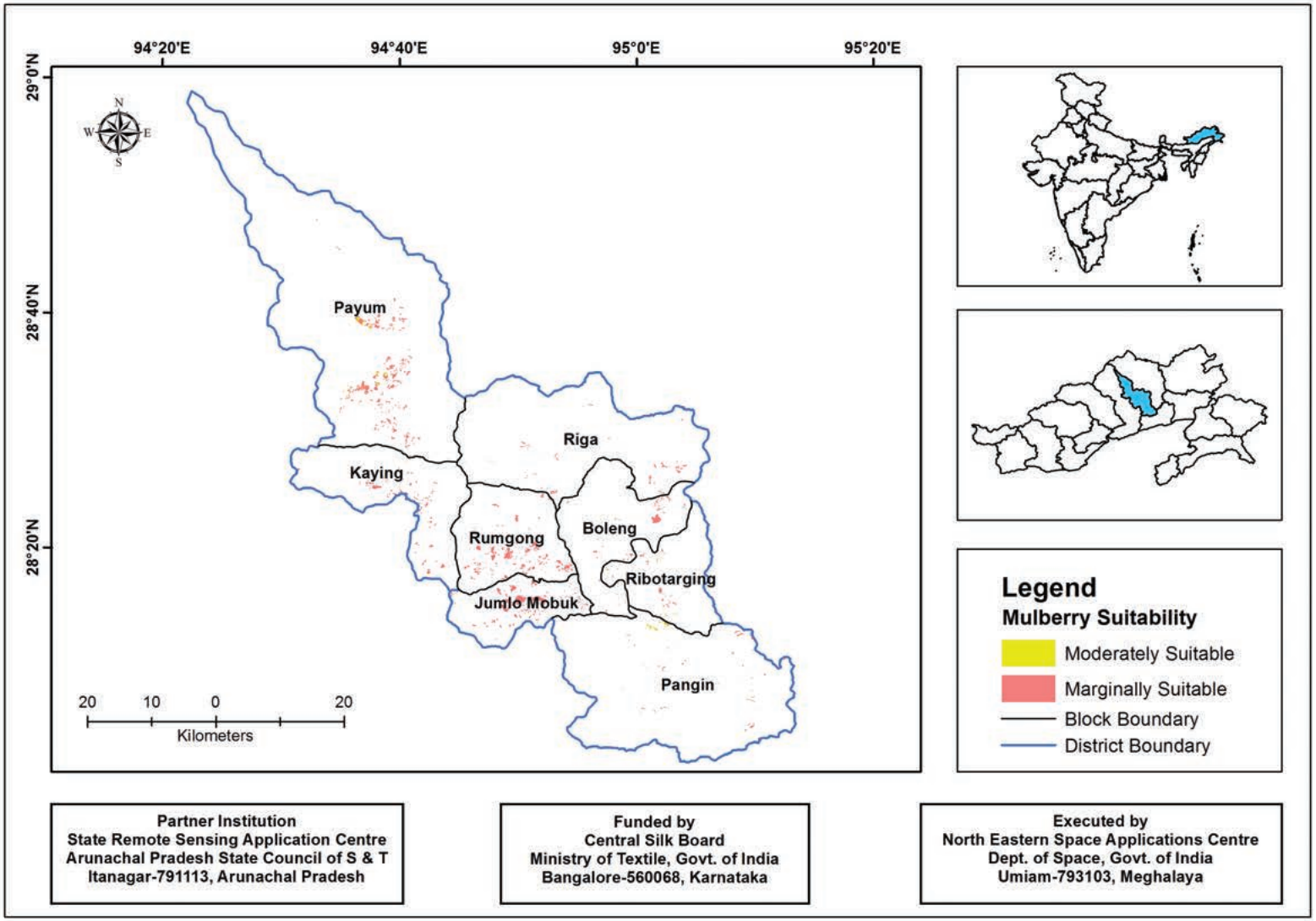

Fig 4.1.7: Suitable areas for Mulberry in Siang district of Arunachal Pradesh

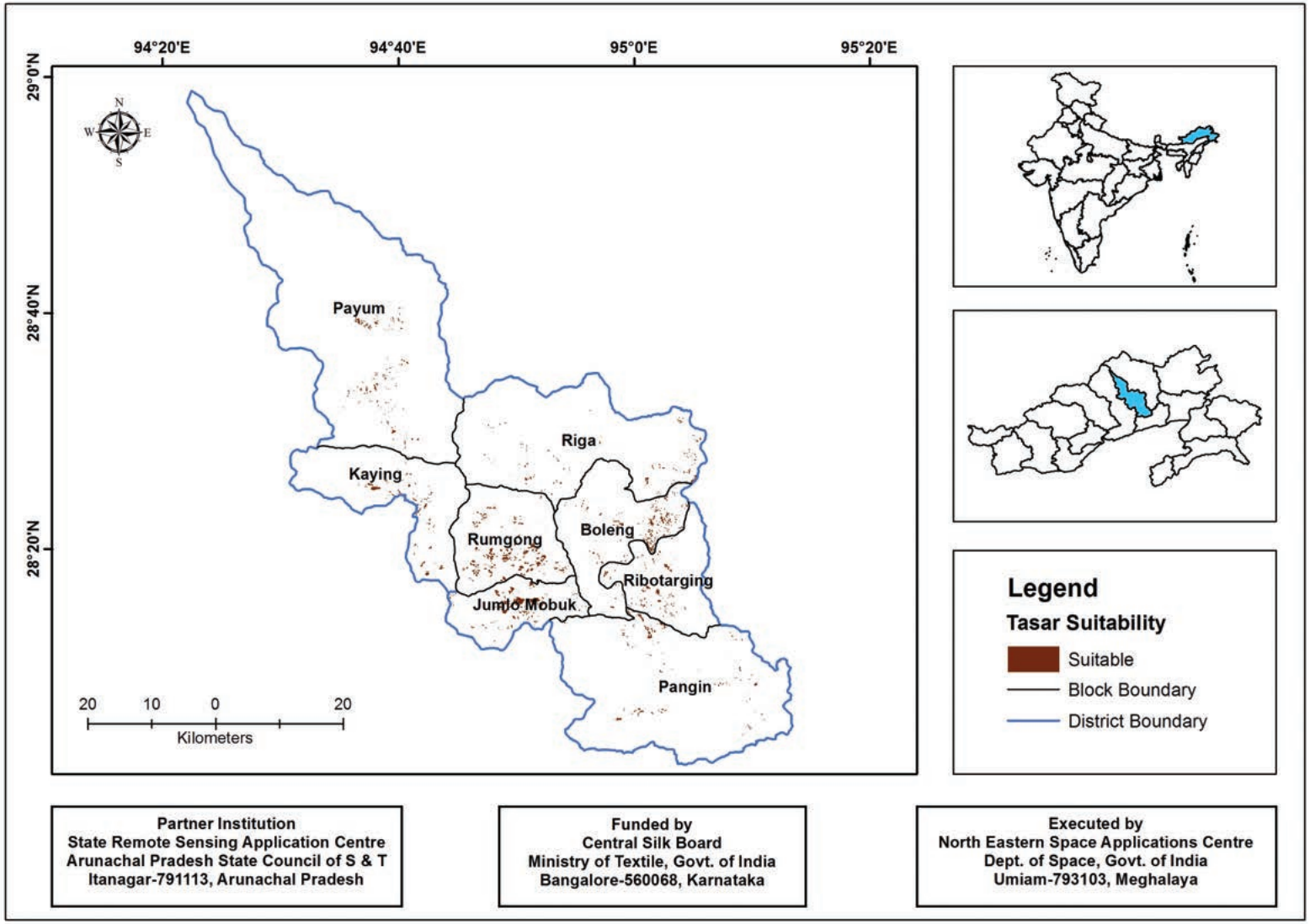

Fig 4.1.8: Suitable areas for Tasar in Siang district of Arunachal Pradesh

Table 4.1.5: Suitable areas for Eri in Siang district of Arunachal Pradesh

Circle	Table Suitable	Total
Boleng	526.15	526.15
Jumlo_Mobuk	642.04	642.04
Kaying	294.74	294.74
Pangin	342.76	342.76
Payum	311.18	311.18
Ribotarging	238.02	238.02
Riga	285.73	285.73
Rumgong	825.97	825.97
Total	**3466.59**	**3466.59**

Table 4.1.6: Suitable areas for Muga in Siang district of Arunachal Pradesh

Circle	Table Suitable	Total(ha)
Boleng	515.11	515.11
Jumlo_Mobuk	640.38	640.38
Kaying	294.73	294.73
Pangin	341.73	341.73
Payum	311.18	311.18
Ribotarging	233.88	233.88
Riga	273.71	273.71
Rumgong	798.36	798.36
Total	**3409.08**	**3409.08**

Table 4.1.7: Suitable areas for Mulberry in Siang district of Arunachal Pradesh

Circle	High	Moderate	Maginal	Total(ha)
Boleng	-	-	268.78	268.78
Jumlo_Mobuk	-	-	878.45	878.45
Kaying	-	-	408.22	408.22
Pangin	-	68.91	210.88	279.79
Payum	-	142.55	1151.98	1294.52
Ribotarging	-	21.2	126	147.2
Riga	-	3.98	240.87	244.84
Rumgong	-	-	905.96	905.96
Total	**-**	**236.63**	**4191.13**	**4427.76**

Table 4.1.8: Suitable areas for Tasar in Siang District of Assam

Circle	Table Suitable	Total(ha)
Boleng	526.19	526.19
Jumlo_Mobuk	642.06	642.06
Kaying	294.74	294.74
Pangin	342.78	342.78
Payum	311.23	311.23
Ribotarging	238.03	238.03
Riga	285.75	285.75
Rumgong	825.97	825.97
Total	**3466.74**	**3466.74**

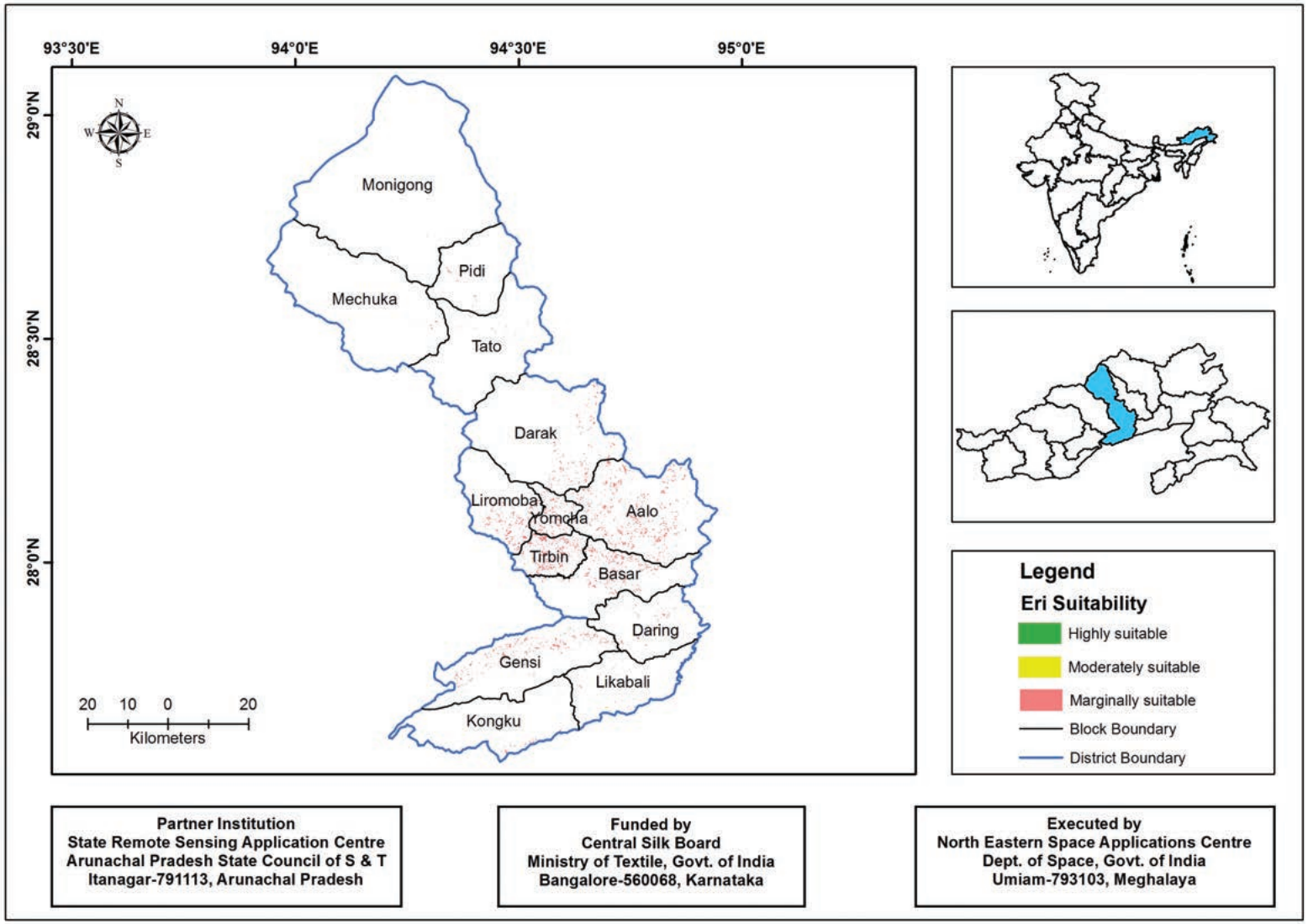

Fig 4.1.9: Suitable areas for Eri in West Siang district of Arunachal Pradesh

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

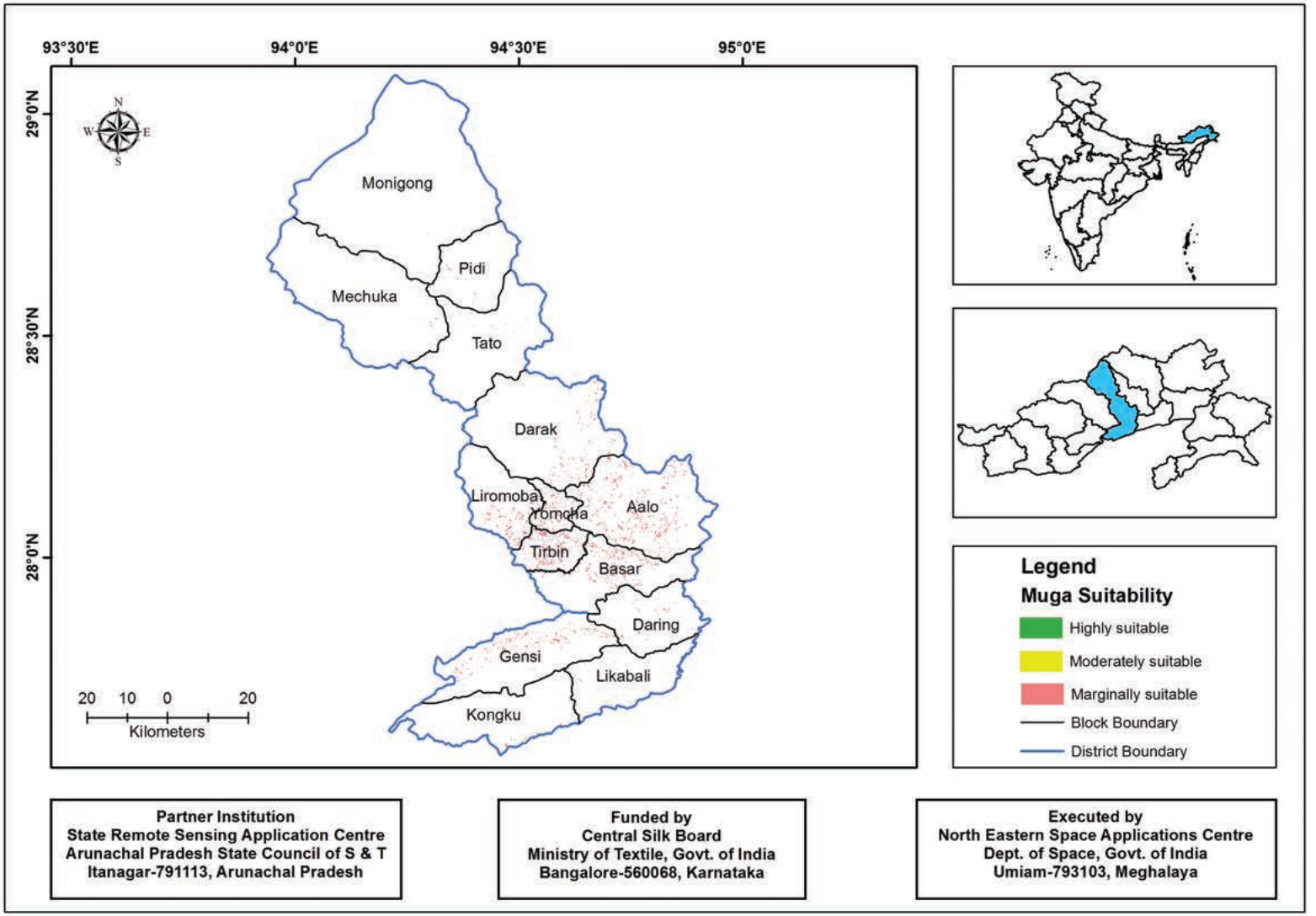

Fig 4.1.10: Suitable areas for Muga in West Siang district of Arunachal Pradesh

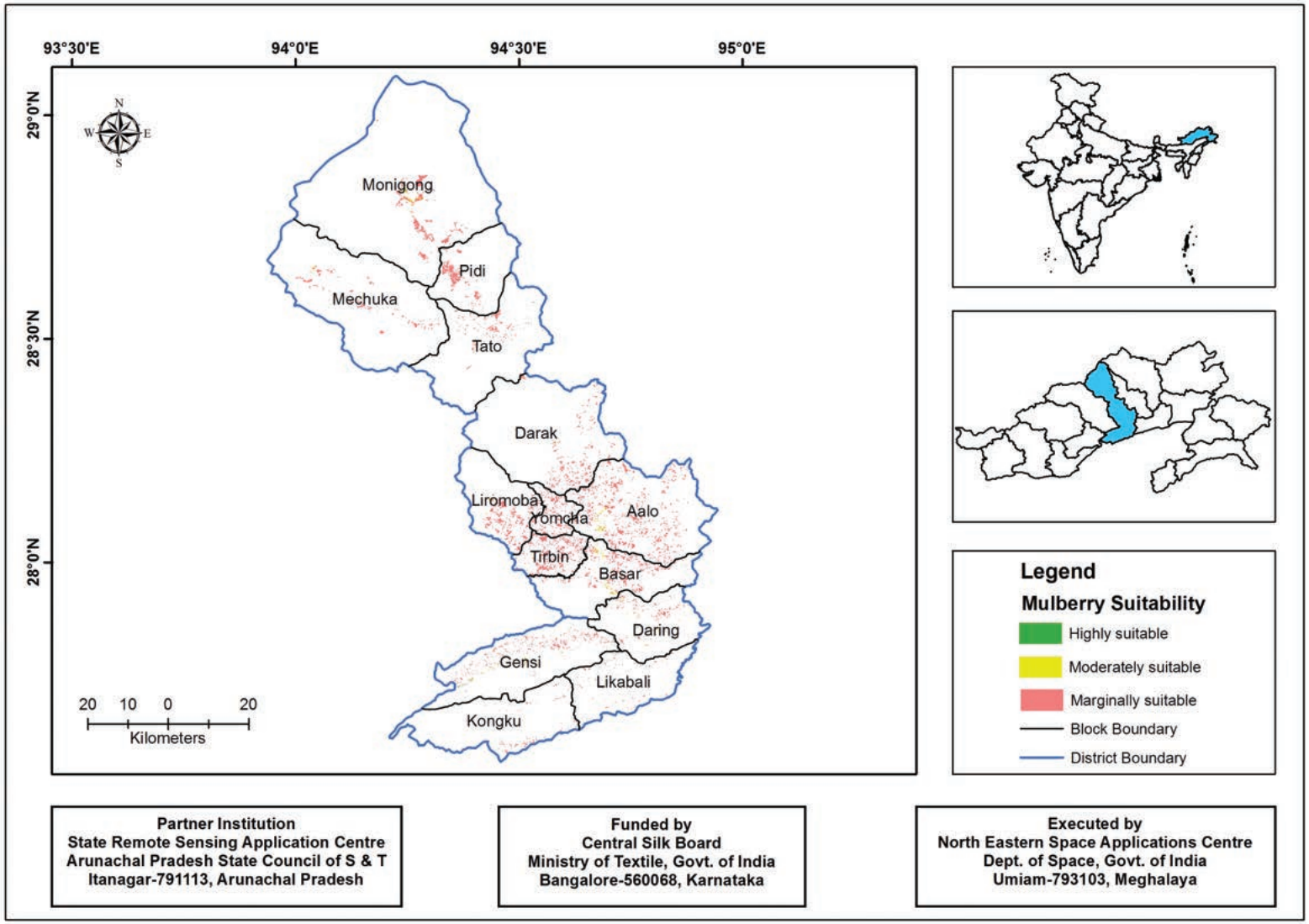

Fig 4.1.11: Suitable areas for Mulberry in West Siang district of Arunachal Pradesh

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

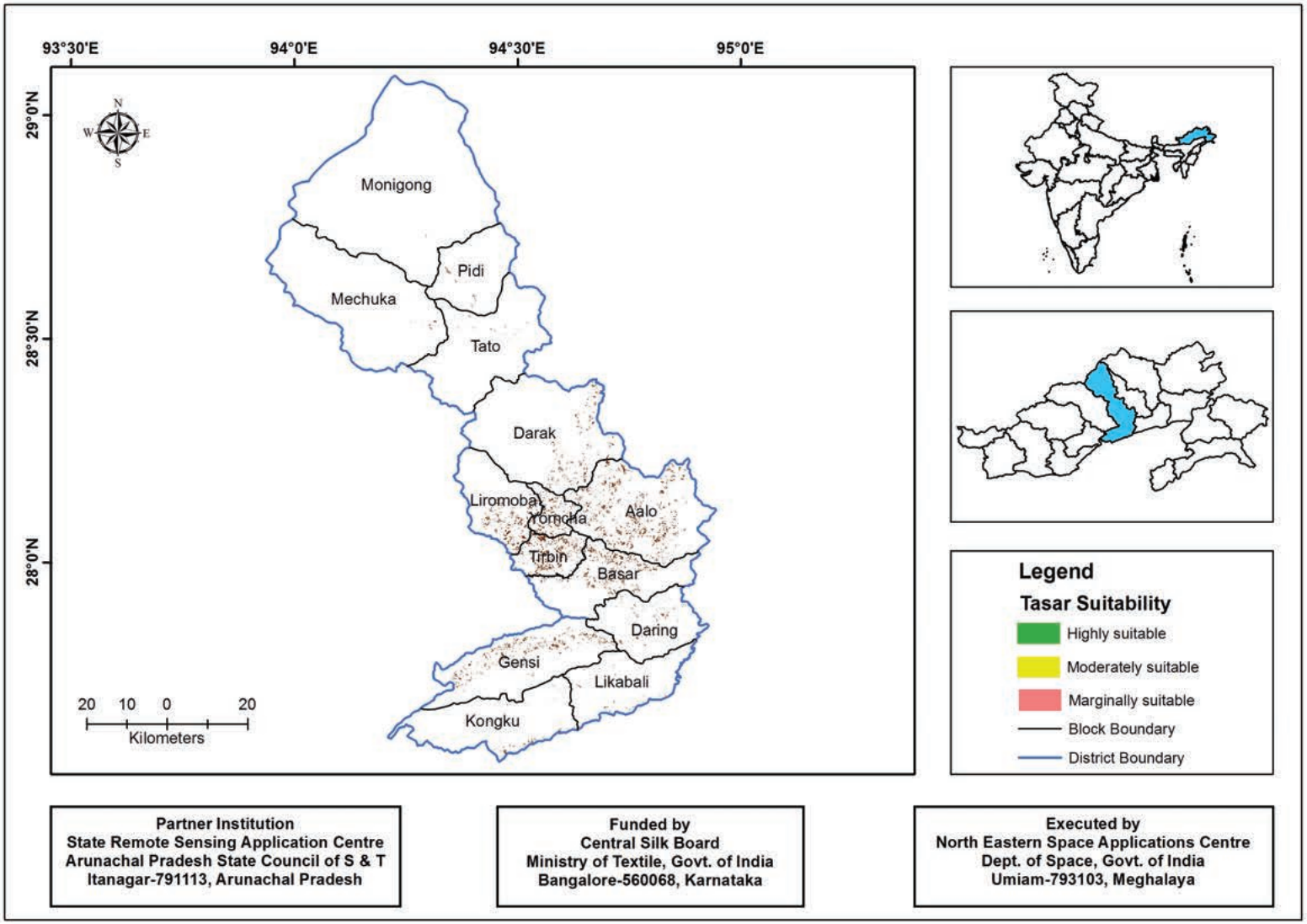

Fig 4.1.12: Suitable areas for Tasar in West Siang district of Arunachal Pradesh

Table 4.1.9: Suitable areas for Eri in West siang district of Arunachal Pradesh

Circle	Highly	Marginal	Moderate	Total(ha)
Aalo	-	2654.29	-	2654.29
Basar	-	1391.03	-	1391.03
Darak	-	747.52	-	747.52
Daring	-	282.46	-	282.46
Gensi	-	1176.21	-	1176.21
Kongku	-	231.82	-	231.82
Likabali	2.00	140.82	16.64	159.46
Liromoba	-	1094.63	-	1094.63
Mechuka	-	36.79	-	36.79
Monigong	-	4.50	-	4.50
Pidi	-	71.24	-	71.24
Tato	-	47.12	-	47.12
Tirbin	-	1576.44	-	1576.44
Yomcha	-	1006.07	-	1006.07
Total	**2.00**	**10460.92**	**16.64**	**10479.57**

Table 4.1.10: Suitable areas for Muga in West siang district of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Aalo	-	-	2654.29	2654.29
Basar	-	-	1391.03	1391.03
Darak	-	-	747.52	747.52
Daring	-	-	282.46	282.46
Gensi	-	-	1176.21	1176.21
Kongku	-	-	231.82	231.82
Likabali	2	16.64	140.82	159.46
Liromoba	-	-	1094.63	1094.63
Mechuka	-	-	36.79	36.79
Monigong	-	-	4.5	4.5
Pidi	-	-	71.24	71.24
Tato	-	-	47.12	47.12
Tirbin	-	-	1576.44	1576.44
Yomcha	-	-	1006.07	1006.07
Total	**2**	**16.64**	**10460.92**	**10479.57**

Table 4.1.11: Suitable areas for Mulberry in West siang district of Arunachal Pradesh

Circle	High	Moderate	Marginal	Total(ha)
Aalo	-	160.92	4766.77	4927.7
Basar	-	181.78	2272.49	2454.26
Darak	-	6.14	1800.98	1807.12
Daring	-	76.9	773.65	850.55
Gensi	65	100.82	1531.18	1696.99
Kongku	-	14.45	546.98	561.43
Likabali	-	21.75	455.16	476.91
Liromoba	-	23.75	2193.76	2217.52
Mechuka	-	24.54	1008.85	1033.39
Monigong	-	179.36	2197.3	2376.66
Pidi	-	-	1549.69	1549.69
Tato	-	-	1062.51	1062.51
Tirbin	-	-	2471.82	2471.82
Yomcha	-	-	1734.72	1734.72
Total	**65**	**790.41**	**24365.86**	**25221.27**

Table 4.1.12: Suitable areas for Tasar in West Siang district of Arunachal Pradesh

Circle	Suitable	Total(ha)
Aalo	2654.34	2654.34
Basar	1391.05	1391.05
Darak	747.55	747.55
Daring	282.52	282.52
Gensi	1176.26	1176.26
Kongku	231.86	231.86
Likabali	159.49	159.49
Liromoba	1094.65	1094.65
Mechuka	36.79	36.79
Monigong	4.5	4.5
Pidi	71.24	71.24
Tato	47.12	47.12
Tirbin	1576.45	1576.45
Yomcha	1006.08	1006.08
Total	**10479.92**	**10479.92**

ASSAM

Located south of the eastern Himalayas, Assam comprises the Brahmaputra and the Barak river valleys along with the Karbi Anglong and the North Cachar Hills with an area of 78,438 sq. km. Assam is surrounded by six of the other Seven Sister States: Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura and Meghalaya. It extends from 89° 42’ to 96° E longitude and 24° 8’ to 28° 2’ N latitude and shares international borders with Bhutan and Bangladesh.

A land of high rainfall, Assam is endowed with lush greenery and the mighty river Brahmaputra, whose tributaries and oxbow lakes provide the region with a unique hydro-geomorphic and aesthetic environment. The forest lands occupy a major part of Assam’s area. Brahmaputra river makes the agricultural area of the state more fertile and is known for its wide-spread tea plantations.

Sericulture of Assam is one of the ancient industries of the region. Assam is endowed by nature with the opportunity of culturing all the four varieties of silk. Silk culture traditionally however is confined more on Muga, Eri and Tasar. Rearing of mulberry silk is relatively less. Among the four, Muga the golden silk is endemic to the state. Usually the cultivation of host plants of all the silk varieties is encircled around the homestead area. The other sources of host plants are government and private farms and the forest for the fringe dwellers. There is ample scope for expanding the area under host plants in the culturable wastelands.

Seven districts viz., Baksa, Dhemaji, Goalpara, Kamrup (Rural), Kokrajhar, Morigaon and Sibsagar were selected for the second phase of the project, brief introduction of the districts are given below-

Baksa

Baksa district covers an area of 2,007.50sq.km. It is situated in the northern bank of the River Brahmaputra.It has the international and state boundaries with Bhutan on north. It is bounded by Chirang district in the west, Nalbari, Barpeta and Kamrup (Rural) district on the south and Udalguri district on the east. Baksa district under Bodoland Teriitorial Council (BTC) is one of the most prospering district in Eri, Mulberry and Muga rearing.

Dhemaji

Dhemaji district is situated in the remote corner of North East India on the north bank of river Brahmaputra between north latitude 27° 15' to 28 00' and east longitude 94° 05' to 95 30'. Dhemaji district occupies an area of 3,237 Km. It is situated in the foothills of the lower Himalayas. The boundaries of the district are the hill ranges of Arunachal Pradesh on the North and East, Lakhimpur district in the

west and Dibrugarh in the south. The district is traditionally known for the Muga cultivation, even though reduction in the production and productivity over the years is a major concern.

Goalpara

Goalpara is located on the bank of the river Brahmaputra. The district is bounded by Barpeta district in the North, Meghalaya in the south, Dhubri in the west and Dispur on the west. The district located in the border of Assam and Meghalaya is considered to be major source of supply of Muga seed in the entire region.

Kamrup rural

Kamrup district of Assam established in 1970 is situated in the west central part of the state of Assam, covering an area of 4111 sq . k m. on both sides of Brahmaputra River. It lies between North latitudes 25° 42' 03" and 26° 50' 10" and East longitudes 91° 00' 01" and 92° 10' 04".

Kokrajhar

It is bounded on the north by Bhutan and by West Bengal on the west; the district of Dhubri in the south and in the east by Chirang district. Kokrajhar district lies roughly within 89°46’ East to 90°38’ East and 26°19’ North to 26°54’ North Latitude. Kokrajhar district under Bodoland Teriitorial Council (BTC) is one of the most prospering district in Eri, Mulberry and Muga rearing.

Morigaon

The Morigaon district of Assam lies in the Central part of Assam on the southern bank of the Brahmaputra River. It is bounded on south by Karbi Anglong and West Khasi Hills district, on east by Nagaon district and on west by Kamrup district, Assam.

Sibsagar

The district is bounded by longitude 94°25 and 95°25E & latitude 21°45 and 27°15N. The district is delimited on its North by the mighty river Brahmaputra; the south is surrounded by the states of Nagaland and Arunachal Pradesh. The East is surrounded by Dibrugarh district and the West by Jorhat district of Assam. The district is traditionally known for the Muga cultivation since the period of Ahom kingdom, even though there is reduction in the production and productivity over the years due to various reason.

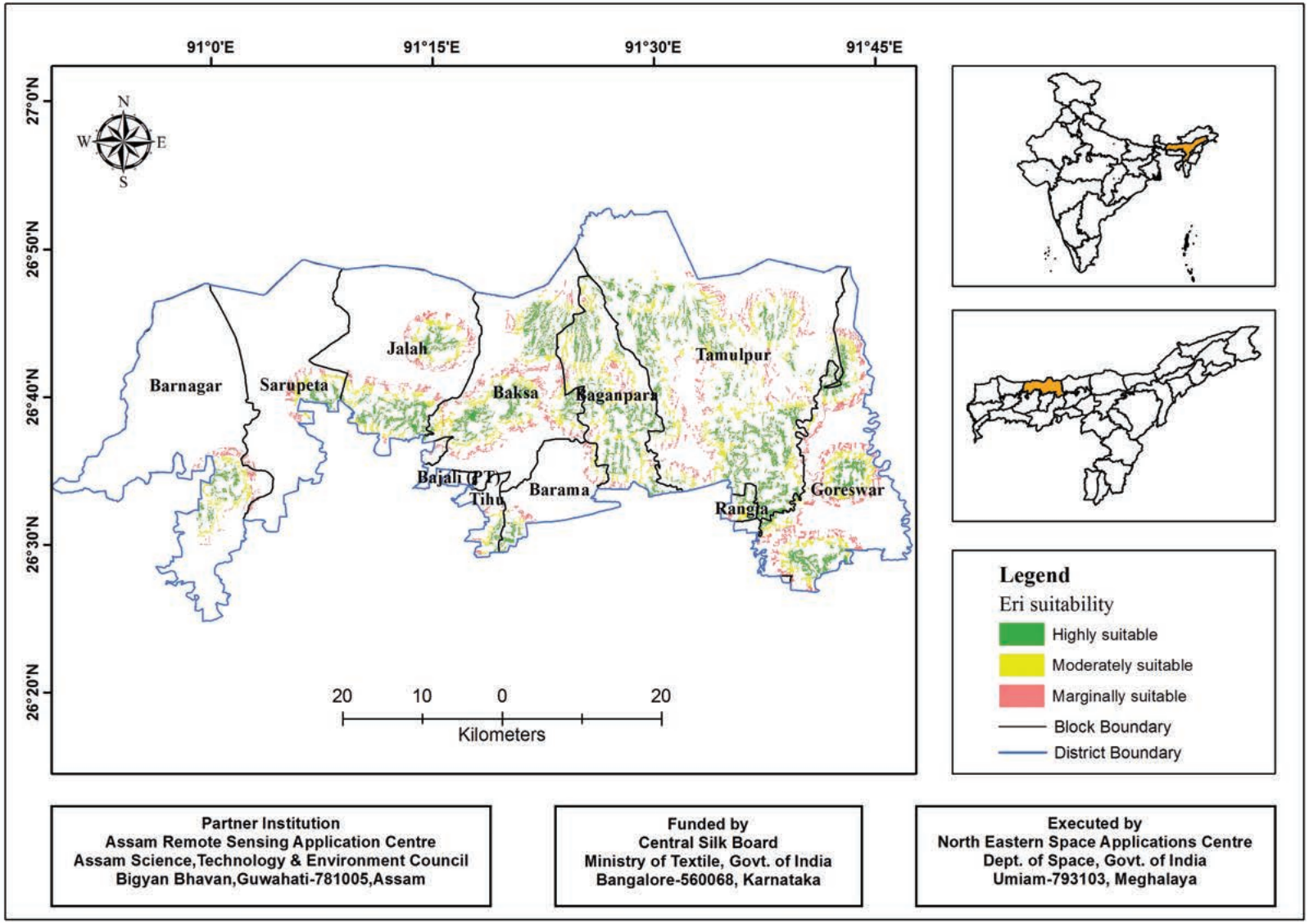

Fig 4.2.1: Suitable areas for Eri in Baksa district of Assam

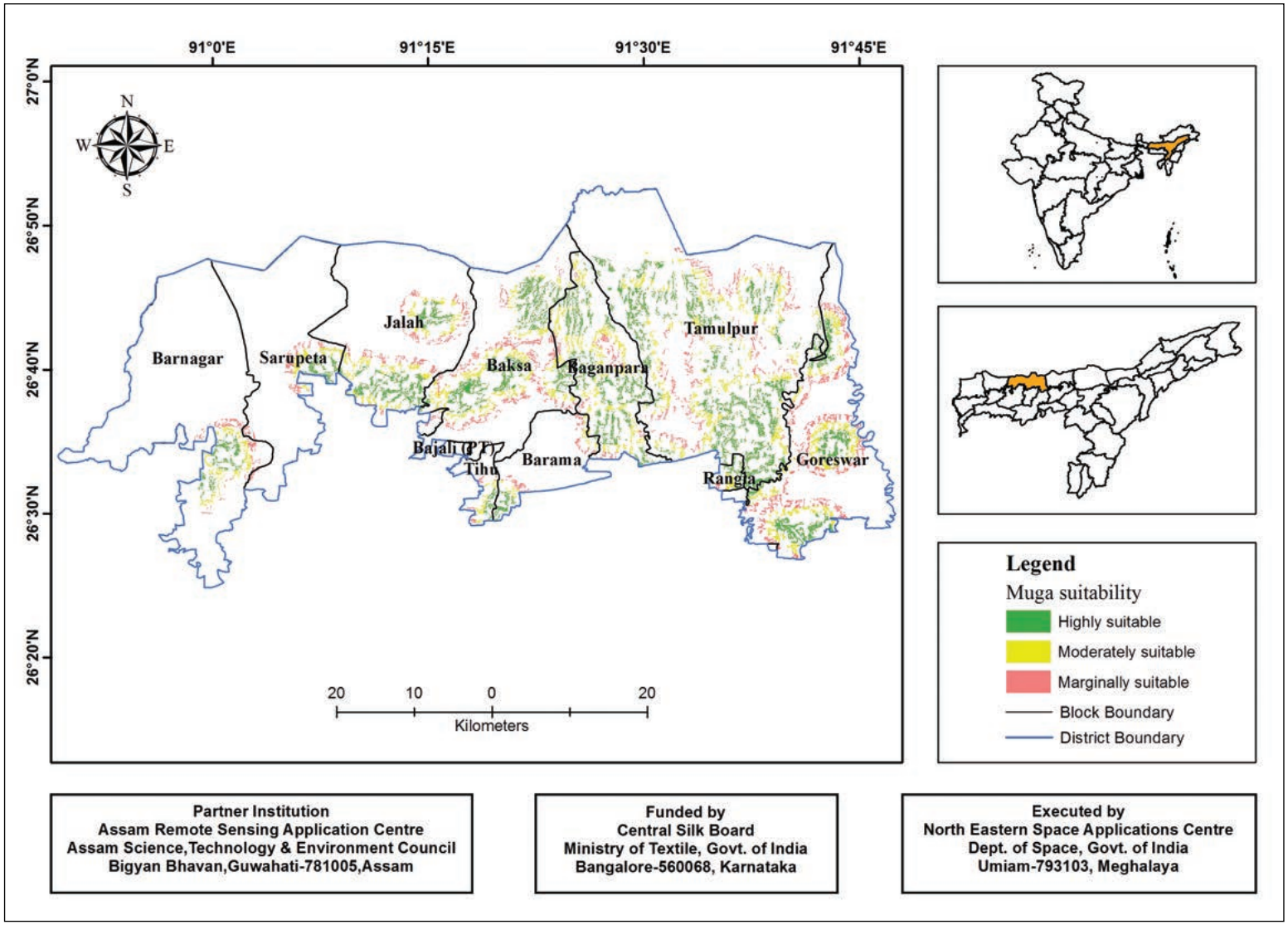

Fig 4.2.2: Suitable areas for Muga in Baksa district of Assam

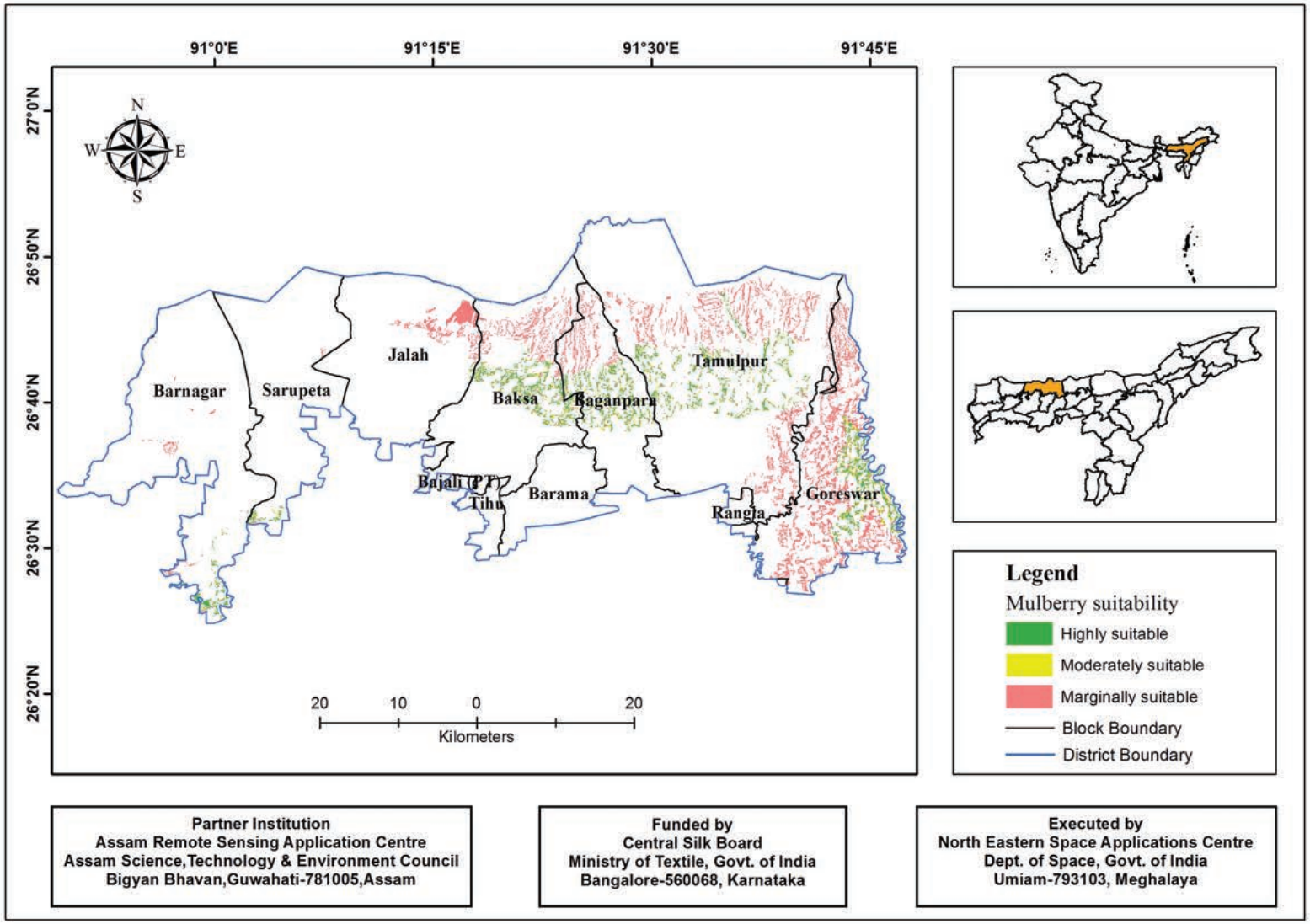

Fig 4.2.3: Suitable areas for Mulberry in Baksa district of Assam

Table 4.2.1: Suitable areas for Eri in Baksa District of Assam

Block	High	Moderate	Marginal	Total(ha)
Baganpara	1751.25	1210.54	370.49	3332.28
Baksa	1860.56	1295.08	1213.61	4369.25
Barama	166.16	123.96	222.03	512.15
Barnagar	386.98	436.05	327.01	1150.04
Goreswar	1463.23	1528.36	2034.48	5026.07
Jalah	1207.79	903.73	870.21	2981.73
Rangia	154.65	108.95	41.51	305.11
Sarupeta	245.78	274.31	376.4	896.49
Tamulpur	4249.23	2275.92	1391.59	7916.74
Tihu	103.62	127.34	82.92	313.88
Total	**11589.3**	**8284.24**	**6930.25**	**26803.7**

Table 4.2.2: Suitable areas for Muga in Baksa District of Assam

Block	High	Moderate	Marginal	Total(ha)
Baganpara	1648.04	1180.24	365.41	3193.69
Baksa	1779.28	1200.66	1133.5	4113.44
Barama	166.17	123.92	222.06	512.15
Barnagar	386.98	433.67	316.09	1136.74
Goreswar	1431.48	1514.76	1976.9	4923.14
Jalah	1091.77	790.37	698.13	2580.27
Rangia	154.65	108.94	41.53	305.12
Sarupeta	245.8	271.71	362.88	880.39
Tamulpur	3984.46	2160.8	1320.21	7465.47
Tihu	103.59	127.37	82.93	313.89
Total	**10992.2**	**7912.44**	**6519.64**	**25424.3**

Table 4.2.3: Suitable areas for Mulberry in Baksa District of Assam

Block	High	Moderate	Marginal	Total(ha)
Baganpara	947.02	228.97	988.5	2164.49
Baksa	1120.54	251.11	1369.7	2741.35
Barnagar	314.72	30.36	237.36	582.44
Goreswar	1155.33	385.59	5549.47	7090.39
Jalah	23.19	4.52	1207.19	1234.9
Rangia	-	-	22.24	22.24
Sarupeta	100.09	31.19	38.65	169.93
Tamulpur	1477.83	254.8	4028.46	5761.09
Total	**5138.72**	**1186.54**	**13441.6**	**19766.8**

Table 4.2.4: Suitable areas for Eri in Dhemaji District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Dhakuakhana RC	-	-	100.6	100.6
Dhemaji RC	566.36	855.73	1109.23	2531.32
Gogamukh RC	1130.76	498.65	498.86	2128.27
Jonai RC	11.31	6.61	28.47	46.39
Sisibargaon RC	1079.35	427.75	591.49	2098.59
Total	**2787.78**	**1788.74**	**2328.65**	**6905.17**

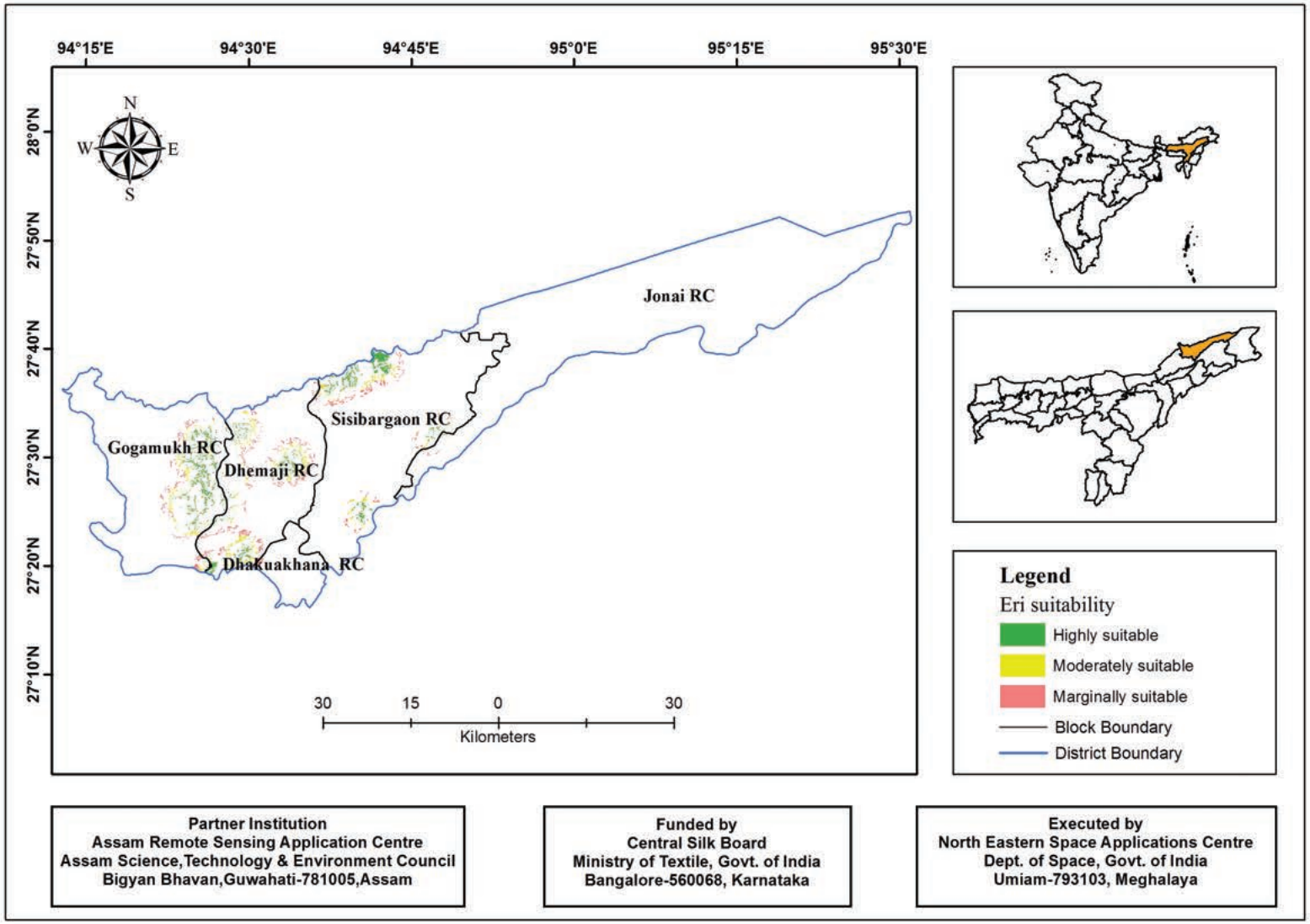

Fig 4.2.4: Suitable areas for Eri in Dhemaji district of Assam

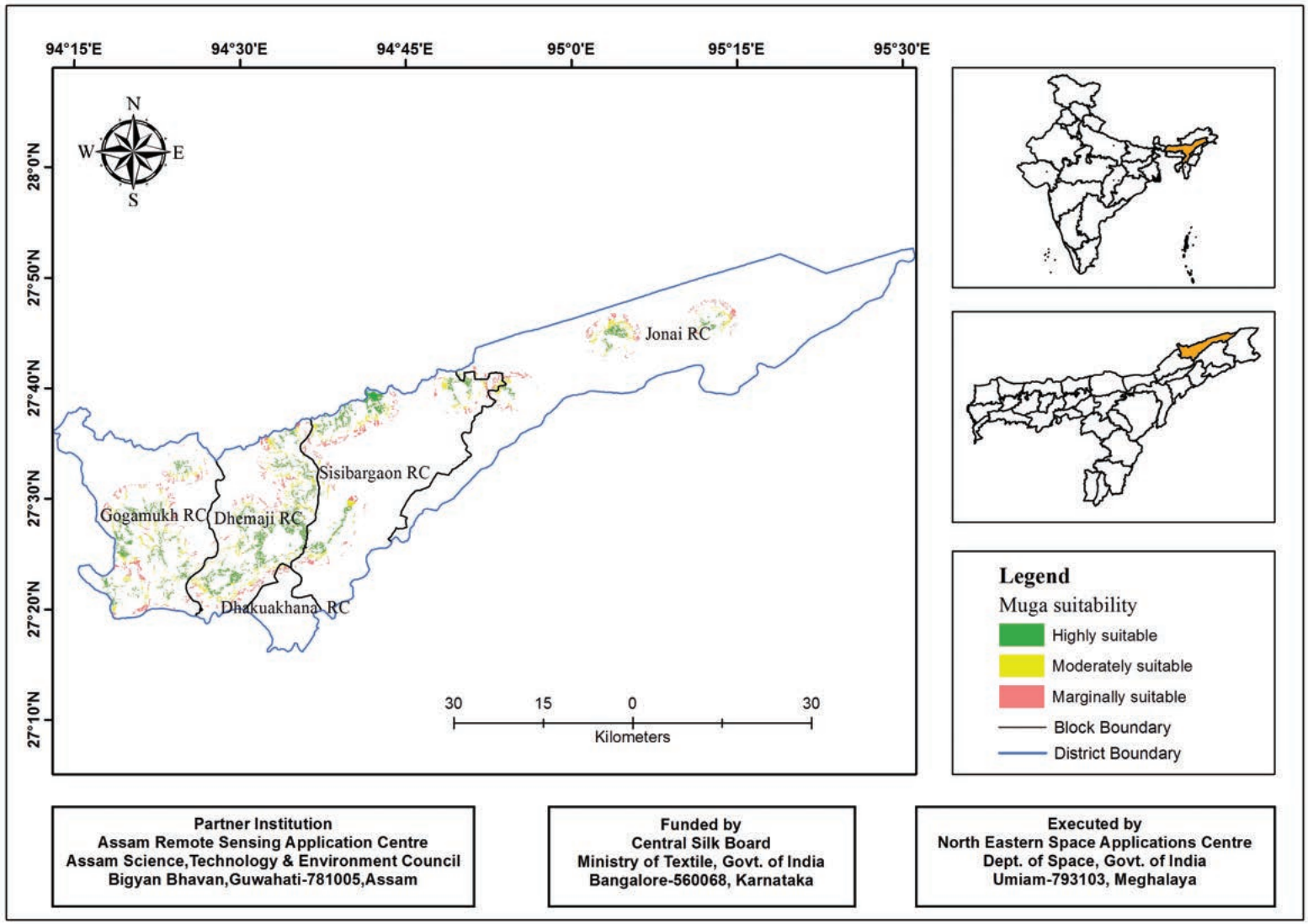

Fig 4.2.5: Suitable areas for Muga in Dhemaji district of Assam

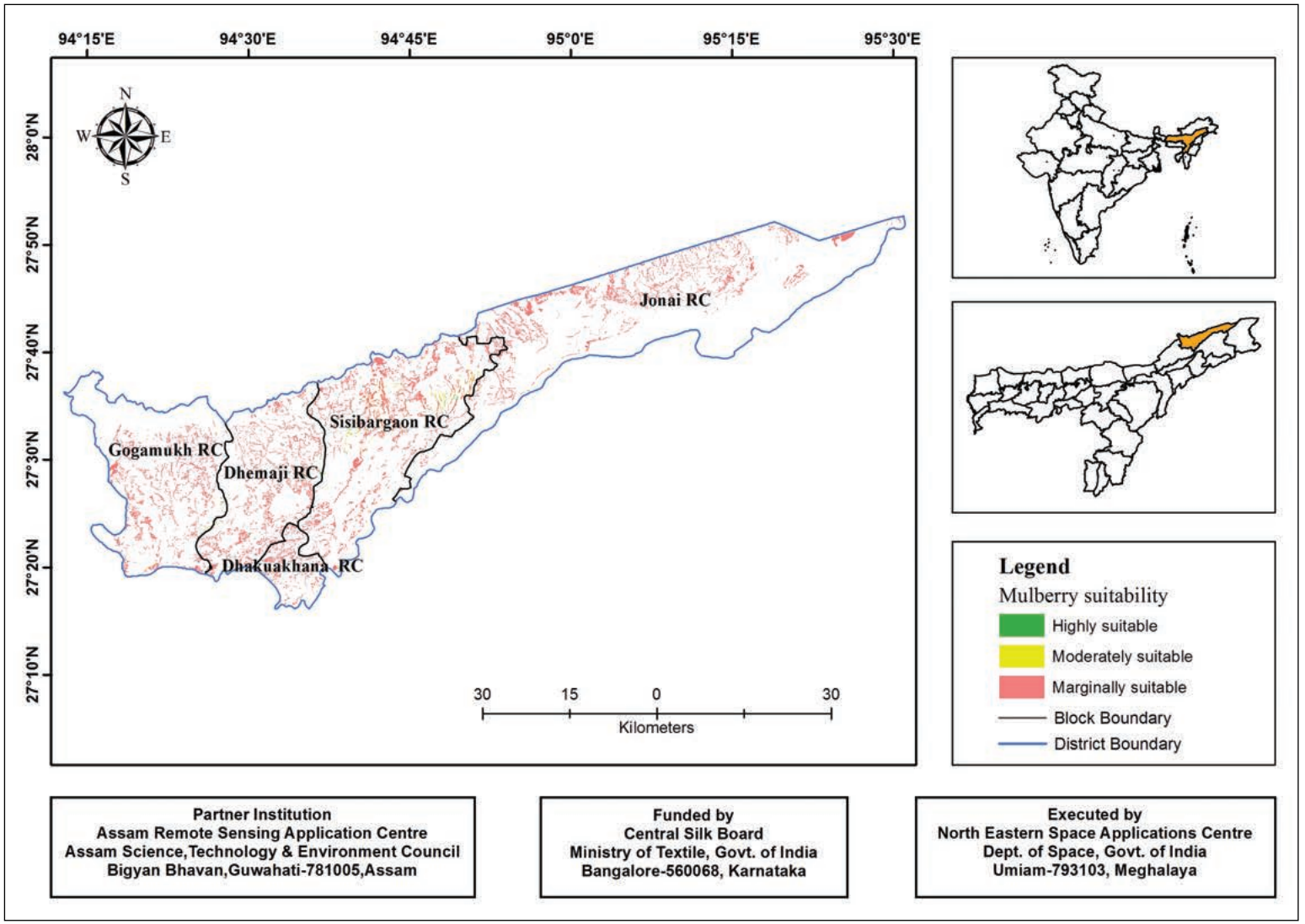

Fig 4.2.6: Suitable areas for Mulberry in Dhemaji district of Assam

Table 4.2.5: Suitable areas for Muga in Dhemaji District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Dhakuakhana RC	-	19.93	64.18	84.11
Dhemaji RC	2320.24	1224.81	844.74	4389.79
Gogamukh RC	1320.02	918.3	1052.76	3291.08
Jonai RC	483.83	542.33	736.22	1762.38
Sisibargaon RC	1440.46	805.81	1001.45	3247.72
Total	**5564.55**	**3511.18**	**3699.35**	**12775.1**

Table 4.2.6: Suitable areas for Mulberry in Dhemaji District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Dhakuakhana RC	-	-	1376.73	1376.73
Dhemaji RC	82.09	11.05	5028.45	5121.59
Gogamukh RC	18.99	32.64	4734.63	4786.26
Jonai RC	1.79	8.7	7294.22	7304.71
Sisibargaon RC	49.24	503.7	7617.56	8170.5
Total	**152.11**	**556.09**	**26051.6**	**26759.8**

Table 4.2.7: Suitable areas for Eri in Goalpara District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Balijana	10685.23	13194.87	14070.94	37951.04
Dudhnoi	5160.18	6553.52	7032.15	18745.85
Lakhipur	4902.7	7044.02	8128.05	20074.77
Matia	7367.18	9396.18	10877.88	27641.24
Rangjuli	8344.62	9682.34	10306.83	28333.79
Total	**36459.9**	**45870.9**	**50415.9**	**132747**

Table 4.2.8: Suitable areas for Muga in Goalpara District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Lakhipur	23110.98	29833.48	-	52944.46
Matia	-	-	33239.41	33239.41
Total	**23111**	**29833.5**	**33239.4**	**86183.9**

Table 4.2.9: Suitable areas for Mulberry in Goalpara District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Balijana	357.84	331.43	1990.34	2679.61
Dudhnoi	-	0.09	757.88	757.97
Lakhipur	324.68	1292.07	1552.41	3169.16
Matia	16.21	205.92	2286.85	2508.98
Rangjuli	-	134.01	1901.01	2035.02
Total	**698.73**	**1963.52**	**8488.49**	**11150.7**

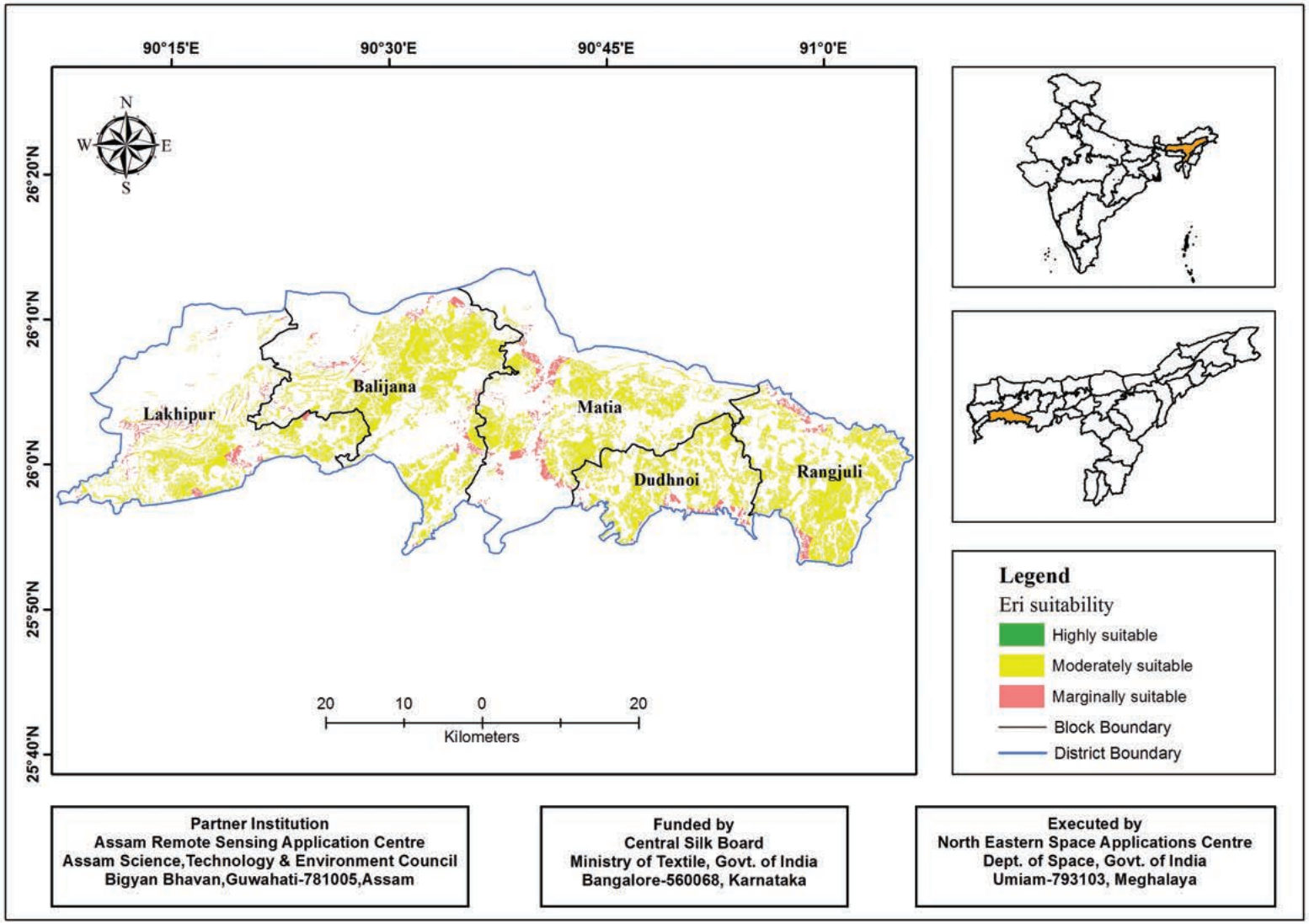

Fig 4.2.7: Suitable areas for Eri in Goalpara district of Assam

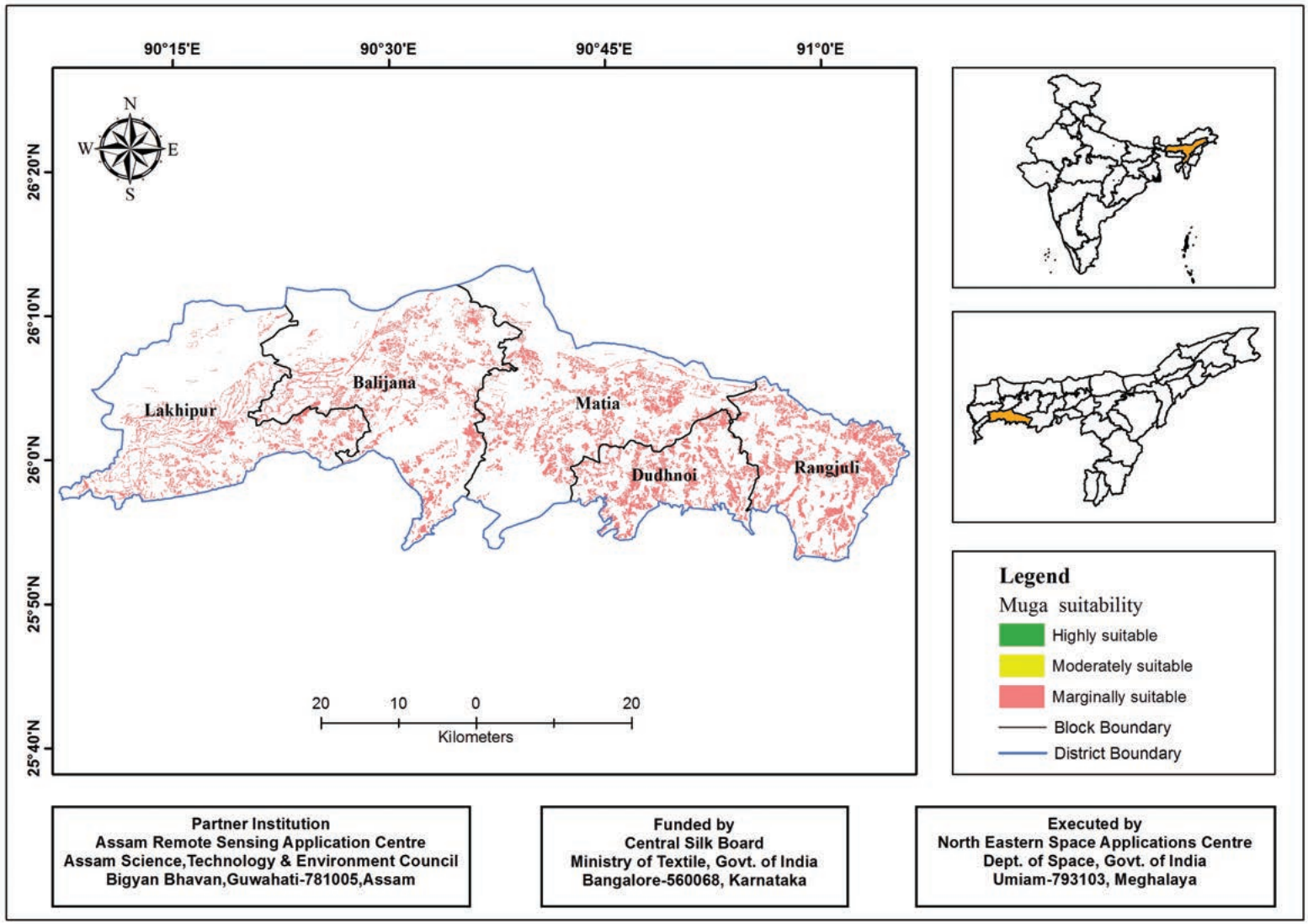

Fig 4.2.8: Suitable areas for Muga in Goalpara district of Assam

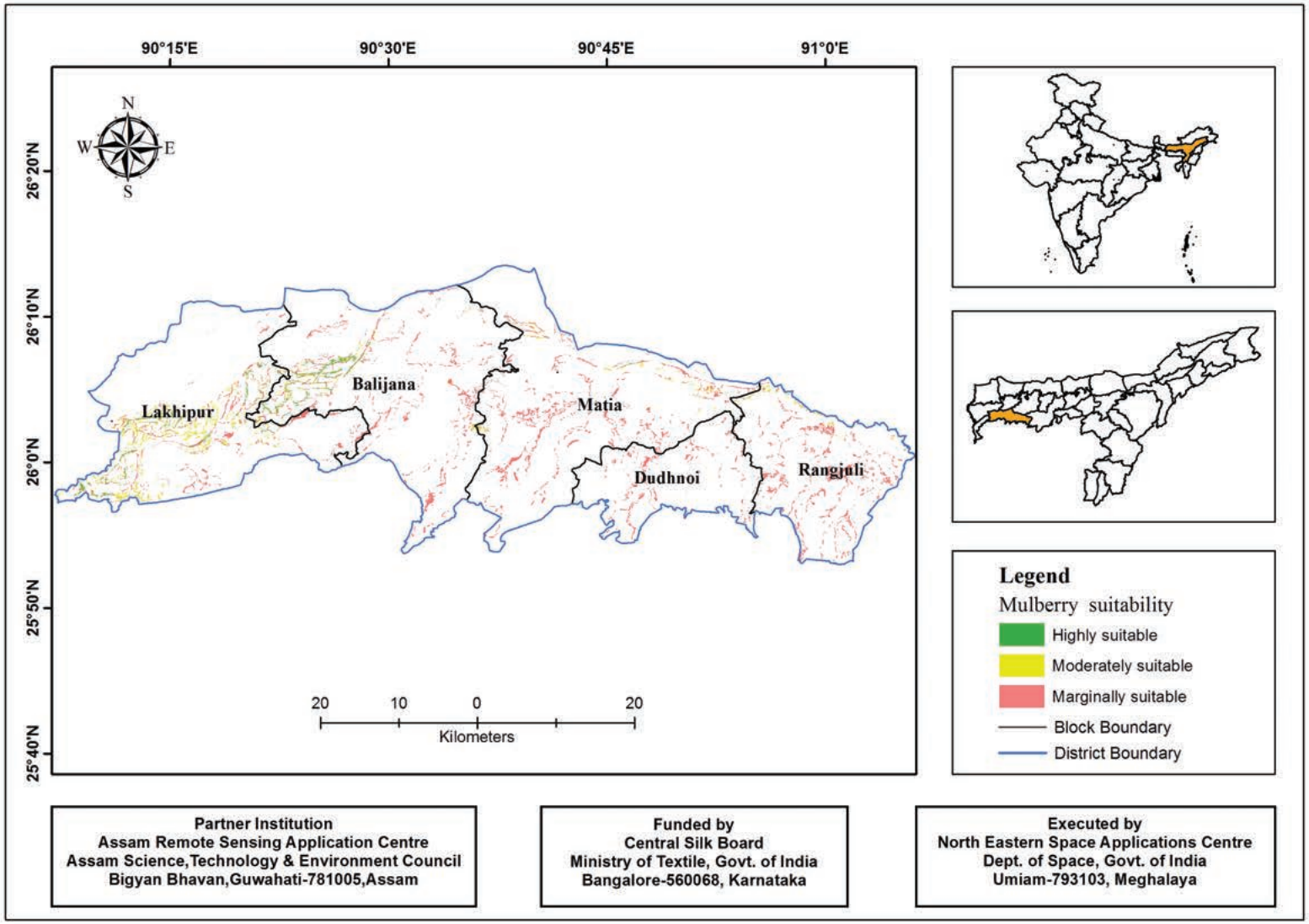

Fig 4.2.9: Suitable areas for Mulberry in Goalpara district of Assam

Table 4.2.10: Suitable areas for Eri in Kamrup District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Boko	5933.84	3225.77	2269.9	11429.51
Chamaria	738	426.6	257.93	1422.53
Chhaygaon	3922.01	2008.05	1284.29	7214.35
Goraimari	752.26	746.6	596.93	2095.79
Goreswar	244.53	443.17	490.79	1178.49
Nagarbera	216.51	131.38	196.18	544.07
Palasbari	2631.01	2946.93	2006.7	7584.64
Total	**14438.2**	**9928.5**	**7102.72**	**31469.4**

Table 4.2.11: Suitable areas for Muga in Kamrup District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Barkhetri	1.12	2.46	4.42	8
Boko	2210.15	2074.92	1206.91	5491.98
Chamaria	181.93	135.38	141.35	458.66
Chhaygaon	3034.51	1575.56	1363.57	5973.64
Goraimari	40.39	92.02	246.14	378.55
Goreswar	103.82	170.23	274.17	548.22
Hajo	1034.04	832.25	811.92	2678.21
Kamalpur	785.59	1015.13	1472.02	3272.74
North guwahati	-	4.65	62.2	66.85
Palasbari	1714.34	1745.33	1769.19	5228.86
Rangia	571.64	733.46	640.37	1945.47
Total	**9677.53**	**8381.39**	**7992.26**	**26051.2**

Table 4.2.12: Suitable areas for Mulberry in Kamrup District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Barbhag	-	-	11	11
Barkhetri	12.58	-	60.54	73.12
Boko	-	-	80.32	80.32
Chamaria	1624.8	10.2	-	1635
Chhaygaon	14.6	-	-	14.6
Goraimari	2071.5	8.33	-	2079.83
Goreswar	580.82	57.4	1444.65	2082.87
Hajo	4379.36	216.66	133.99	4730.01
Kamalpur	2550.34	278.34	4787.1	7615.78
Nagarbera	858.75	26.46	16.97	902.18
Nalbari	-	-	4.35	4.35
North guwahati	265.56	-	627.32	892.88
Palasbari	805.11	3.34	0.27	808.72
Rangia	1357.01	84.25	4499.09	5940.35
Total	**14520.4**	**684.98**	**11665.6**	**26871**

Table 4.2.13: Suitable areas for Eri in Kokrajhar Distric in Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhowranguri	248.32	233.87	651.35	1133.54
Bilasipara	-	76.48	35.89	112.37
Dotoma	716.74	751.54	895.83	2364.11
Gossaigaon	191.19	347.43	411.59	950.21
Kokrajhar	930.46	1109.22	1215.64	3255.32
Total	**2086.71**	**2518.54**	**3210.3**	**7815.55**

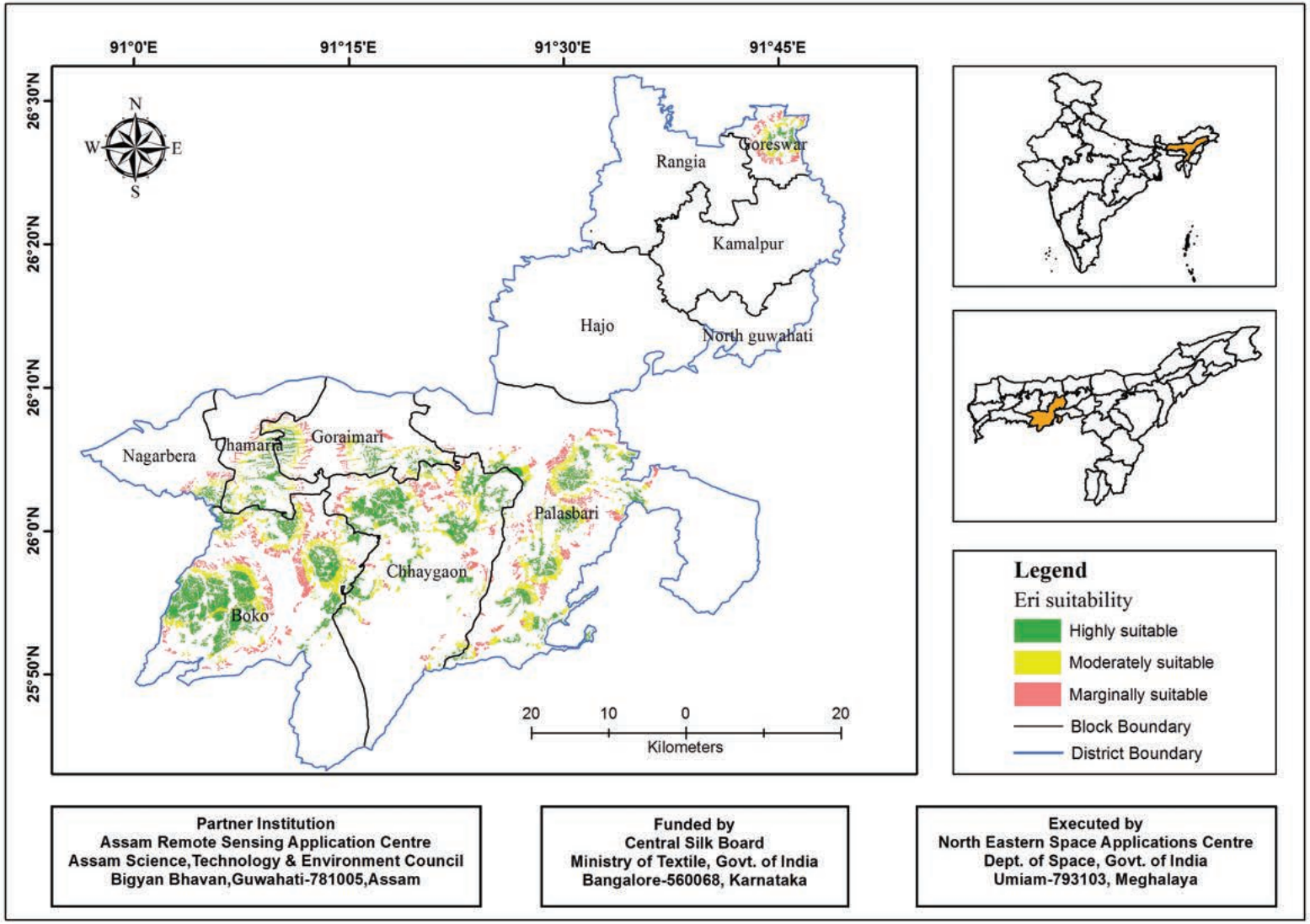

Fig 4.2.10: Suitable areas for Eri in Kamrup district of Assam

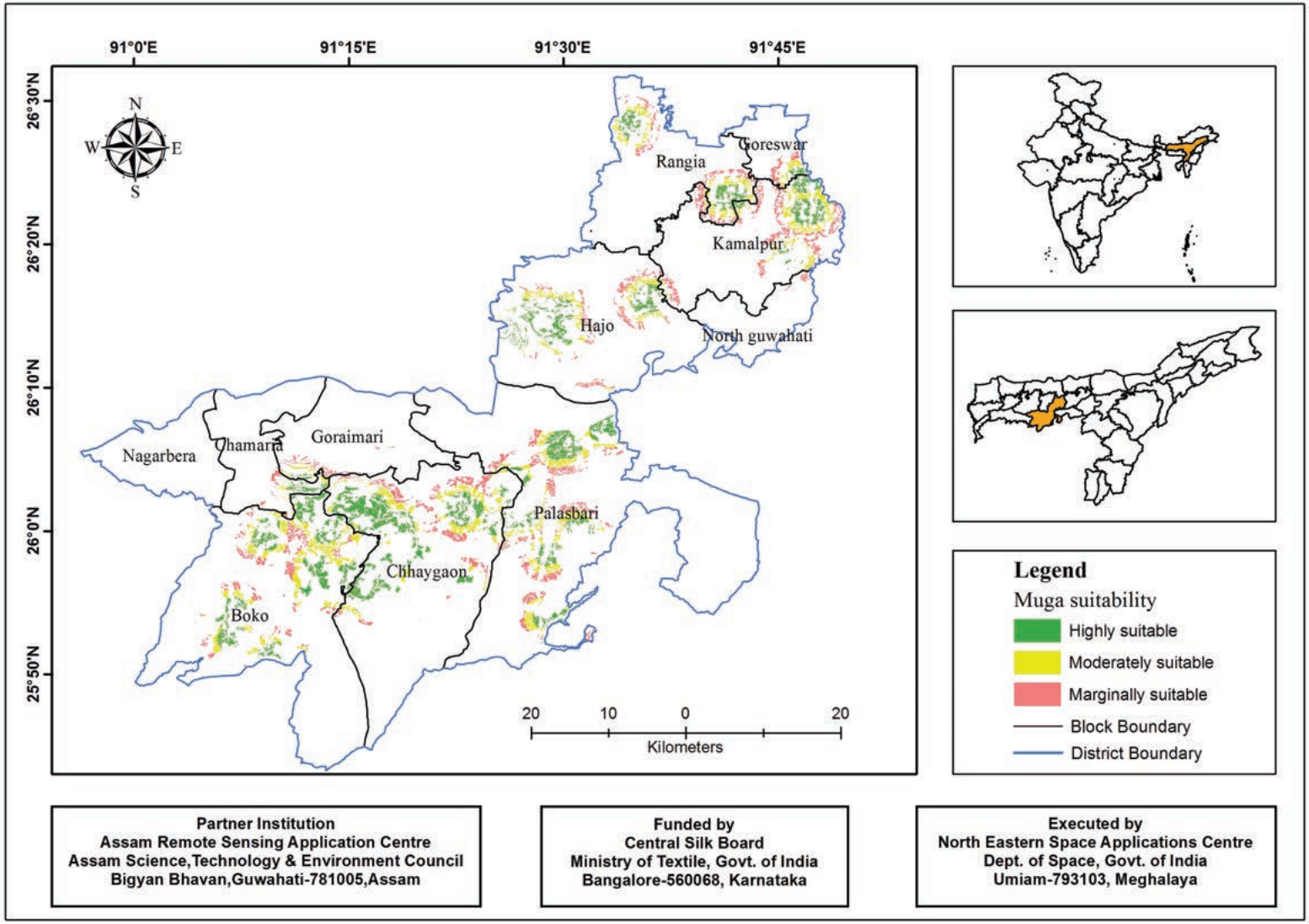

Fig 4.2.11: Suitable areas for Muga in Kamrup district of Assam

APPLICATIONS OF REMOTE SENSING AND GIS IN SERICULTURE DEVELOPMENT PHASE II (NER STATES)

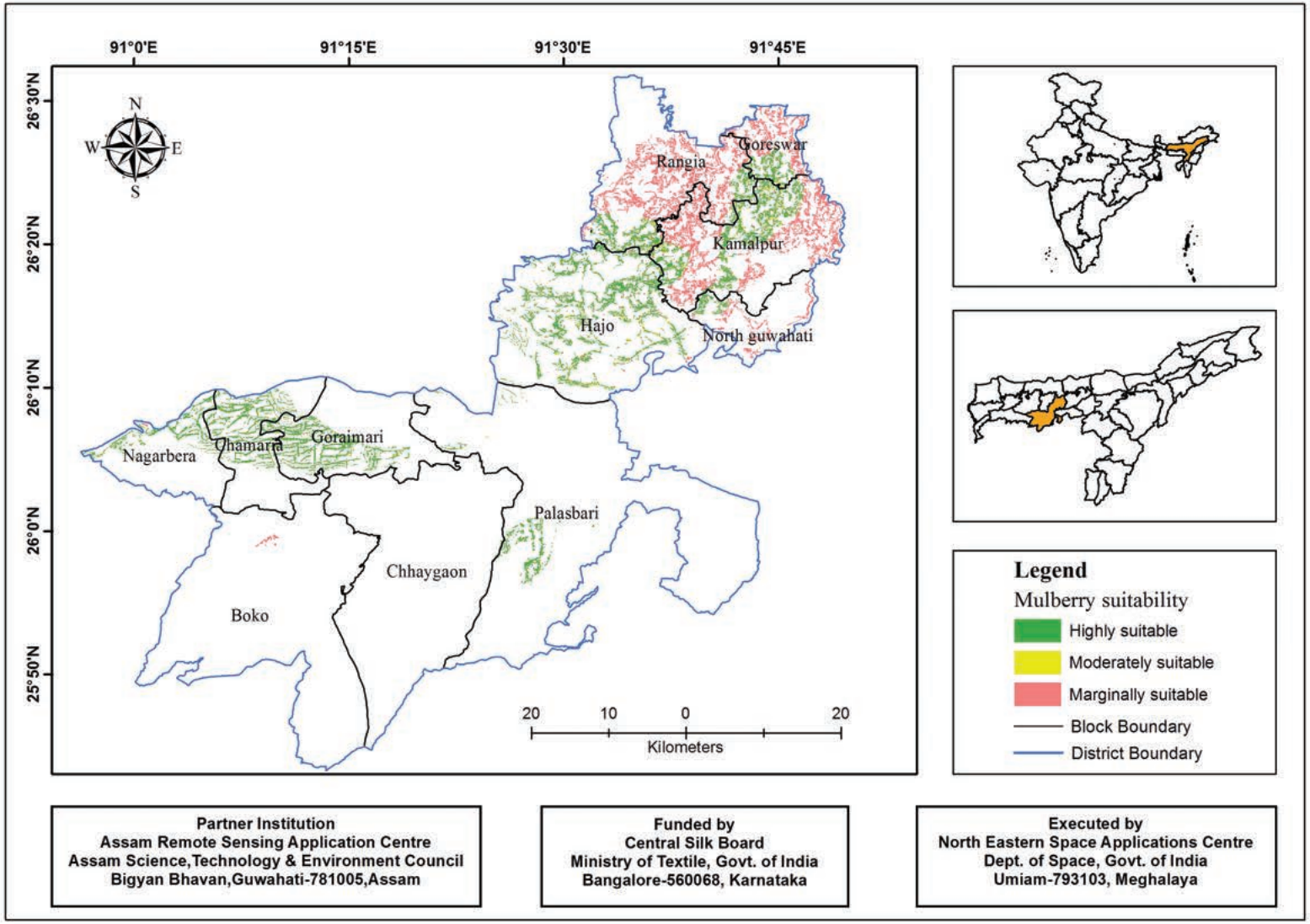

Fig 4.2.12: Suitable areas for Mulberry in Kamrup district of Assam

Table 4.2.14: Suitable areas for Muga in Kokrajhar District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhowranguri	60.43	95.58	184.37	340.38
Dotoma	428.71	419.65	547.69	1396.05
Gossaigaon	26.32	102.11	144.35	272.78
Kokrajhar	449.8	376.13	330.53	1156.46
Total	**965.26**	**993.47**	**1206.94**	**3165.67**

Table 4.2.15: Suitable areas for Mulberry in Kokrajhar District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhowranguri	-	2848.05	1416.7	4264.75
Dotoma	-	13.56	5916.99	5930.55
Gossaigaon	-	3754.7	4948.11	8702.81
Kokrajhar	-	61	4063.41	4124.41
Total	**-**	**6677.31**	**16345.2**	**23022.5**

Table 4.2.16: Suitable areas for Eri in Morigaon District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhuragaon	614.43	172.96	73.19	860.57
Laharighat	468.58	59.18	50.6	578.35
Mayong	1505.5	213.54	198.83	1917.87
Mikirbheta	1848.71	-	-	1848.71
Morigaon	2952.71	24.57	11.35	2988.62
Total	**7389.92**	**470.24**	**333.96**	**8194.12**

Table 4.2.17: Suitable areas for Muga in Morigaon District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhuragaon	607.87	171.92	73.16	852.95
Laharighat	468.63	59.14	50.61	578.38
Mayong	1334.69	162.81	185.08	1682.58
Mikirbheta	1848.43	-	-	1848.43
Morigaon	2760.67	22.76	11.35	2794.78
Total	**7020.29**	**416.63**	**320.2**	**7757.12**

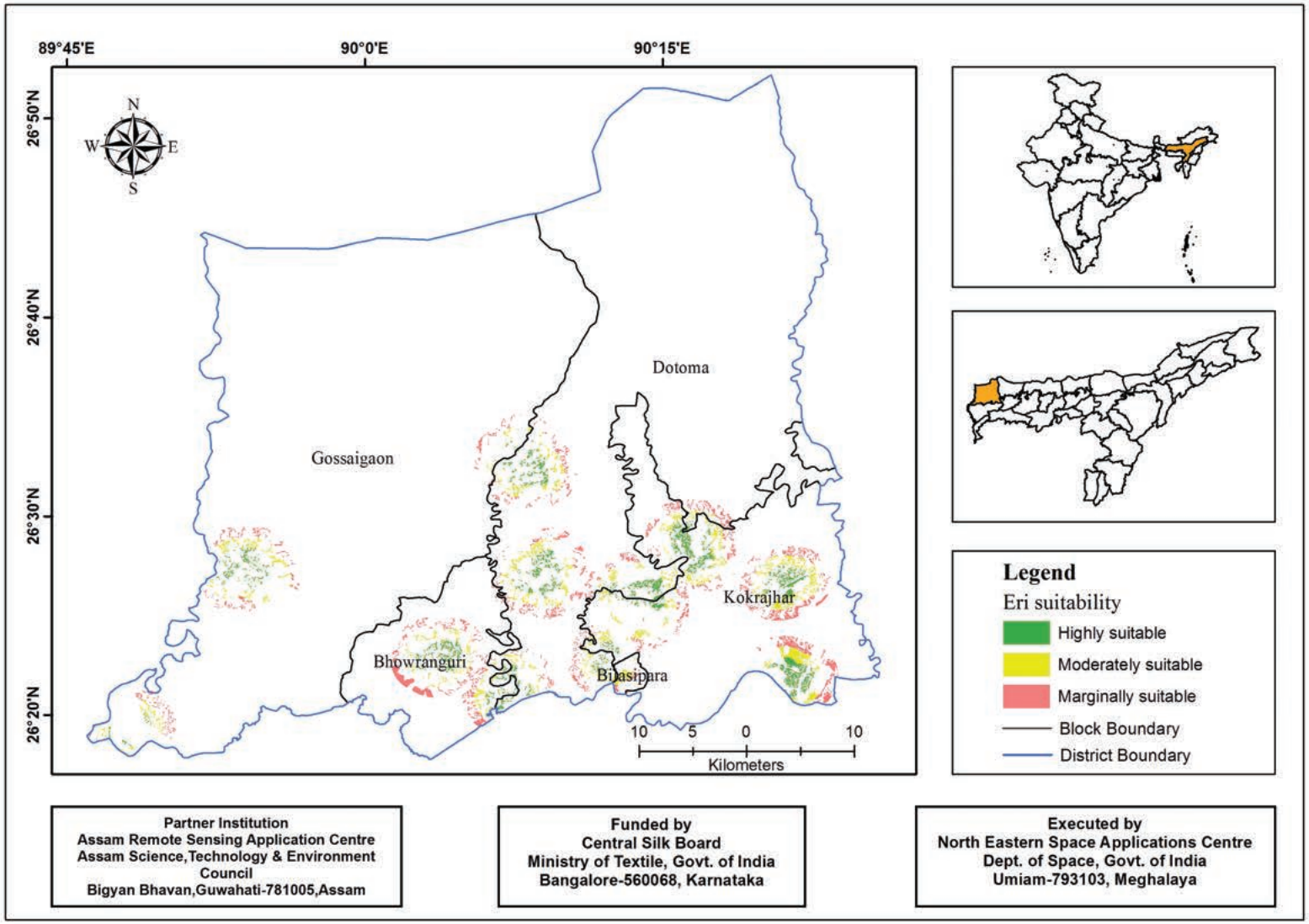

Fig 4.2.13: Suitable areas for Eri in Kokrajhar district of Assam

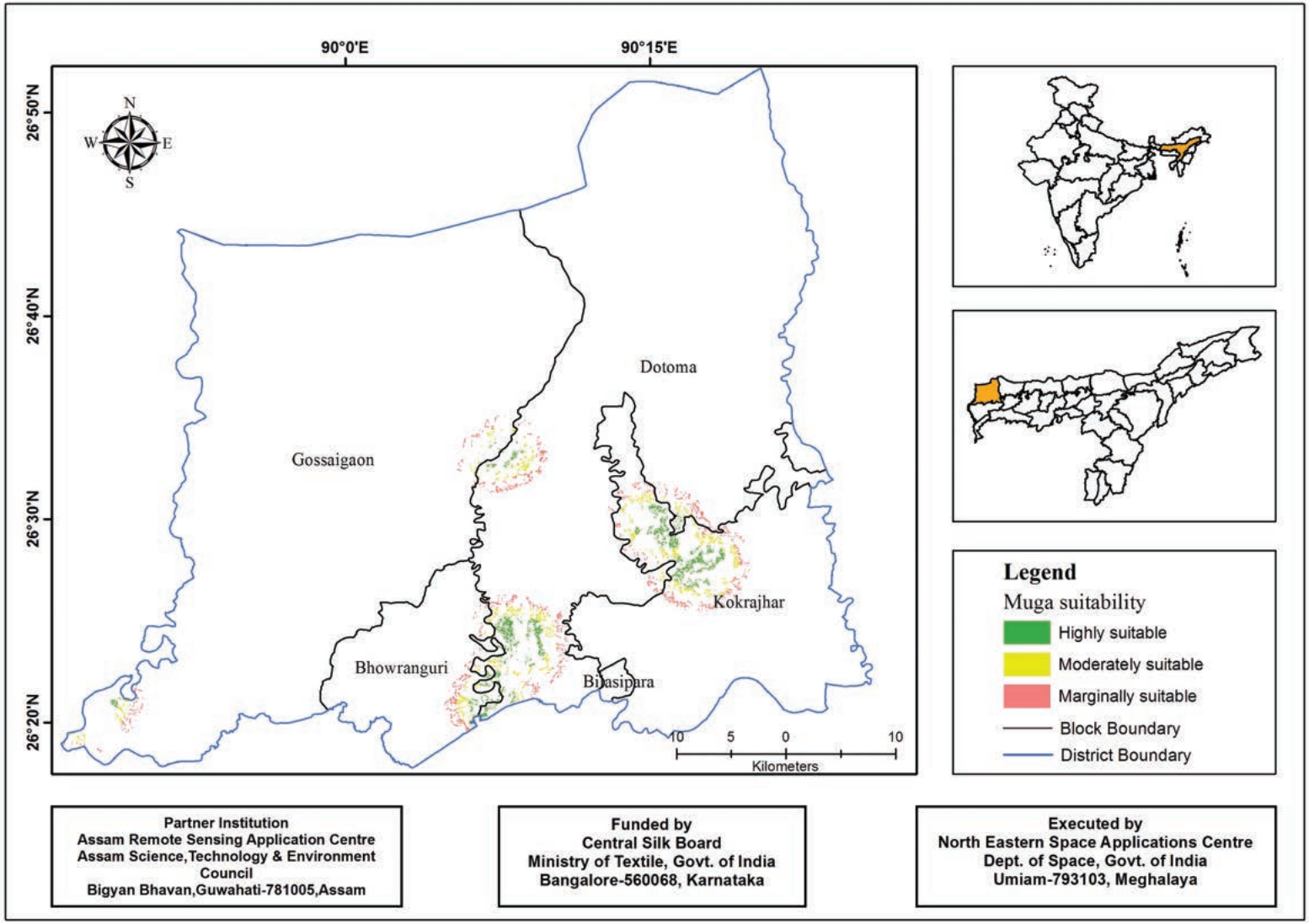

Fig 4.2.14: Suitable areas for Muga in Kokrajhar district of Assam

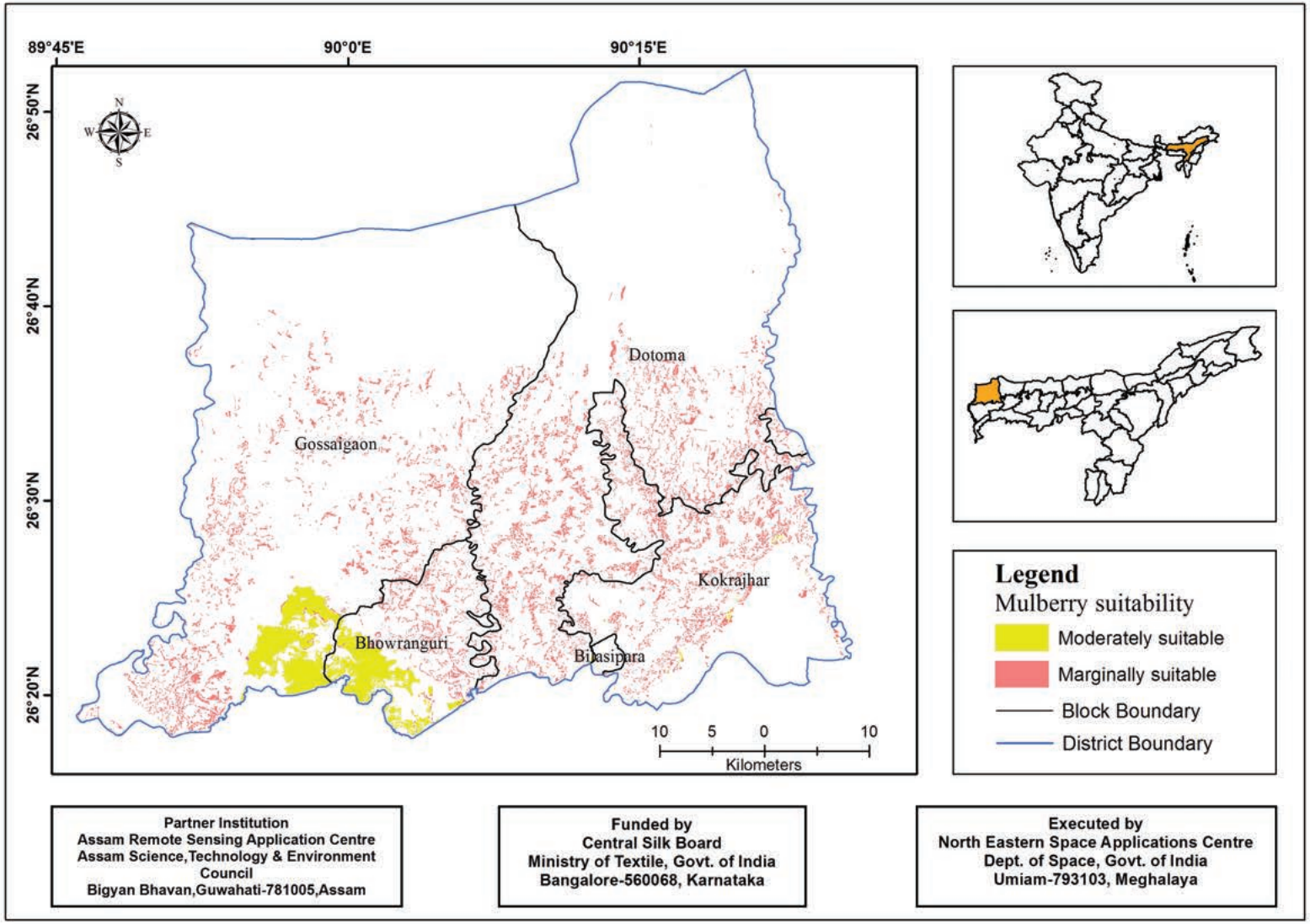

Fig 4.2.15: Suitable areas for Mulberry in Kokrajhar district of Assam

Table 4.2.18: Suitable areas for Mulberry in Morigaon District of Assam

Circle	High	Moderate	Marginal	Total(ha)
Bhuragaon	-	129.85	11.68	141.53
Laharighat	-	52.65	3.03	55.68
Mayong	-	-	40.63	40.63
Mikirbheta	-	-	1285.3	1285.3
Morigaon	-	-	1325.88	1325.88
Total	**-**	**182.5**	**2666.52**	**2849.02**

Table 4.2.19 Suitable areas for Eri in Sibsagar district of Assam

Block	Highly	Marginally	Moderately	Total(ha)
Amguri	3564.37	464.44	1804.57	5833.38
Dimow	4243.15	993.94	1685.4	6922.49
Mahmora	1389.48	1139.39	841.06	3369.93
Nazira	3467.15	1647.64	2092.18	7206.97
Sibsagar	3679.75	791.61	2021.72	6493.08
Sonari	4371.82	2759.62	3363.17	10494.61
Total	**20715.72**	**7796.64**	**11808.1**	**40320.46**

Table 4.2.20: Suitable areas for Muga in Sibsagar District

Circle	High	Moderate	Marginal	Total(ha)
Amguri	3961.78	1276.65	251.63	5490.06
Dimow	3124.24	1641.99	870.31	5636.54
Mahmora	1761.35	1466.54	1349.76	4577.65
Nazira	4175.68	1571.36	1076.61	6823.65
Sibsagar	2518.96	1587.6	810.55	4917.12
Sonari	2884.31	2433.35	2092.23	7409.89
Total	**18426.3**	**9977.49**	**6451.1**	**34854.9**

Table 4.2.21: Suitable areas for Mulberry in Sibsagar District

Block	High	Moderate	Marginal	Total(ha)
Amguri	-	-	3385.56	3385.56
Dimow	-	-	5304.02	5304.02
Mahmora	-	-	6638.15	6638.15
Nazira	-	-	7148.7	7148.7
Sibsagar	-	-	3262.81	3262.81
Sonari	-	-	13283.16	13283.16
Total	**-**	**-**	**39022.4**	**39022.4**

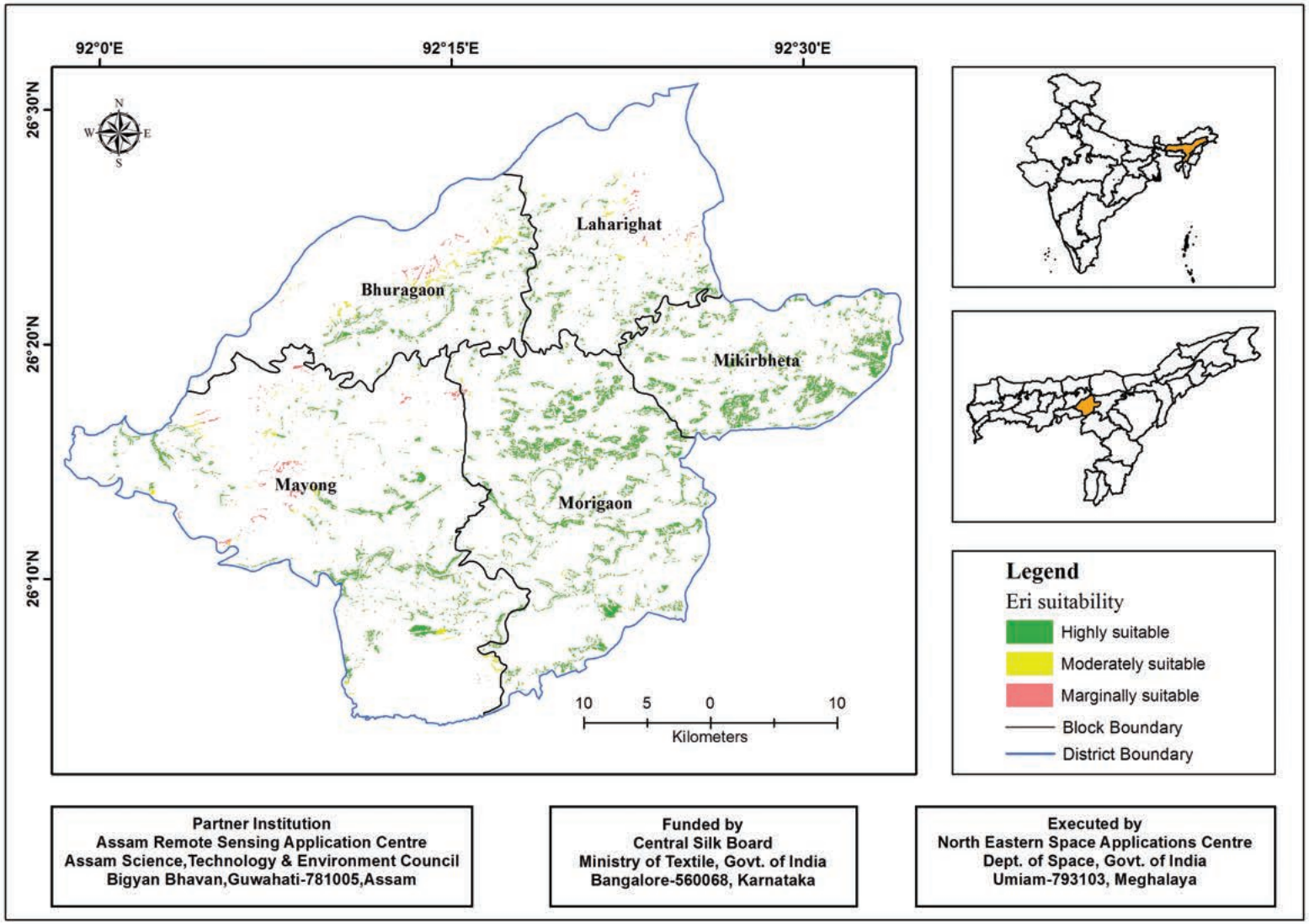

Fig 4.2.16: Suitable areas for Eri in Morigaon district of Assam

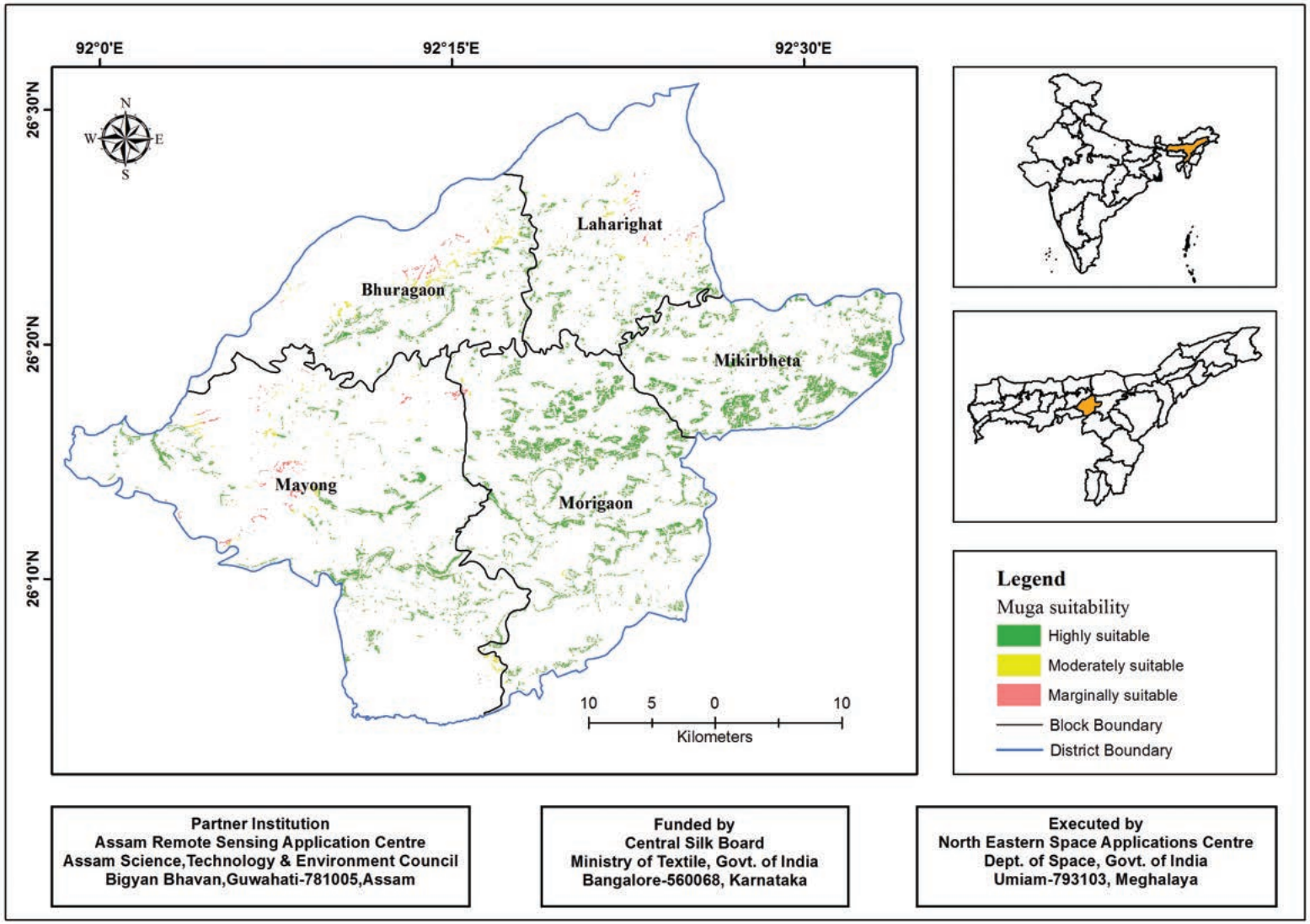

Fig 4.2.17: Suitable areas for Muga in Morigaon district of Assam

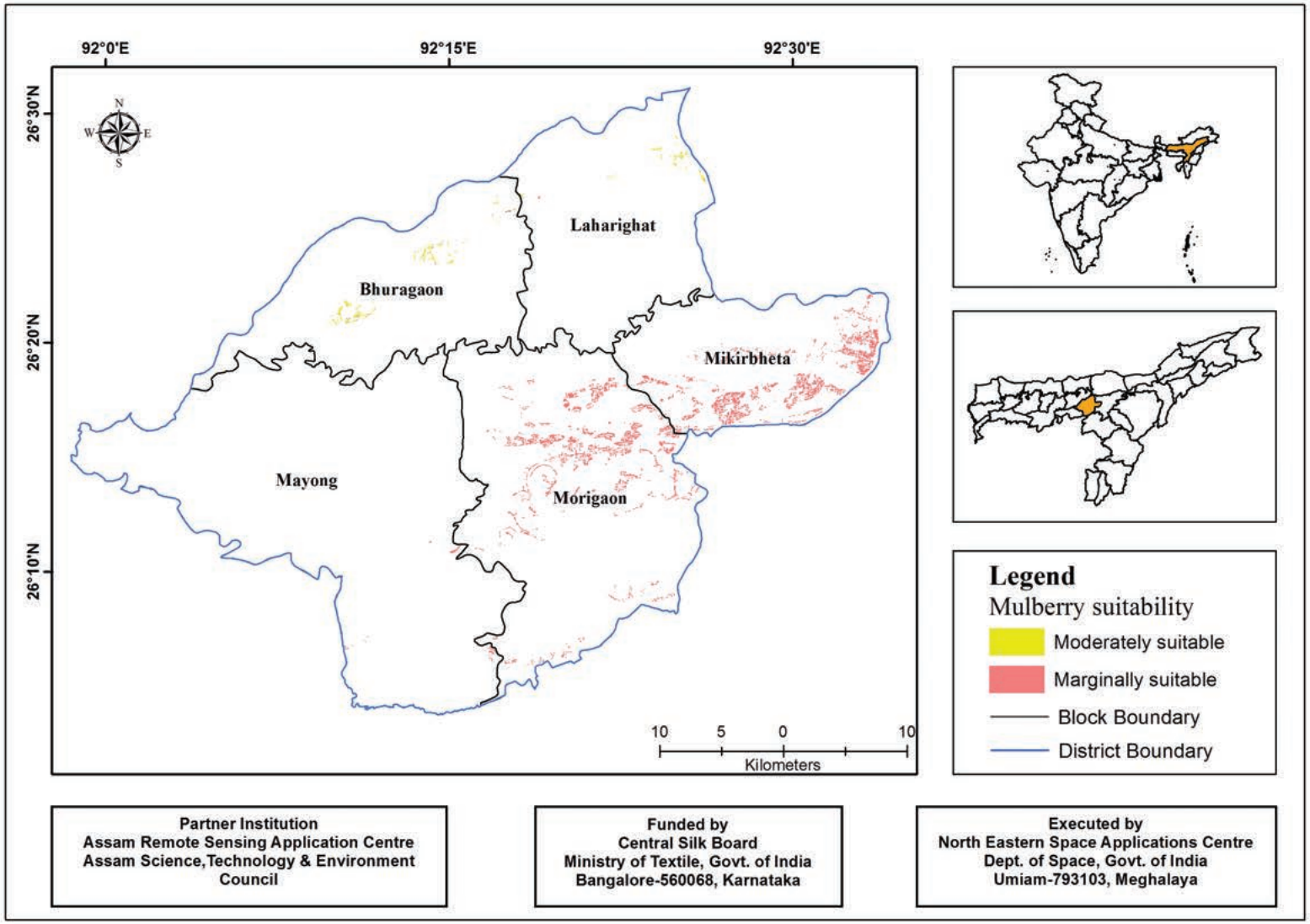

Fig 4.2.18: Suitable areas for Mulberry in Morigaon district of Assam

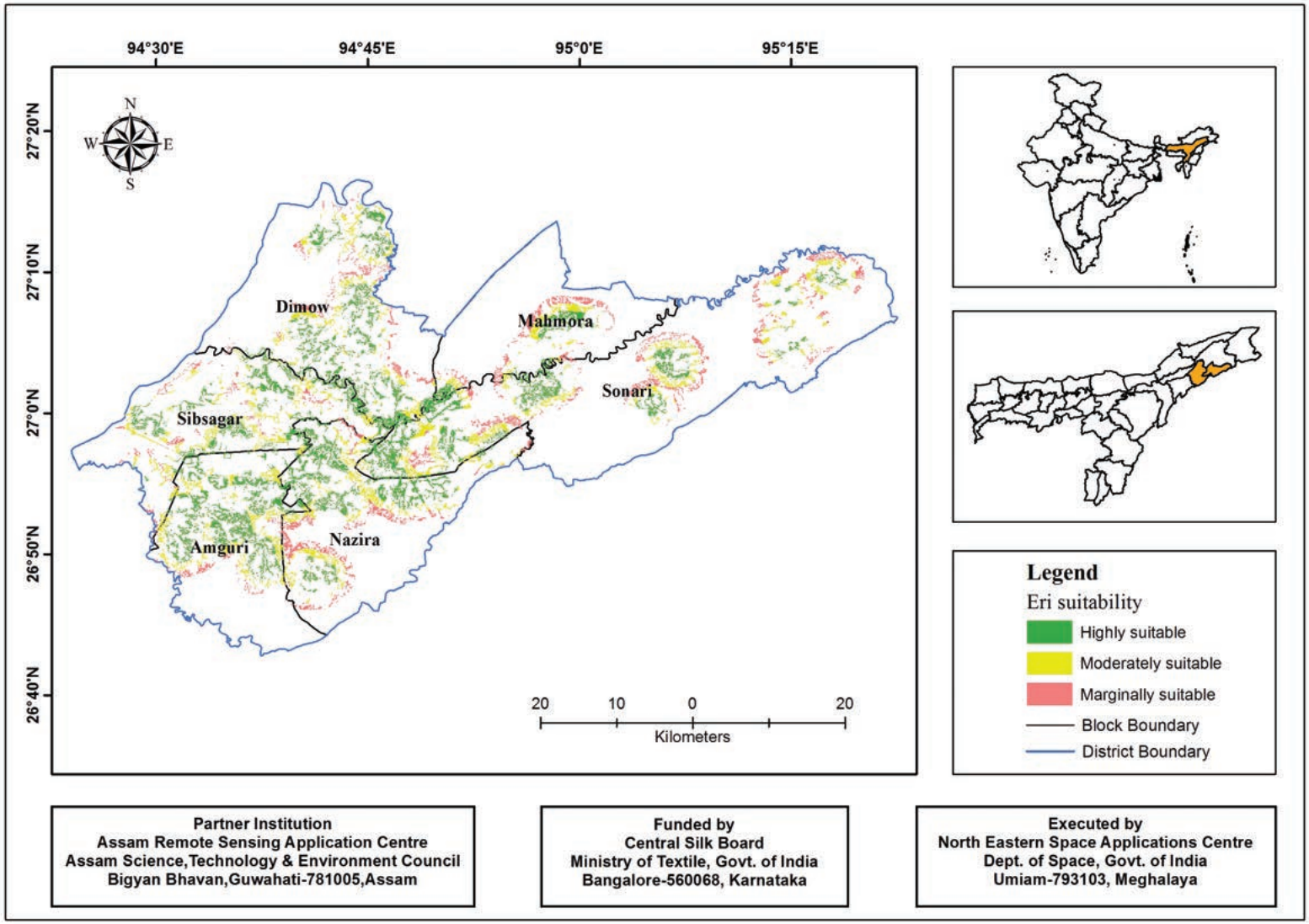

Fig 4.2.19: Suitable areas for Eri in Sibsagar district of Assam

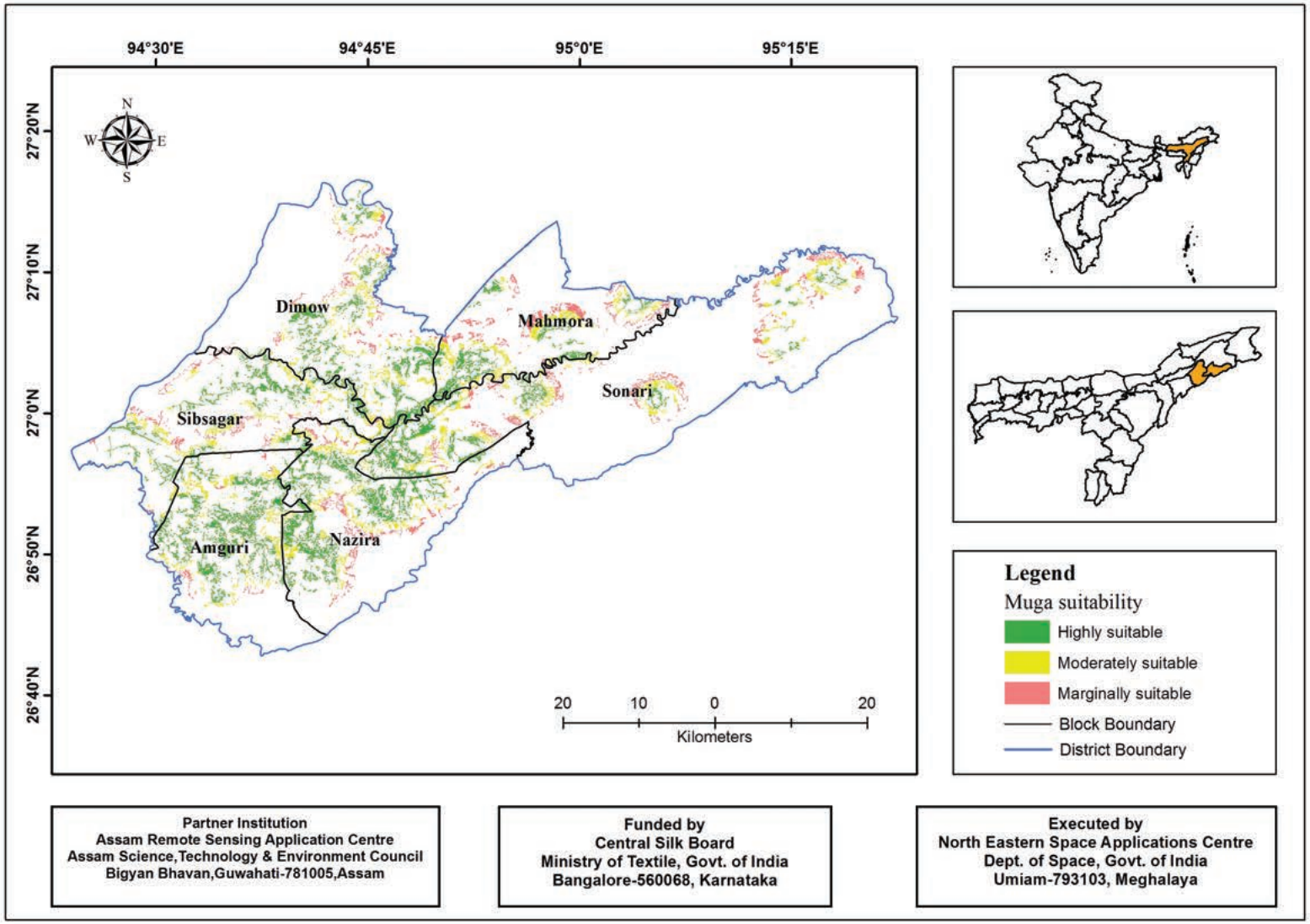

Fig 4.2.20: Suitable areas for Muga in Sibsagar district of Assam

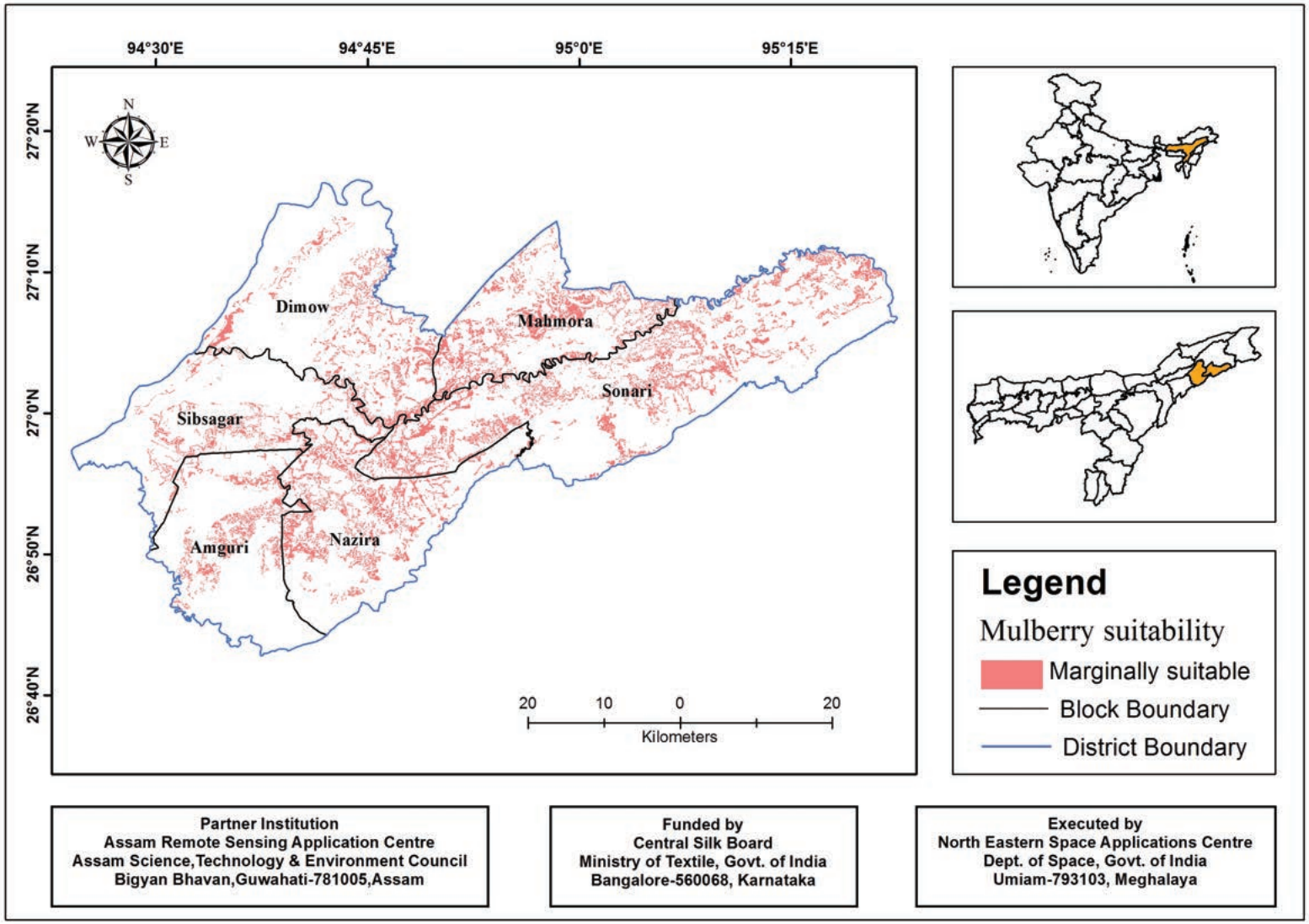

Fig 4.2.21: Suitable areas for Mulberry in Sibsagar district of Assam

MEGHALAYA

Meghalaya is a southern state in north eastern region of the country that covers an area of approximately 22,430 square kilometers with a population of 2,964,007 as per 2011 census. This state is bounded to the south by the districts of greater Mymensingh and the Division of Sylhet and the west by the Division of Rangpur of the Bangladesh and the north and the east by Assam state. The capital is Shillong, known as the “Scotland of the East”. The state is the wettest region of India, recording an average of 1200 cm of rains a year. About 70% of the state is forested. Meghalaya has predominantly an agrarian economy with a significant commercial forestry industry. The important crops are potatoes, rice, maize, pineapples, bananas, papayas, spices, etc. Besides agriculture, a small part of the economy is occupied in small-scale industries such as sericulture & weaving, animal husbandry and dairy farming, carpentry & bamboo-working, brick-making, etc. Mining is another important industry. The state has fairly large reserves of coal, limestone and clay.

Sericulture and weaving in Meghalaya are the two most important cottage based, eco-friendly industries in the rural areas. These twin industries portray the cultural ethos and rich heritage of the people of the State. In the absence of a textile industry, Sericulture and weaving can play an important role for the production of silk fabrics and hand woven fabrics of ethnic designs.

Sericulture and weaving play a very important role in providing self employment opportunities and additional earning especially for the rural women. The climate in Meghalaya is conducive for rearing of Eri, Muga and Mulberry silkworms. Rearing of Eri, Muga and Mulberry is being practiced by the rural people of the state, mostly by women. At present there are around 28,000 Sericultural farmers and 23,000 weavers in the state. Meghalaya stands second in production of Eri and Muga silk yarn i.e. next to Assam. In Meghalaya, there are 12 seed farms, 6 for mulberry, 3 for Eri and 2 for Muga. There are 9 mulberry and 3 Muga nurseries to rear planting materials in different Districts. Two districts viz, (including North Garo Hills) and Ri Bhoi were selected for mapping of potential areas for Mulberry, Eri and Muga.

Jaintia Hills District

The name "Jaintia" has been using only when the area came under the British rule in 1835 it was derived from that of the goddess "Jayanti Devi" one of the deities worshipped by the Jaintia royal family. The Jaintia Hills District is located in the easternmost part of Meghalaya and lies approximately between 25°07 to 25°41 N lat and 91°21 to 92°09 E. It was the second largest district in Meghalaya with about 3819 Sq. Kms area and Jowai was the district headquarter. On 31 July 2012, the district was divided into two District i.e. East

Jaintia hills with an area of 2115 sq.km, headquarter at Khliehriat and Khliehriat and Saipung block under it and West Jaintia Hills with an area of 1693 sq km with its headquarter at Jowai and three blocks Amlarem, Laskein, and Thadlaskein.

West Garo Hills

The West Garo Hills district was created on 22nd October 1976 keeping Tura as its headquarters by bifurcating the then composite Garo Hills District into West Garo Hills and East Garo Hills District. The West Garo Hills is once again bifurcated, creating South Garo Hills by upgrading Baghmara Subdivision to District level in 1991. The District derives its name from the predominant inhabitants of the district. It lies approximately between 26 to 252°0' N latitudes 90°30' to 89°40' E longitude, covering an area of 3677 Sq.Km.

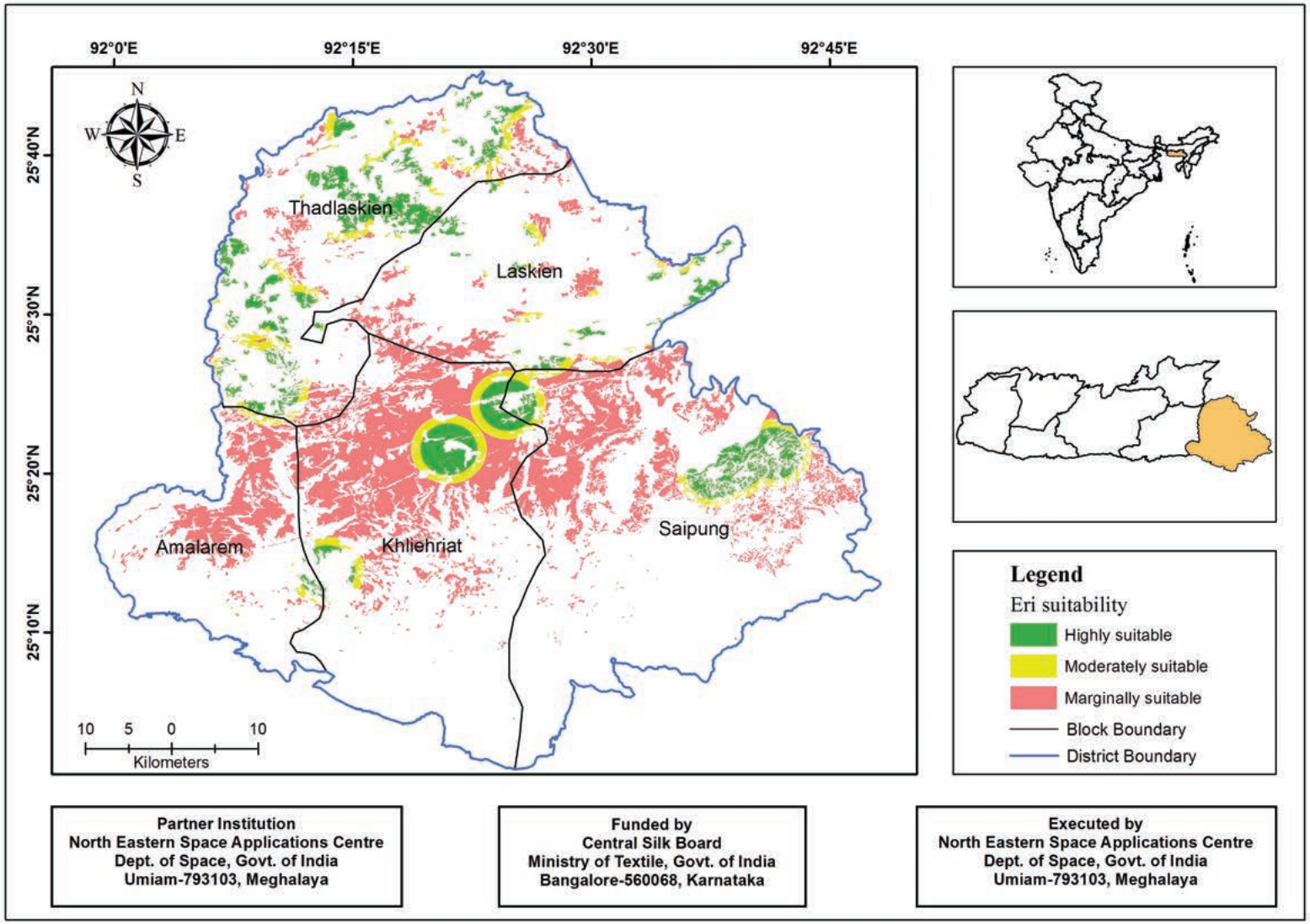

Fig 4.3.1: Suitable areas for Eri in Jaintia Hills district of Meghalaya

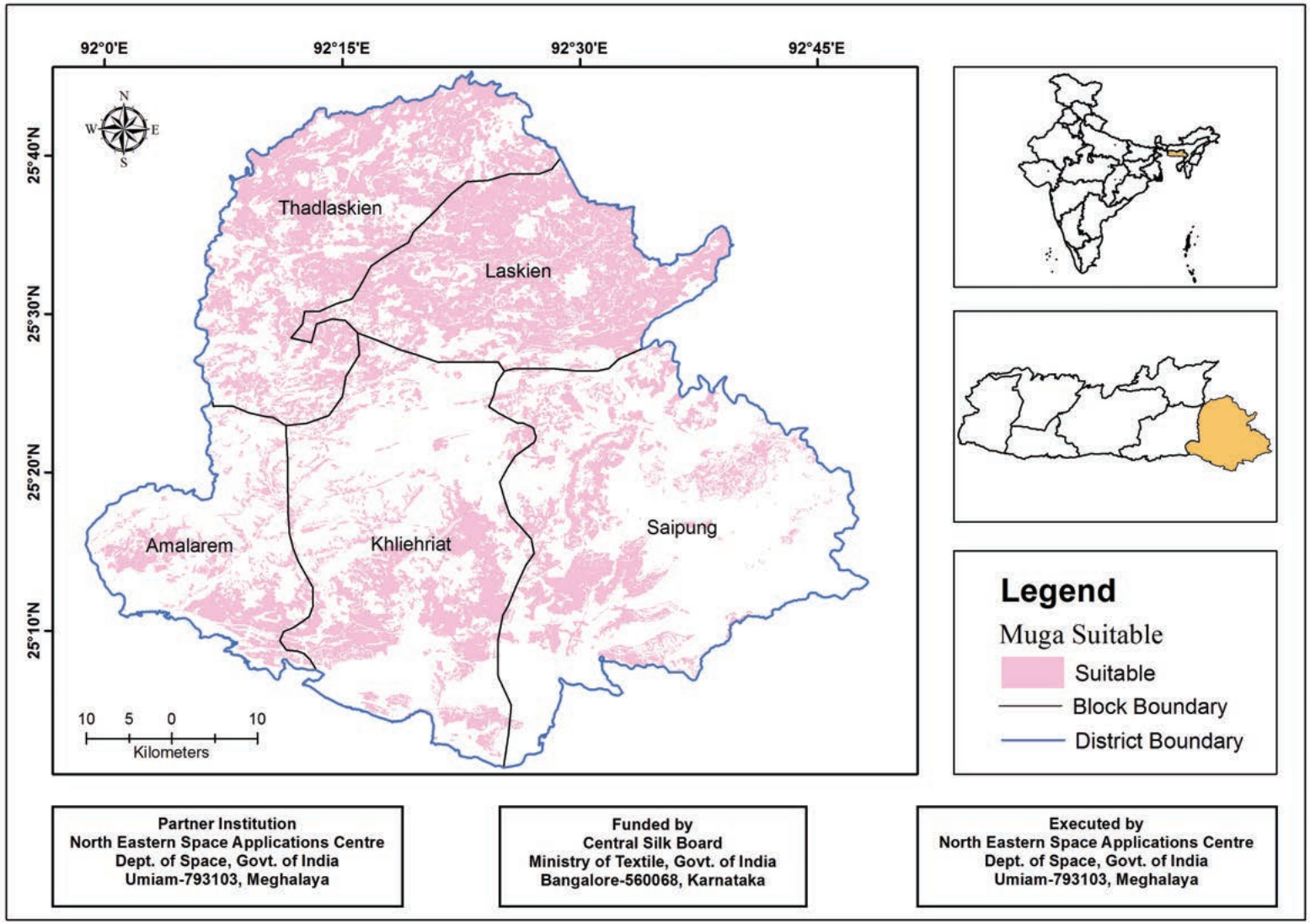

Fig 4.3.2: Suitable areas for Muga in Jaintia Hills district of Meghalaya

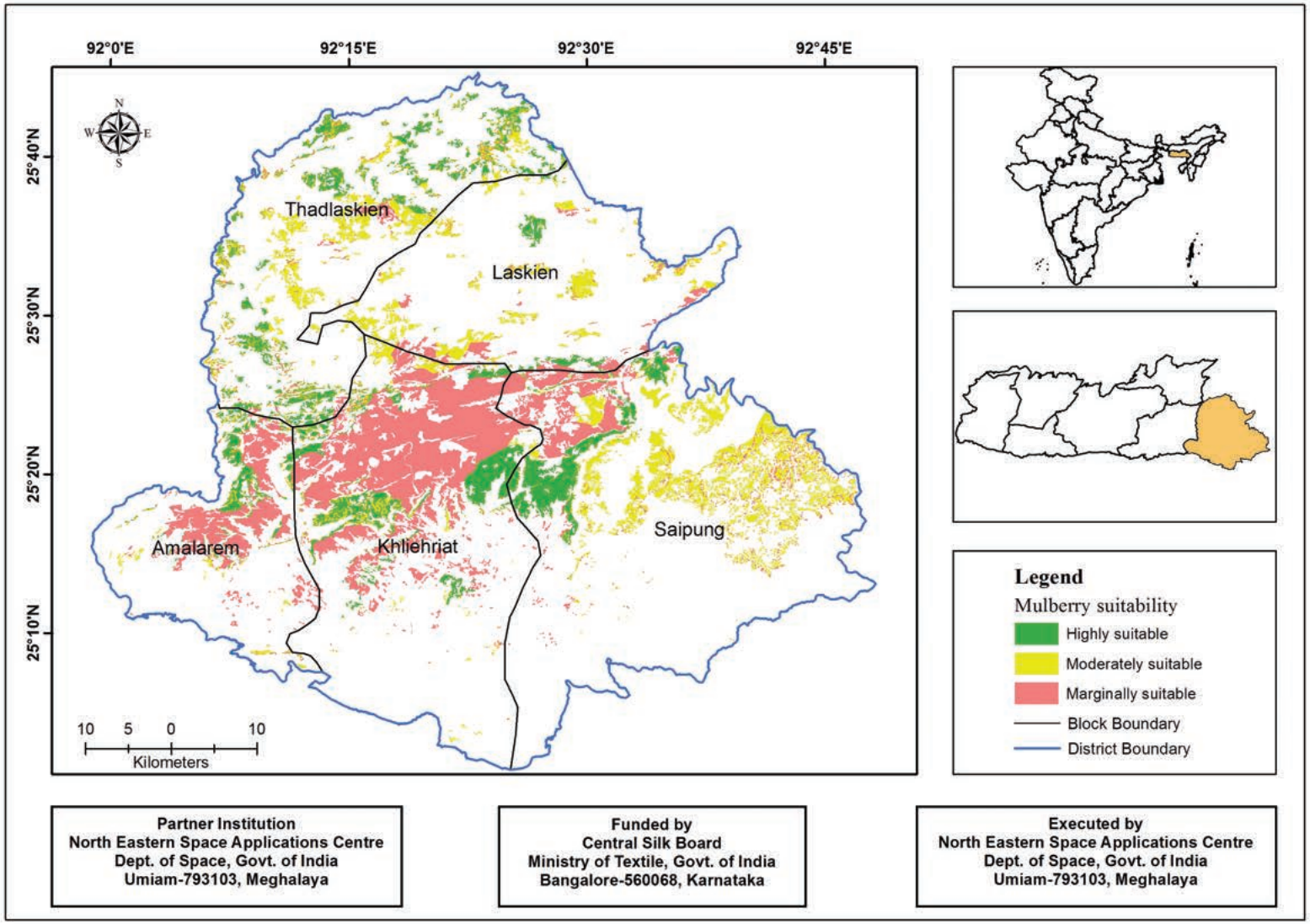

Fig 4.3.3: Suitable areas for Mulberry in Jaintia Hills district of Meghalaya

Table 4.3.1: Suitable areas for Eri in Jaintia District of Meghalaya

Block	High	Moderate	Marginal	Total(ha)
Amalarem block	426.35	442	28771.09	29639.44
Khliehriat block	4547.85	3890.11	42497.6	50935.56
Laskien block	3275.37	1329.46	28995.41	33600.24
Saipung block	4606.47	3125.38	37792	45523.85
Thadlaskien block	7273.14	3506.62	5202.67	15982.43
Total	**20129.18**	**12293.57**	**143258.8**	**175681.5**

Table 4.3.2: Suitable areas for Muga in Jaintia District of Meghalaya

Block	Suitable	Total(ha)
Amalarem block	20935.87	20935.87
Khliehriat block	75748.99	75748.99
Laskien block	76904.38	76904.38
Saipung block	70180.77	70180.77
Thadlaskien block	80218.81	80218.81
Total	**323989**	**323989**

Table 4.3.3: Suitable areas for Mulberry in Jaintia District of Meghalaya

Block	High	Moderate	Marginal	Total(ha)
Amalarem block	2337.43	1125.7	29924.46	33387.59
Khliehriat block	9408.05	3019.9	30736.93	43164.88
Laskien block	1392.79	6633.08	3630.57	11656.44
Saipung block	7131.72	12867.57	26535.69	46534.98
Thadlaskien block	6533.87	8311.32	1797.41	16642.6
Total	**26803.9**	**31957.6**	**92625.1**	**151386**

Table 4.3.4: Suitable areas for Eri in West Garo Hills district of Meghalaya

Block	Suitable	Total(ha)
Betasing	1527.75	1527.75
Dadenggre	6670.7	6670.7
Dalu	1756.66	1756.66
Gambegre	4139.91	4139.91
Rongram	6563.7	6563.7
Selsella	2214.74	2214.74
Tikrikilla	3329.3	3329.3
Zikzak	2724.53	2724.53
Total	**28927.29**	**28927.29**

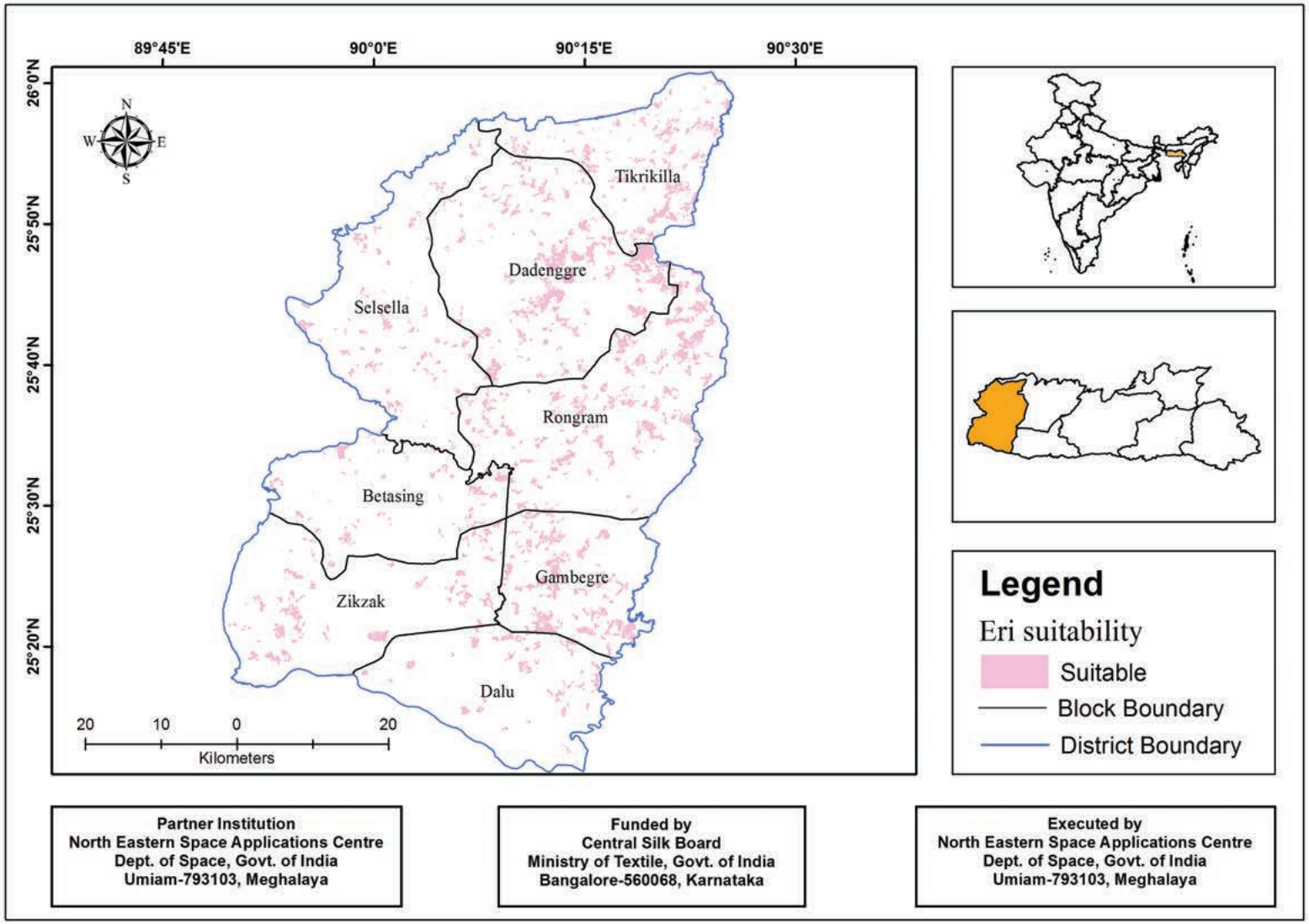

Fig 4.3.4: Suitable areas for Eri in West Garo Hills district of Meghalaya

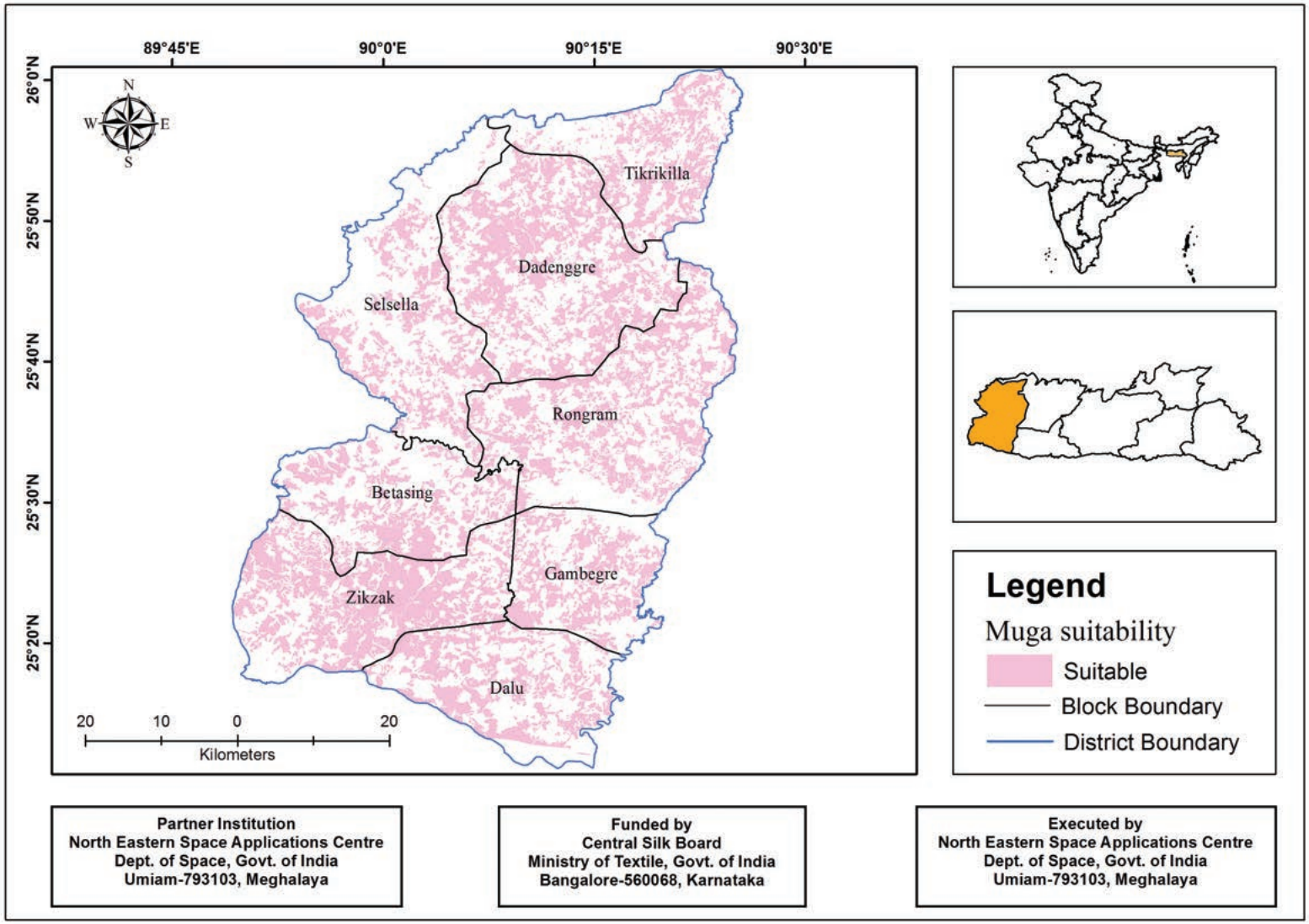

Fig 4.3.5: Suitable areas for Muga in West Garo Hills district of Meghalaya

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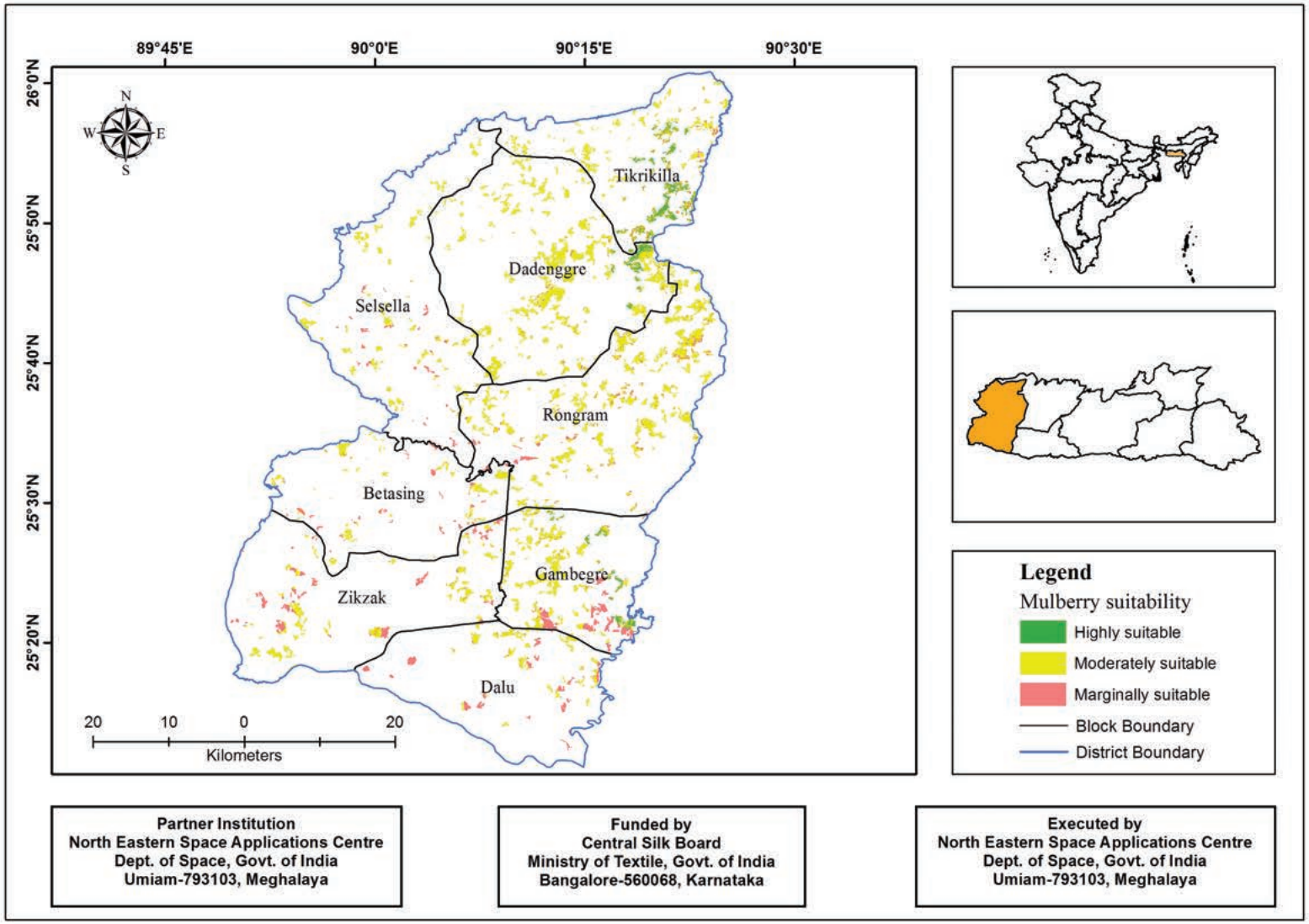


Fig 4.3.6: Suitable areas for Mulberry in West Garo Hills district of Meghalaya

Table 4.3.5: Suitable areas for Muga in West Garo Hills district of Meghalaya

Block	Suitable	Total(ha)
Betasing	14029.53	14029.53
Dadenggre	28764.87	28764.87
Dalu	15805.97	15805.97
Gambegre	12070.8	12070.8
Rongram	24058.17	24058.17
Selsella	14650.85	14650.85
Tikrikilla	12343.11	12343.11
Zikzak	26575.83	26575.83
Total	**148299.13**	**148299.13**

Table 4.3.6: Suitable areas for Mulberry in West Garo Hills District of Meghalaya

Block	High	Moderate	Marginal	Total(ha)
Betasing	-	1114.67	442.4	1557.07
Dadenggre	348.8	6321.95	165.89	6836.64
Dalu	-	1077.58	736	1813.58
Gambegre	347.35	2840.97	1129.89	4318.21
Rongram	19.85	6304.03	761.03	7084.91
Selsella	-	1839.22	410.26	2249.48
Tikrikilla	896.94	2386.41	298.66	3582.01
Zikzak	-	1803.13	1001.41	2804.54
Total	**1612.94**	**23687.96**	**4945.54**	**30246.44**

MIZORAM

Mizoram is a state in Northeast India, with Aizawl as its capital city. Within the northeast region, it is the southernmost landlocked state, sharing borders with three of the Seven Sister States, namely Tripura, Assam and Manipur. The state also shares a 722 kilometre border with the neighbouring countries of Bangladesh and Myanmar.

Mizoram's population was 1,091,014, according to a 2011 census. It is the 2nd least populous state in the country. This is the highest concentration of tribal people among all states of India, and they are currently protected under Indian constitution as a Scheduled Tribe with a Christian majority (87%). Mizoram covers an area of approximately 21,087 square kilometres. About 91% of the state is forested.

Mizoram is a highly literate agrarian economy, but suffers from slash-and-burn jhum, or shifting cultivation, and poor crop yields. In recent years, the jhum farming practices are steadily being replaced with a significant horticulture and bamboo products industry.

Mizoram has a mild climate, being relatively cool in summer 20 to 29°C (68 to 84°F) but progressively warmer most probably due to climate change with temperature crossing 30 degrees Celsius with winter temperatures ranging from 7 to 22°C (45 to 72°F), which is conducive for all the four types of sericulture viz., Eri, Muga, Mulberry and Tasar. Six districts were selected for mapping of potential areas for sericulture development in the state.

A significant area of Mizoram falls under cultivable wasteland which can be brought under silkworm host plant thereby expanding the areas under sericulture activities.

Kolasib

Kolasib district is one of the eight districts of Mizoram state in India. It is the smallest district in Mizoram with an area of 1,386 km2. It is located at 24°13'48"N latitude 92°40'48"E longitude. The district is bounded on the north and northwest by Hailakandi district of Assam state, on the west by Mamit district, on the south and east by Aizawl districtand on the northeast by Cachar district of Assam state.

Serchhip

Serchhip District is one of the eight districts of Mizoram state in India. The district occupies an area of 1421.60 km². Serchhip town is the administrative headquarters of the district. It has the highest literacy rate in India, and is the second least populous district of Mizoram. It is located at 24°18'36"N latitude 92°51'00"E longitude.

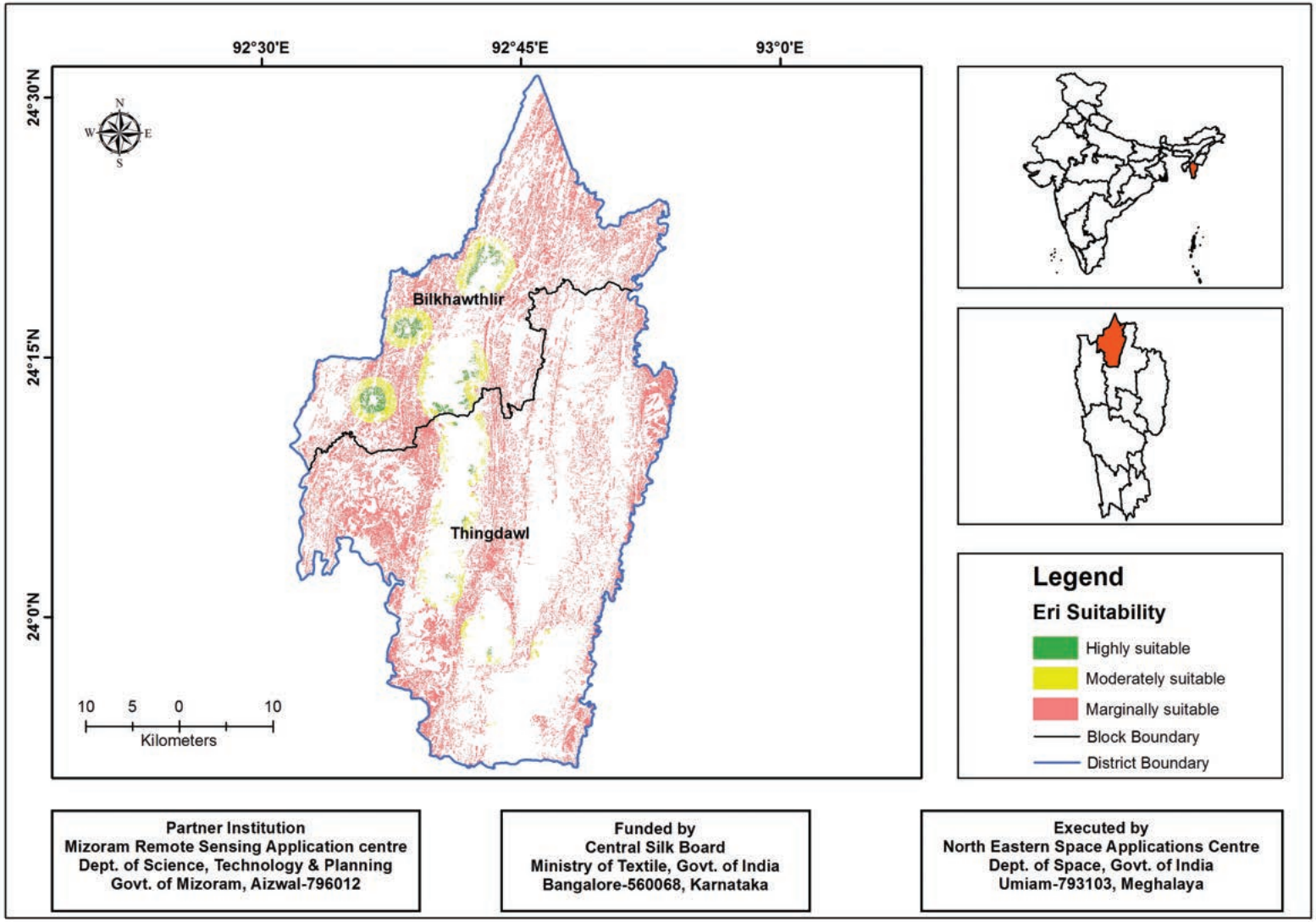


Fig 4.4.1: Suitable areas for Eri in Kolasib district of Mizoram

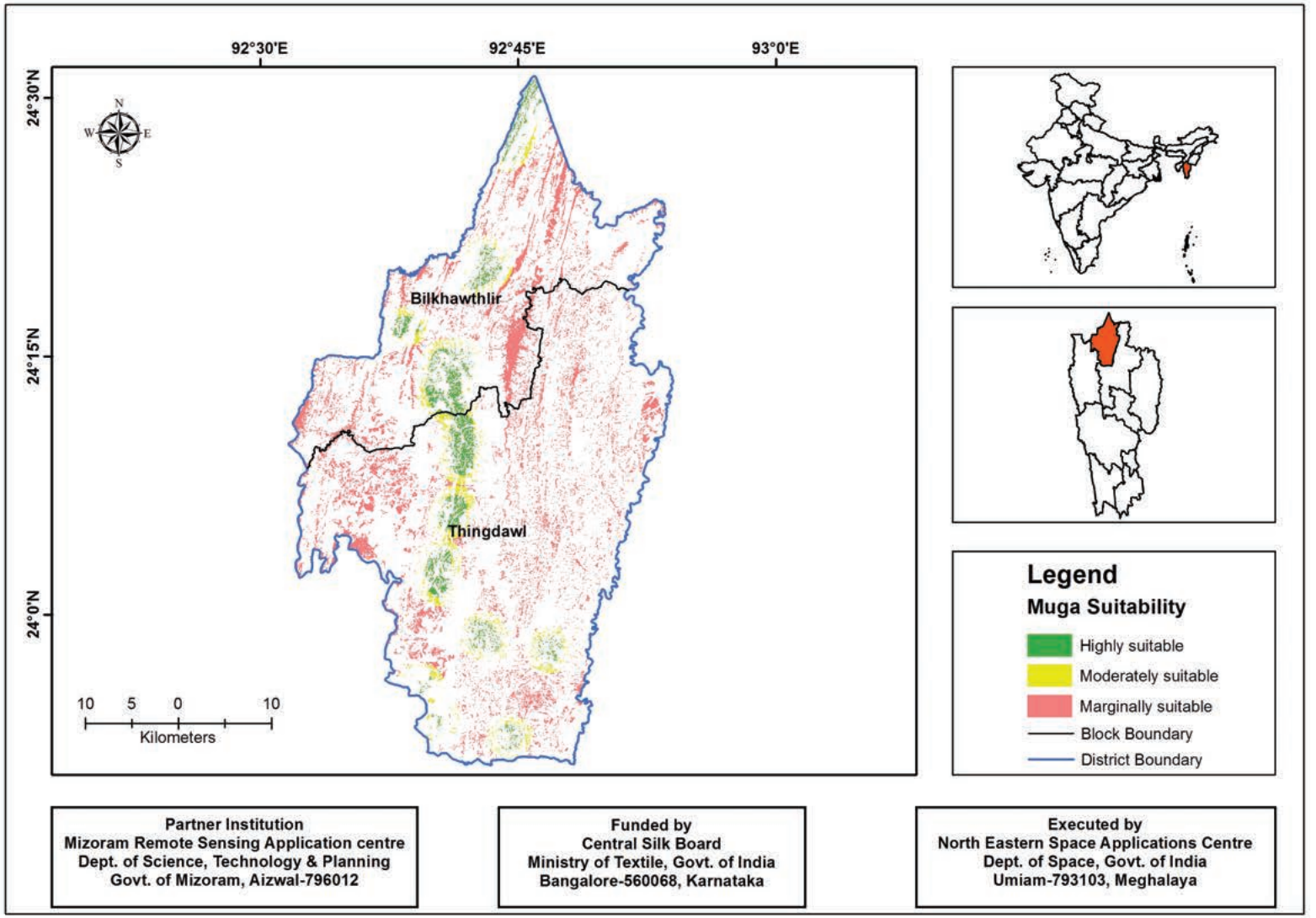


Fig 4.4.2: Suitable areas for Muga in Kolasib district of Mizoram

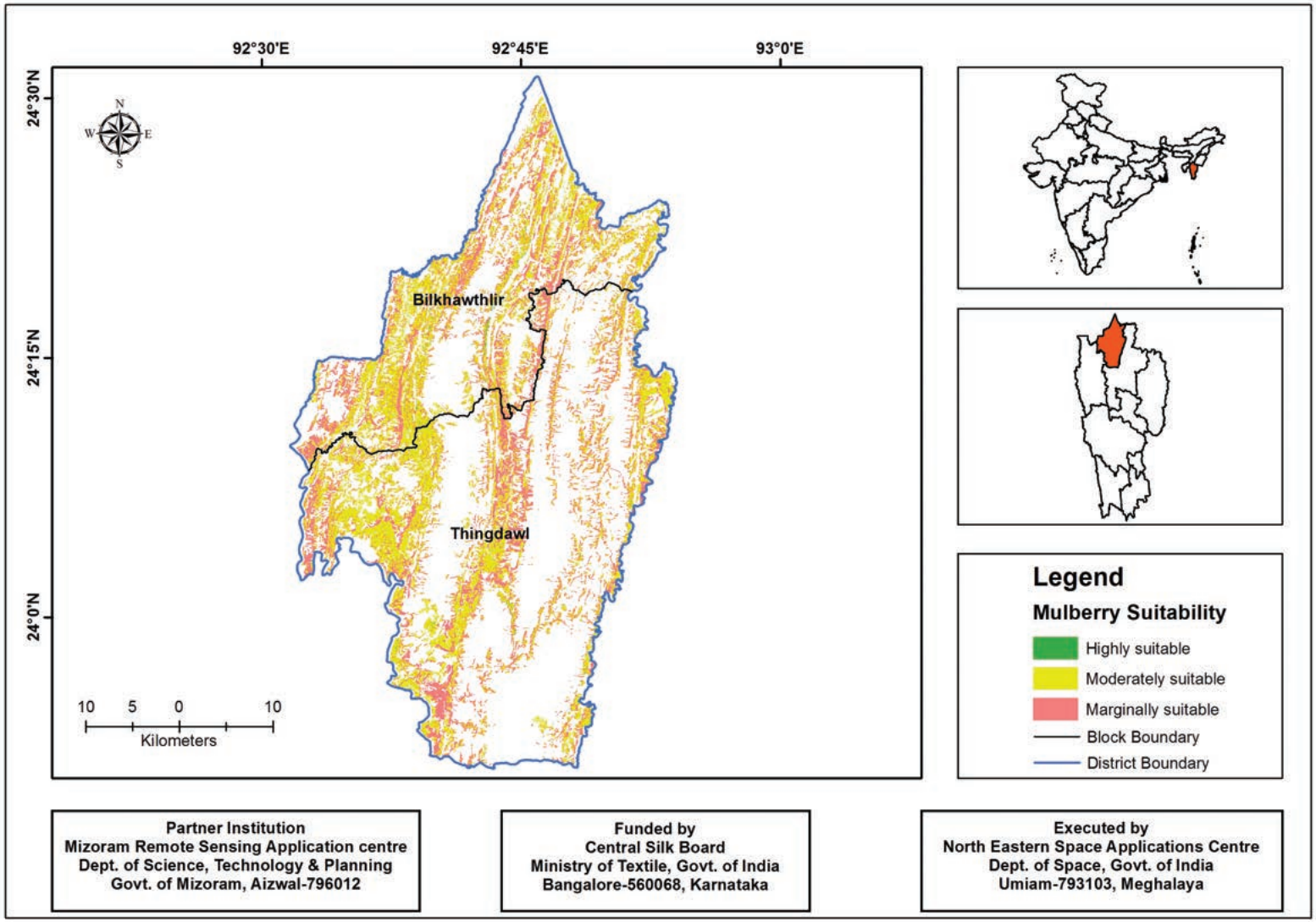


Fig 4.4.3: Suitable areas for Mulberry in Kolasib district of Mizoram

Table 4.4.1: Suitable areas for Eri in Koilasib District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Bilkhawthlir	1519.43	1884.46	12237.89	15641.78
Thingdawl	129.96	739.8	20889.95	21759.71
Total	**1649.39**	**2624.26**	**33127.84**	**37401.49**

Table 4.2.2: Suitable areas for Muga in Koilasib District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Bilkhawthlir	1381.79	771.93	7715.57	9869.29
Thingdawl	1641.13	1692.52	11564.85	14898.5
Total	**3022.92**	**2464.45**	**19280.42**	**24767.79**

Table 4.2.3: Suitable areas for Mulberry in Koilasib District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Bilkhawthlir	119.61	15229.63	10165.42	25514.66
Thingdawl	100.41	19945.34	15489.08	35534.83
Total	**220.02**	**35174.97**	**25654.5**	**61049.49**

Table 4.4.4: Suitable areas for Eri in Serchhip District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Lungdar	12.3	104.23	2933.74	3050.27
Serchhip	155.25	477.39	7774.91	8407.55
Total	**167.55**	**581.62**	**10708.65**	**11457.82**

Table 4.4.5: Suitable areas for Muga in Serchhip District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Lungdar	-	-	7380.28	7380.28
Serchhip	2120.63	1971.32	10777.28	14869.23
Total	**2120.63**	**1971.32**	**18157.56**	**22249.51**

Table 4.4.6: Suitable areas for Mulberry in Serchhip District of Mizoram

Block	High	Moderate	Marginal	Total(ha)
Lungdar	13.68	1424.51	1833.82	3272.01
Serchhip	49.93	7067.07	7357.92	14474.92
Total	**63.61**	**8491.58**	**9191.74**	**17746.93**

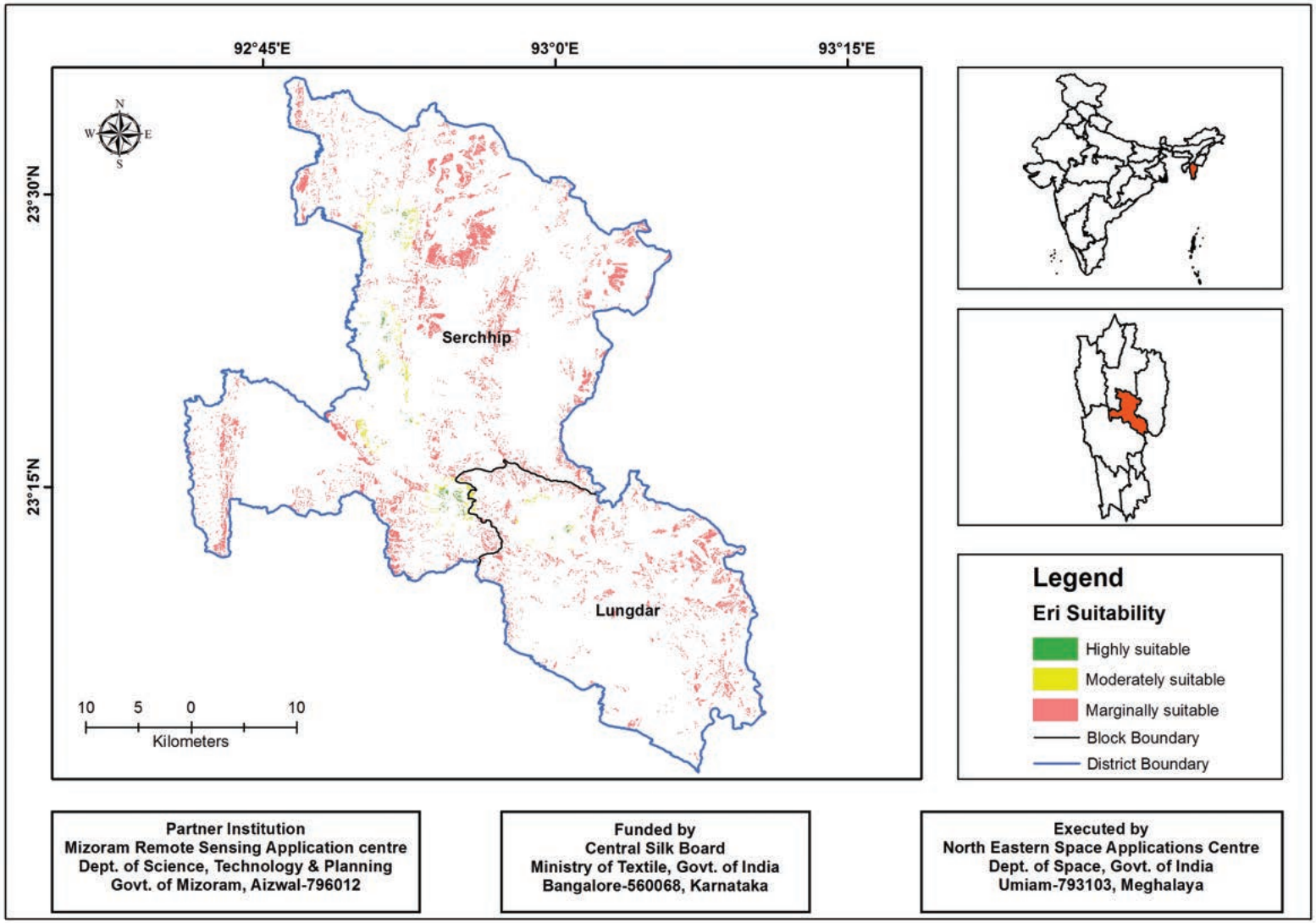


Fig 4.4.4: Suitable areas for Eri in Serchhip district of Mizoram

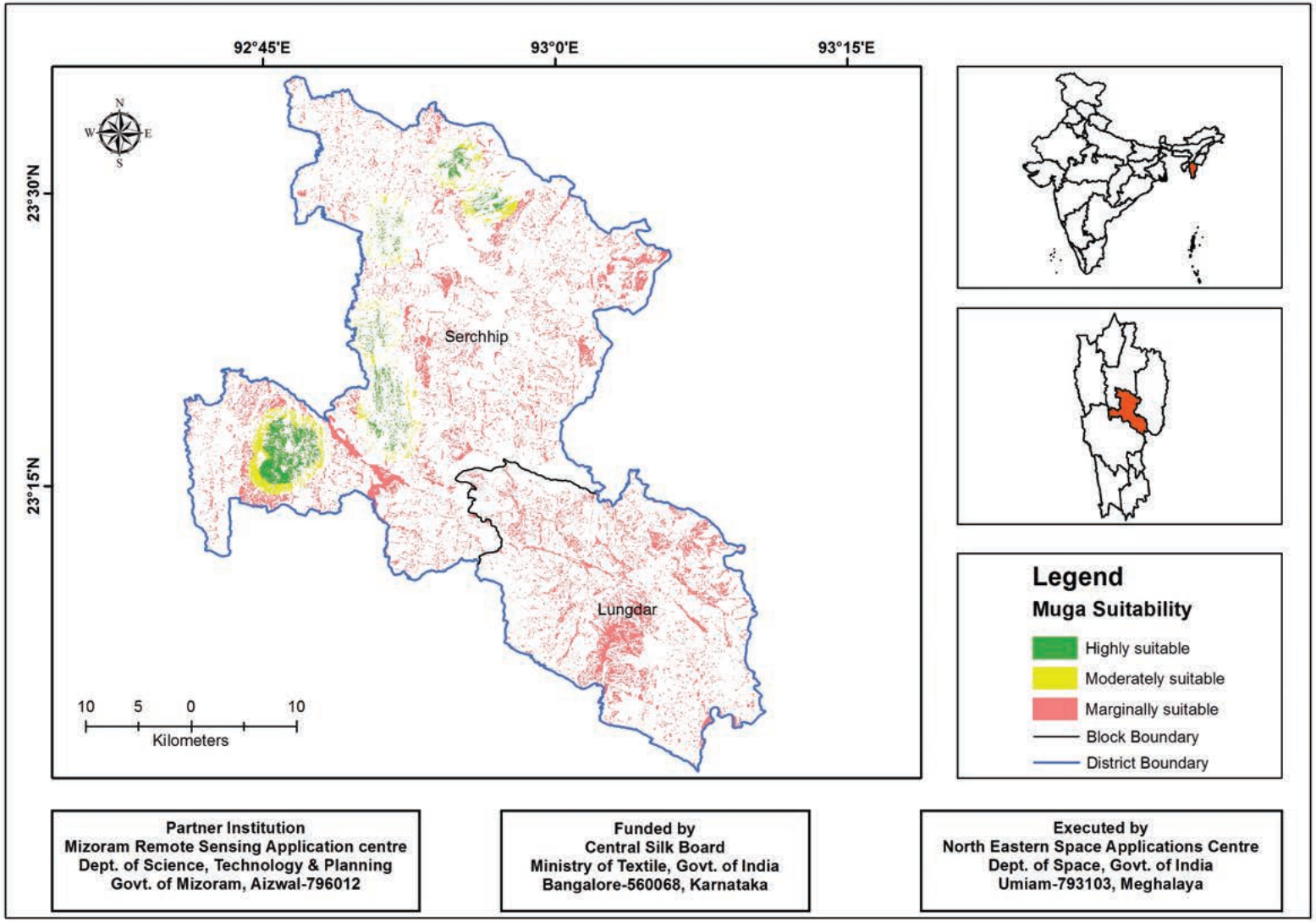


Fig 4.4.5: Suitable areas for Muga in Serchhip district of Mizoram

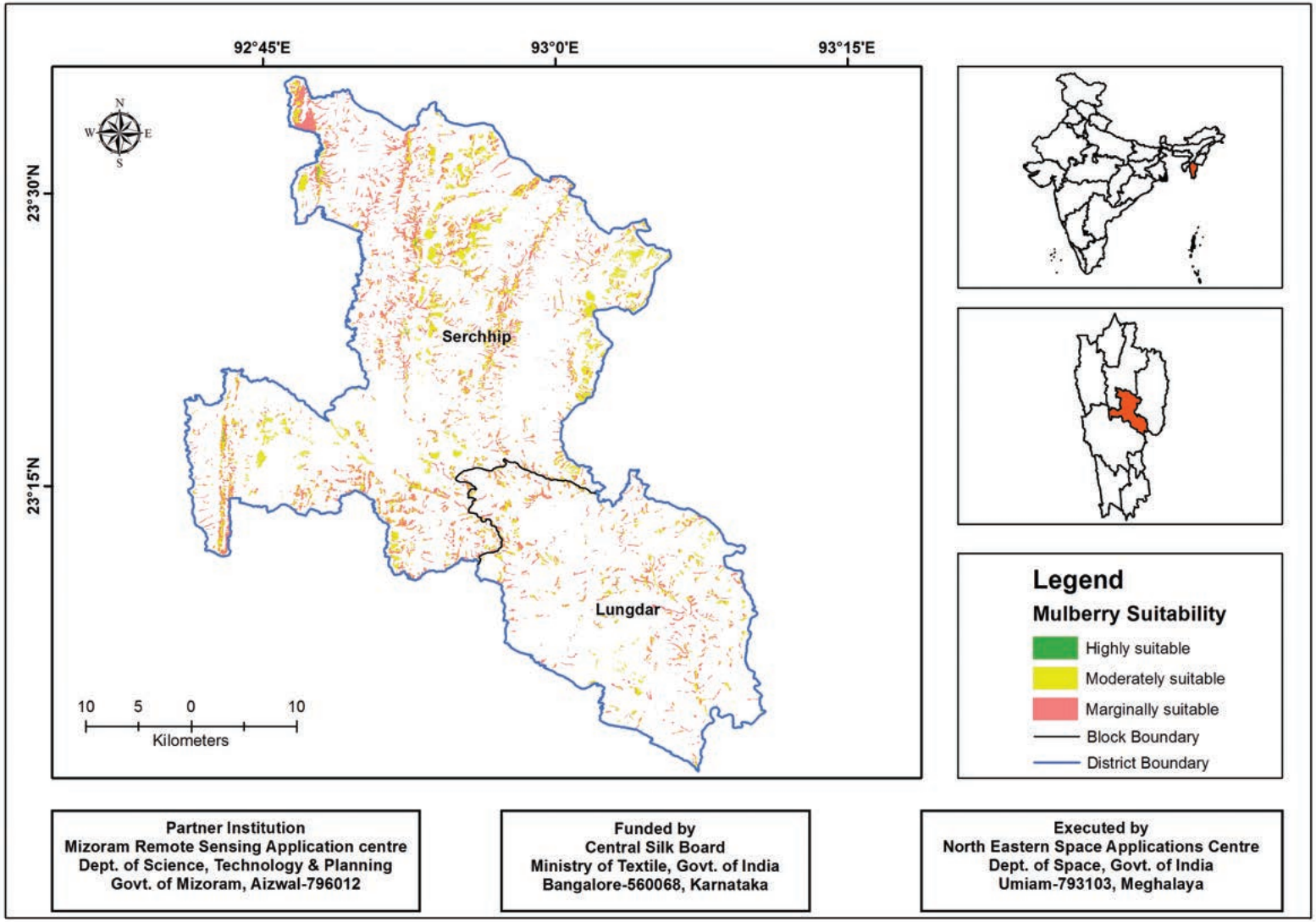


Fig 4.4.6: Suitable areas for Mulberry in Serchhip district of Mizoram

NAGALAND

Nagaland is located in the extreme north eastern end of India and lies between 96° to 98° E longitude and 26.6° to 27.4° N latitude. The state is bounded by Myanmar in the East; Assam in the West; Arunachal Pradesh and a part of Assam in the North with Manipur in the south. The state capital is Kohima, and the largest city is Dimapur. It has an area of 16579 km² with a population of 1,980,602 according to census 2011, India. Nagaland is a mountainous state and has a monsoon climate with high humidity levels.

The population mostly consists of Agriculturalist and around 75% of the population lives in the rural areas. In Nagaland, sericulture deals with all four types of silkworms that feed on different host plants to produce various qualities of silk, viz. *Bombyx mori* (Mulberry silkworm) feeds on Mulberry leaves, *Philosomia ricini* (Eri silkworm) on Castor leaves, *Anthraea assama* (Muga silkworm) on Som and Soalu leaves and *Anthraea proylei* (Temperate/ Oak Tasar silkworm) on Oak leaves. In order to boost the production of mulberry silks government is taking initiatives to increase the rearing activities in the state. The Central Silk Board is helping the farmers for involving sericulture development and to make sericulture as thriving industry. Three districts were selected for mapping of potential areas for further expansion of sericulture activities in the state.

Dimapur

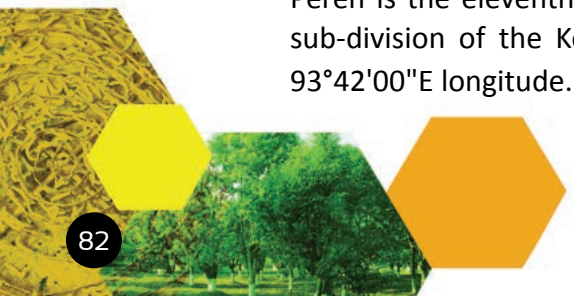
Dimapur is the largest city in Nagaland, India. Contrary to popular belief, the city's formation in Nagaland is separate from that of Assam. It is located at 25°54'45"N 93°44'30"E and is bounded by Kohima district on the south and east, the Karbi Anglong district of Assam on the west and stretch of Golaghat District of Assam, in the west and the north.

Kohima

Kohima is the hilly capital city of India's north eastern state of Nagaland. With a resident population of 99,039 it is the second largest city in the state. Originally known as Kewhira, it was founded in 1878 when the British Empire established its headquarters of the then Naga Hills. Kohima is the land of the Angami Naga tribe. It is situated in the foothills of Japfu range located south of Kohima District (25.67°N 94.12°E) and has an average elevation of 1261 metres.

Peren

Peren is the eleventh and newest district of Nagaland and has been formed by the partition of Kohima district. It was originally a sub-division of the Kohima district. It was declared a separate district on 24 October 2003. It is located at 25°30'15"N latitude 93°42'00"E longitude.



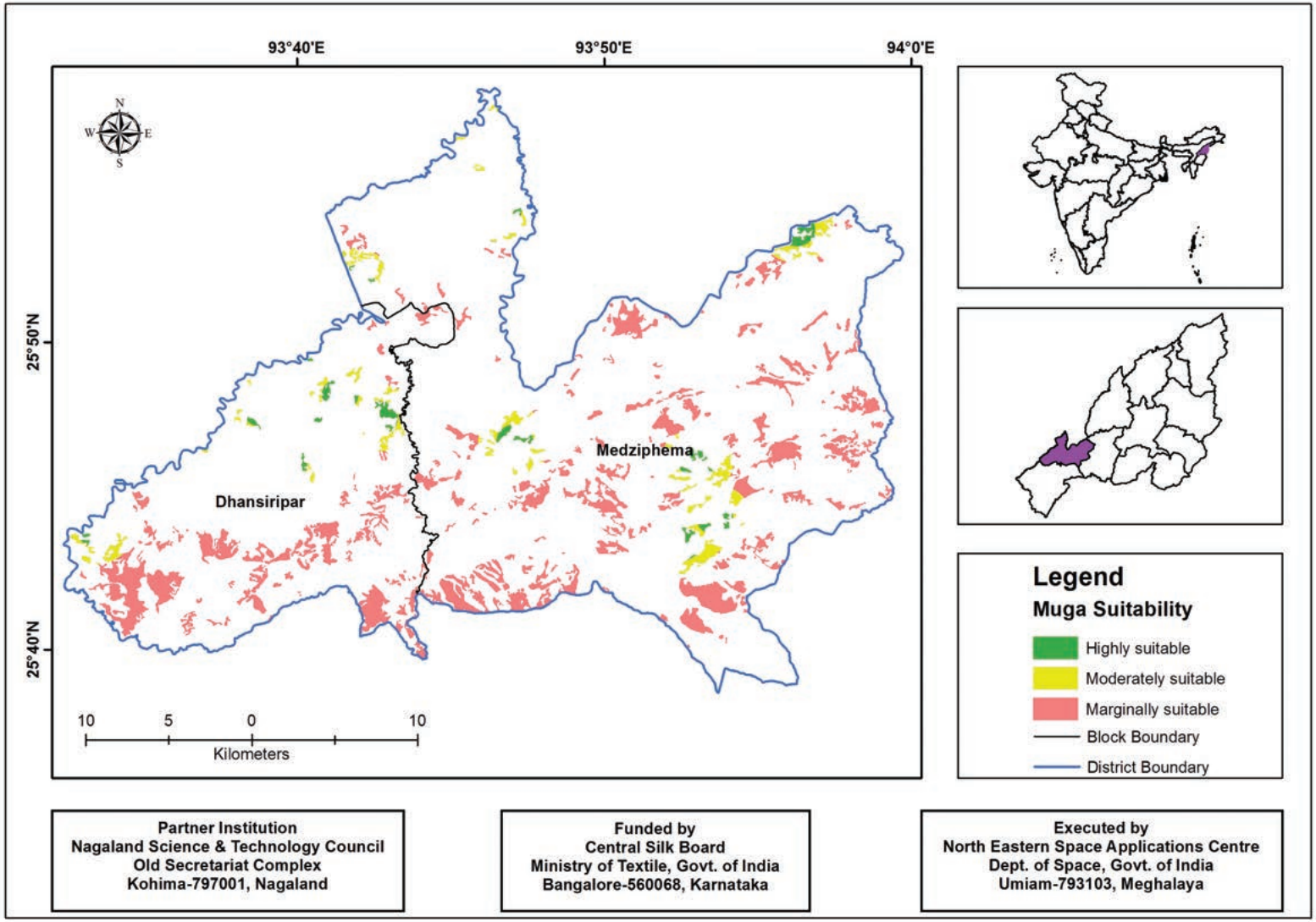


Fig 4.5.1: Suitable areas for Muga in Dimapur district of Nagaland

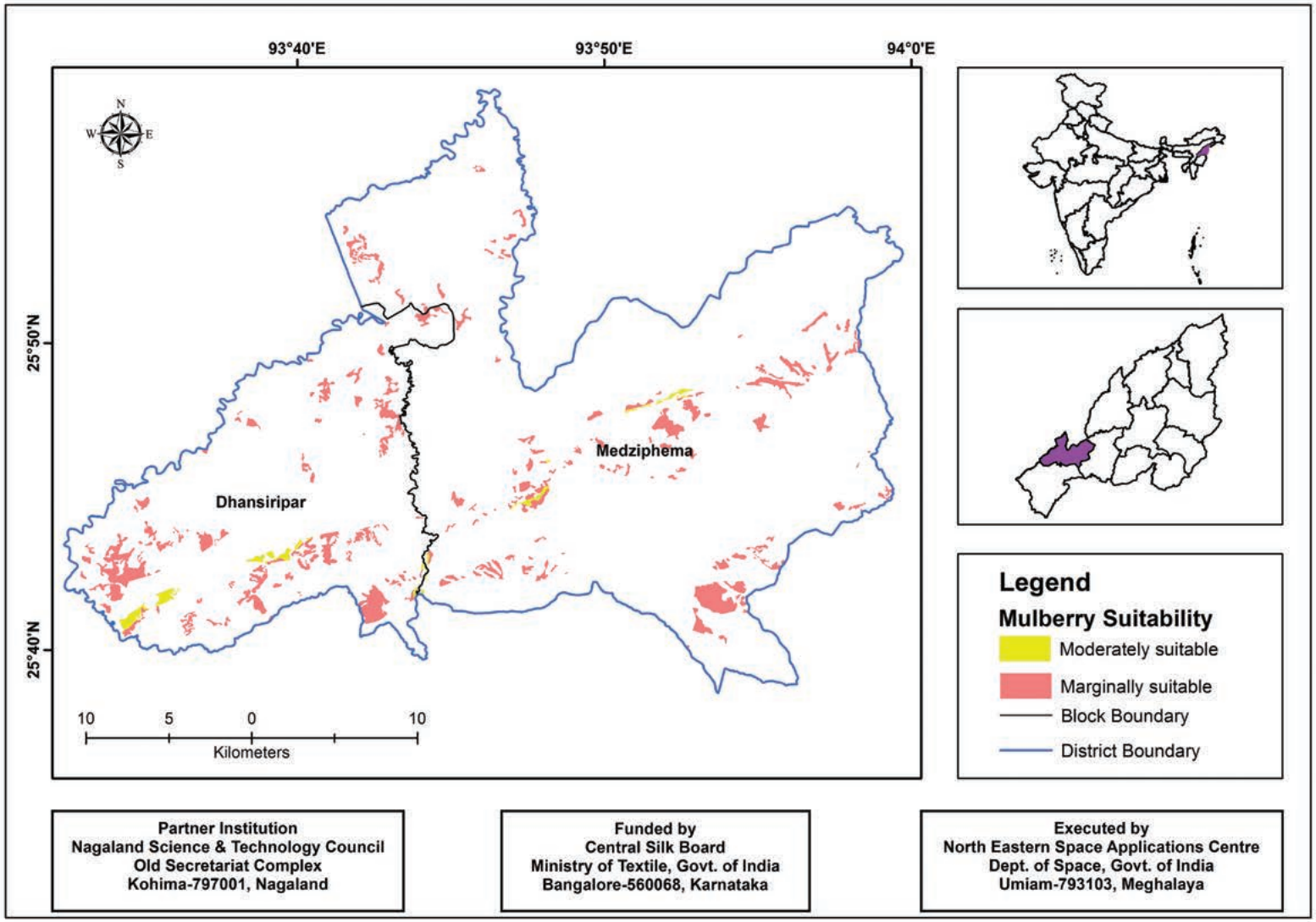


Fig 4.5.2: Suitable areas for Mulberry in Dimapur district of Nagaland

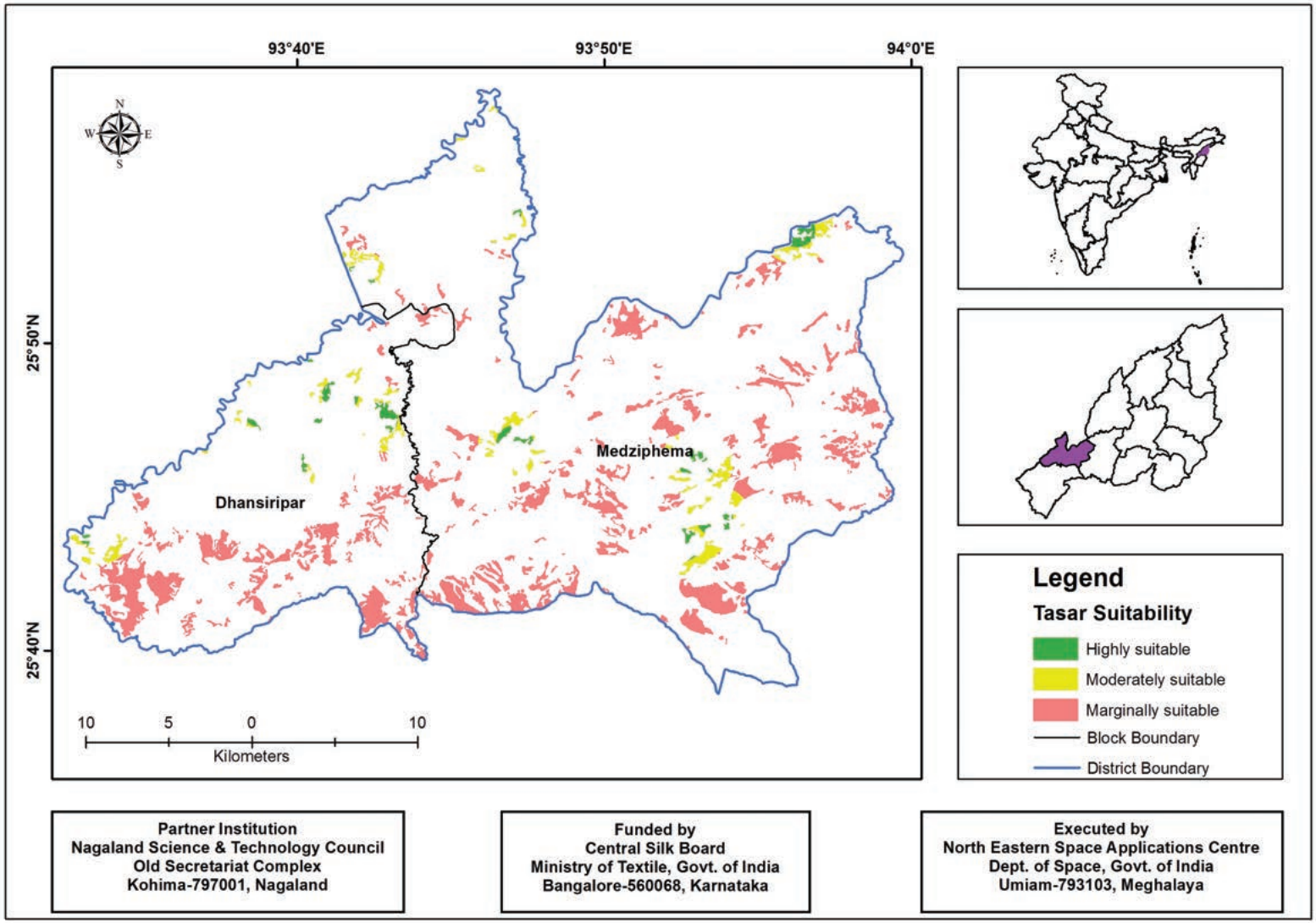


Fig 4.5.3: Suitable areas for Tasar in Dimapur district of Nagaland

Table 4.5.1: Suitable Areas for Muga in Dimapur District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Dhansiripar	180.07	342.48	2860.17	3382.72
Medziphema	282.82	848.27	5009.34	6140.43
Total	**462.89**	**1190.75**	**7869.51**	**9523.15**

Table 4.5.2: Suitable Areas for Mulberry in Dimapur District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Dhansiripar	-	259.26	1950.42	2209.68
Medziphema	-	116.52	2093.72	2210.24
Total	**-**	**375.78**	**4044.14**	**4419.92**

Table 4.5.3: Suitable Areas for Tasar in Dimapur District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Dhansiripar	180.07	342.48	2860.17	3382.72
Medziphema	282.82	848.27	5009.34	6140.43
Total	**462.89**	**1190.75**	**7869.51**	**9523.15**

Table 4.5.4: Suitable Areas for Eri in Kohima District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Chiephobozou	611.4	2088.73	6242.37	8942.5
Jakhama	741.75	1632.12	1788.53	4162.4
Kohima	210.55	849.87	1741.48	2801.9
Tseminyu	460.04	1693.14	2901.94	5055.12
Total	**2023.74**	**6263.86**	**12674.3**	**20961.9**

Table 4.5.5: Suitable Areas for Muga in Kohima District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Chiephobozou	18.54	203.23	8298.01	8519.78
Jakhama	54.81	224.05	3797.18	4076.04
Kohima	-	-	2528.34	2528.34
Tseminyu	-	-	4690.21	4690.21
Total	**73.35**	**427.28**	**19313.7**	**19814.4**

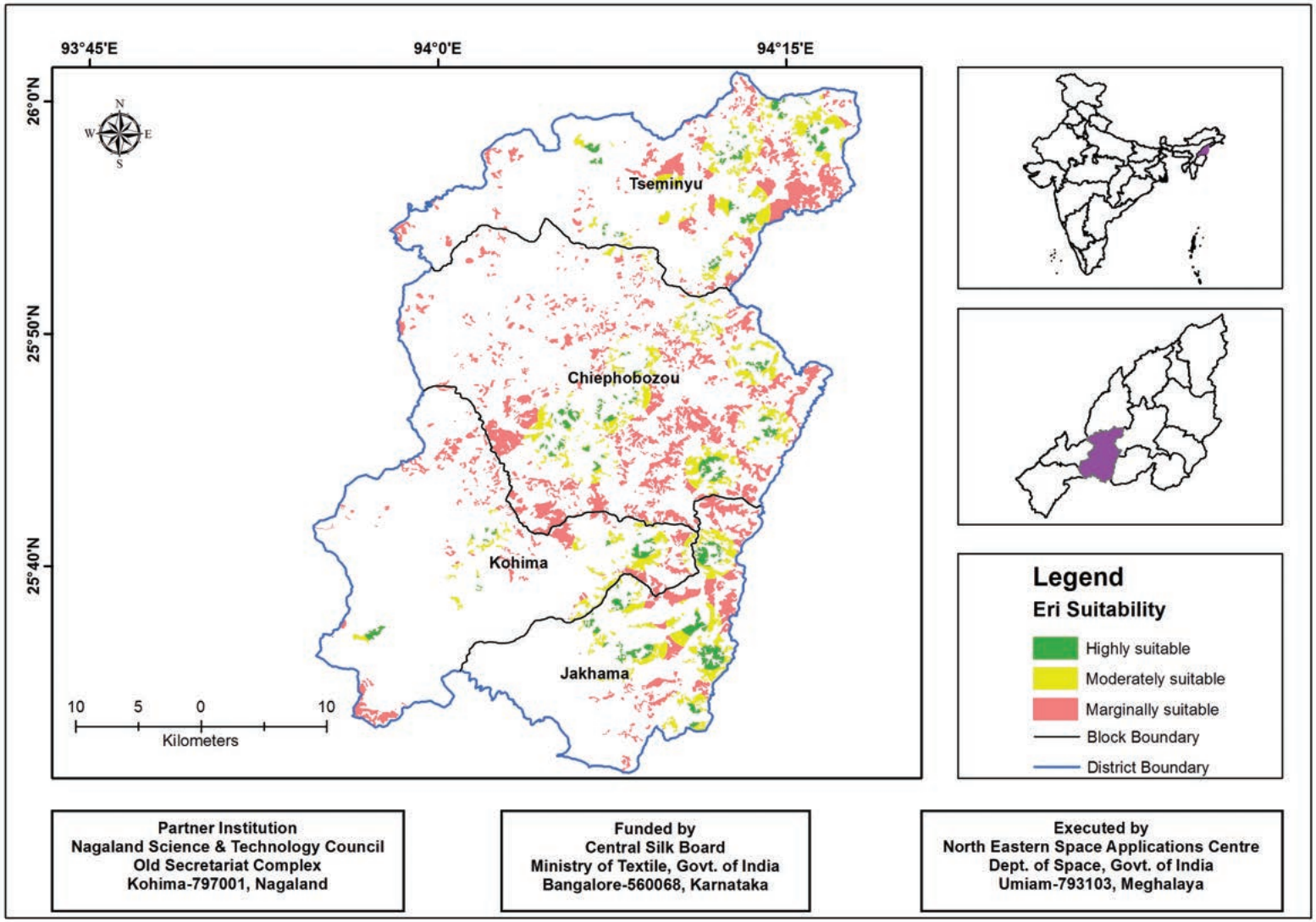


Fig 4.5.4: Suitable areas for Eri in Kohima district of Nagaland

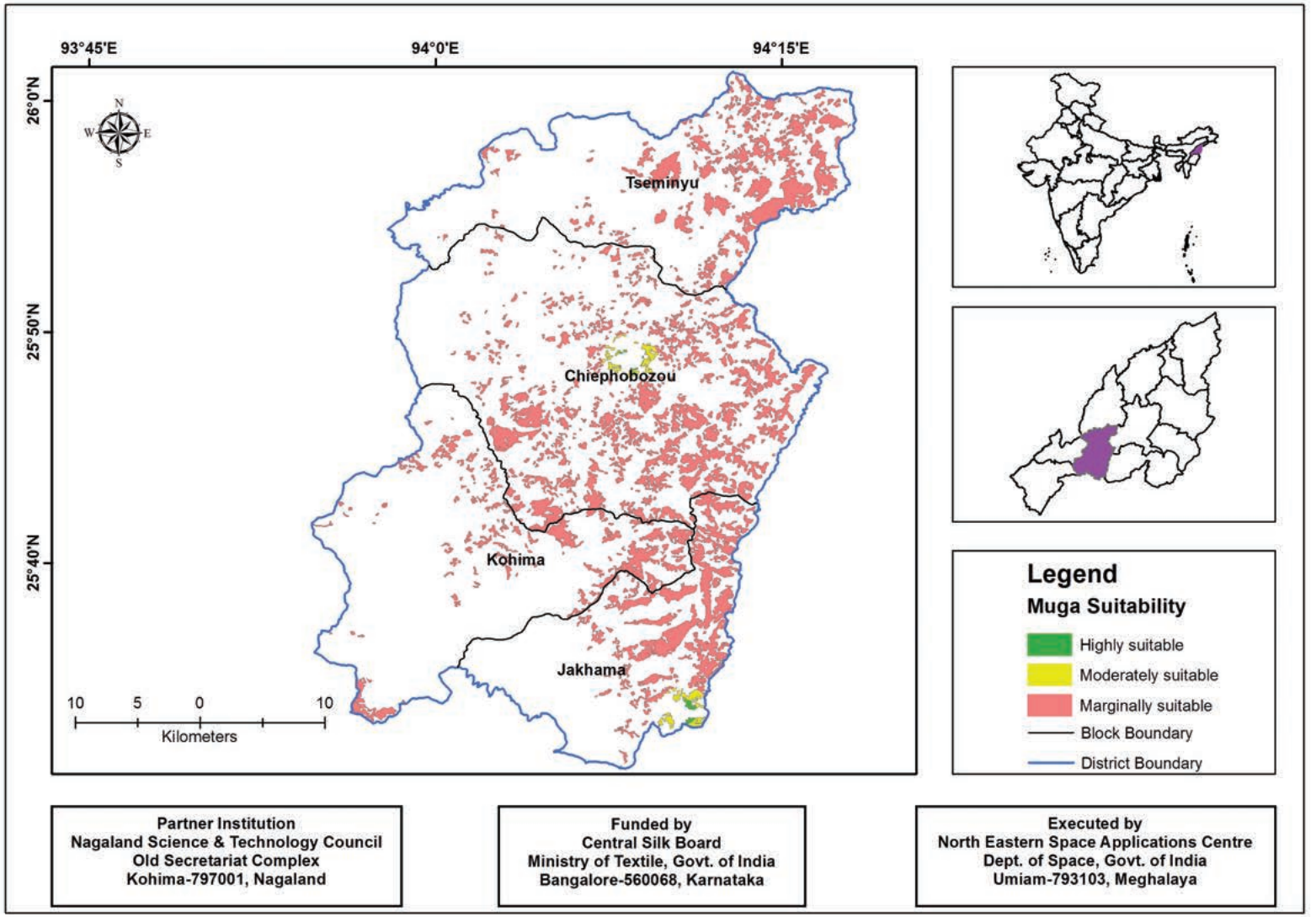


Fig 4.5.5: Suitable areas for Muga in Kohima district of Nagaland

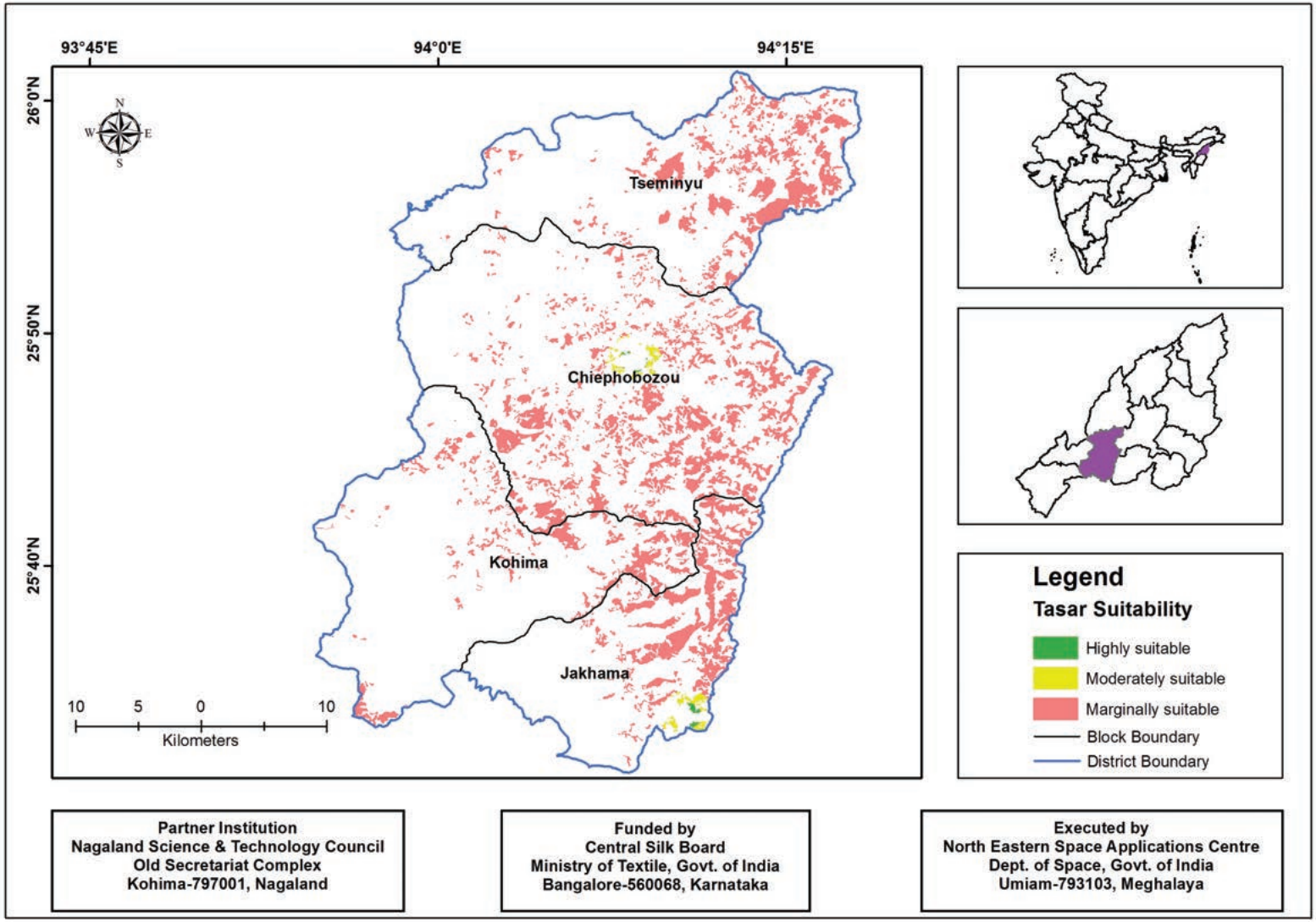


Fig 4.5.6: Suitable areas for Mulberry in Kohima district of Nagaland

Table 4.5.6: Suitable areas for Tasar in Kohima District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Chiephobozou	18.54	203.23	8298.01	8519.78
Jakhama	54.81	224.05	3797.18	4076.04
Kohima	-	-	2528.34	2528.34
Tseminyu	-	-	4690.21	4690.21
Total	**73.35**	**427.28**	**19313.7**	**19814.4**

Table 4.5.7: Suitable Areas for Eri in Peren District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Ahthibung	49.83	407.21	6637.45	7094.49
Peren	219.28	754.46	6775.37	7749.11
Tening	-	-	9367.56	9367.56
Total	**269.11**	**1161.67**	**22780.4**	**24211.2**

Table 4.5.8: Suitable Areas for Tasar in Peren District of Nagaland

Block	High	Moderate	Suitable	Total(ha)
Ahthibung	-	-	9484.89	9484.89
Peren	-	-	7363.26	7363.26
Tening	-	-	9400.59	9400.59
Total	**-**	**-**	**26248.7**	**26248.7**

Table 4.5.9: Suitable Areas for Mulberry in Peren District of Nagaland

Block	High	Moderate	Marginal	Total(ha)
Ahthibung	-	857.27	6740.96	7598.23
Peren	-	-	6006.74	6006.74
Tening	-	-	9623.46	9623.46
Total	**-**	**857.27**	**22371.16**	**23228.43**

Table 4.5.10: Suitable Areas for Muga in Peren District of Nagaland

Block	High	Moderate	Suitable	Total(ha)
Ahthibung	-	-	9484.89	9484.89
Peren	-	-	7363.26	7363.26
Tening	-	-	9400.59	9400.59
Total	**-**	**-**	**26248.7**	**26248.7**

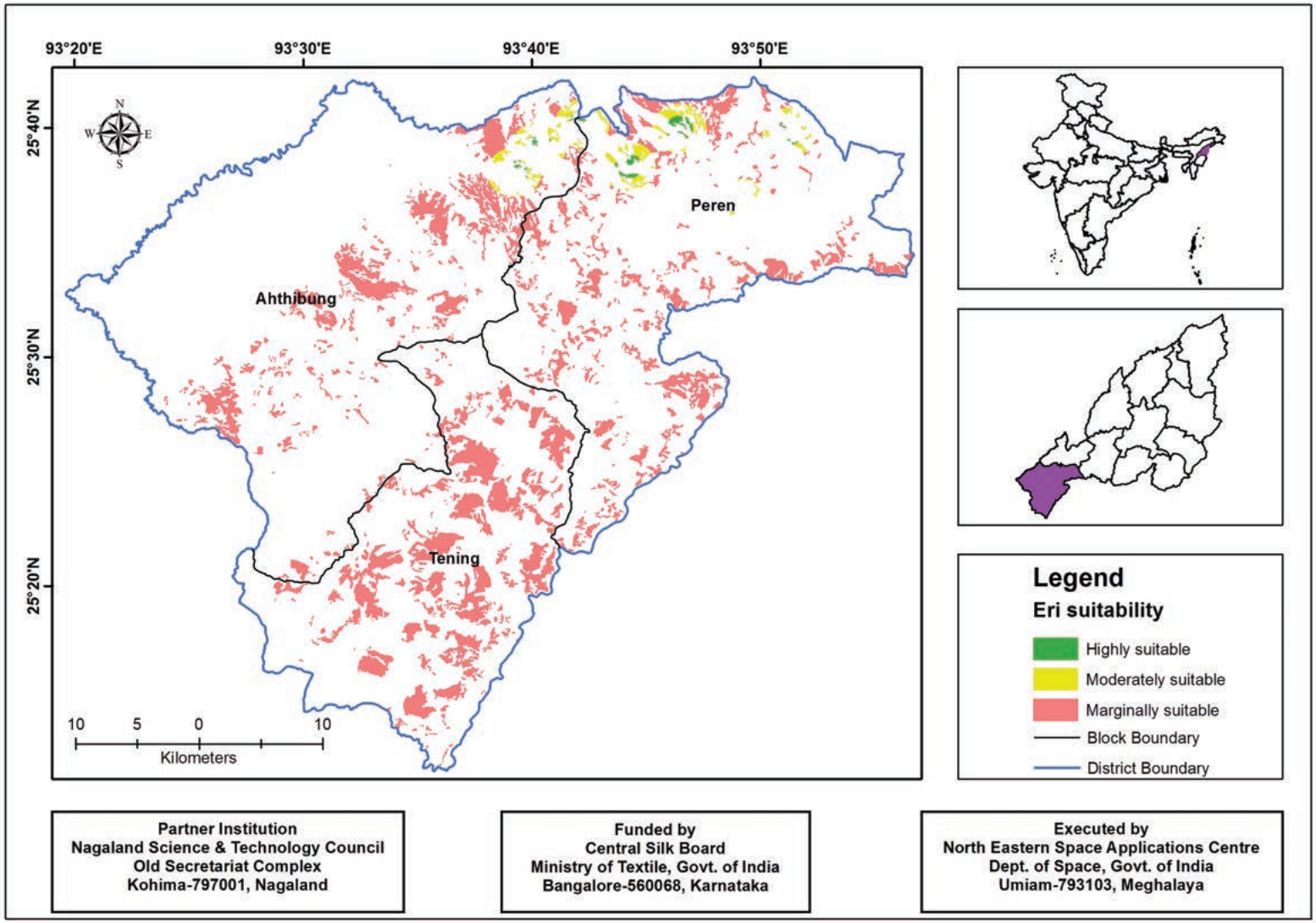


Fig 4.5.7: Suitable areas for Eri in Peren district of Nagaland

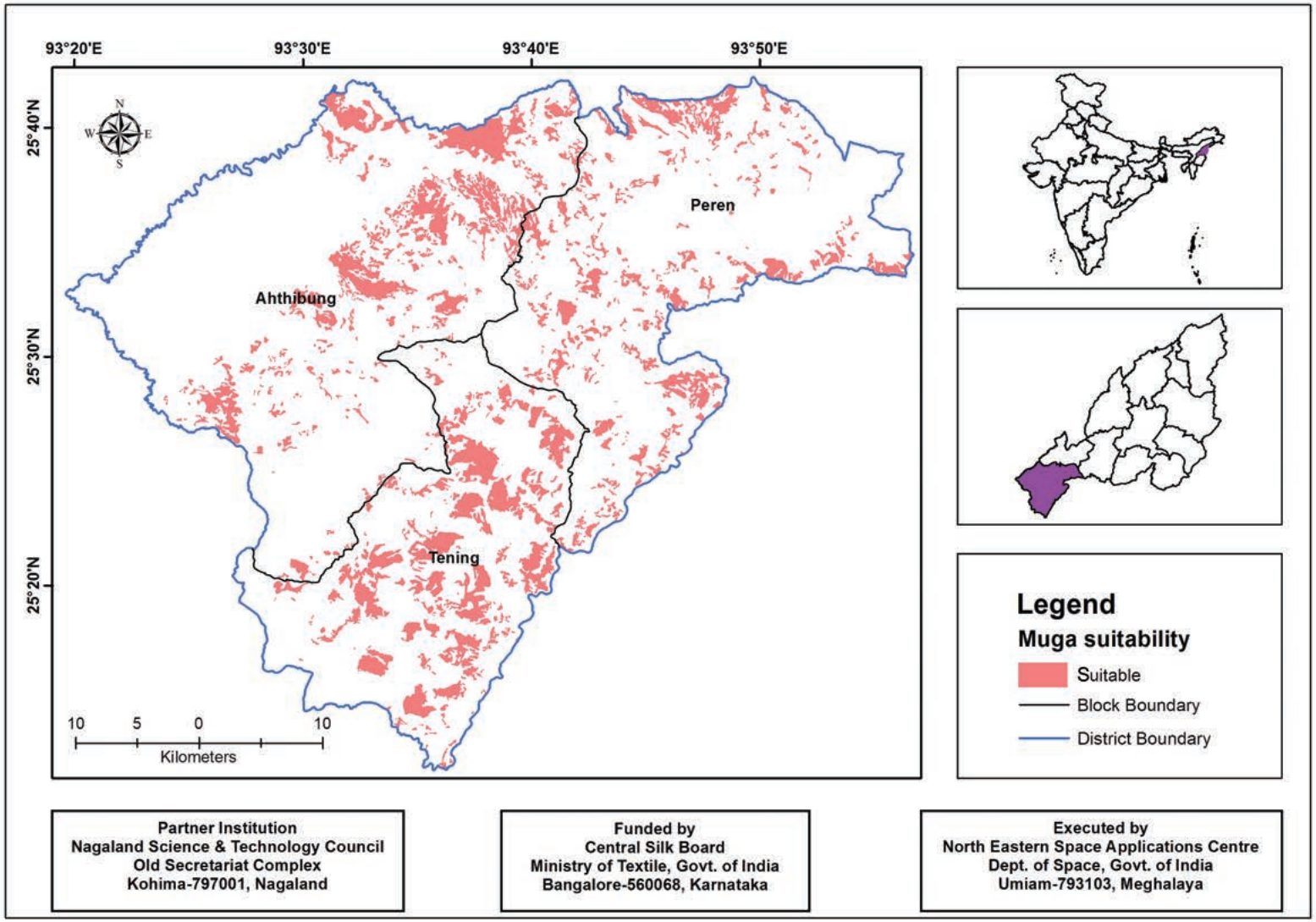


Fig 4.5.8: Suitable areas for Muga in Peren district of Nagaland

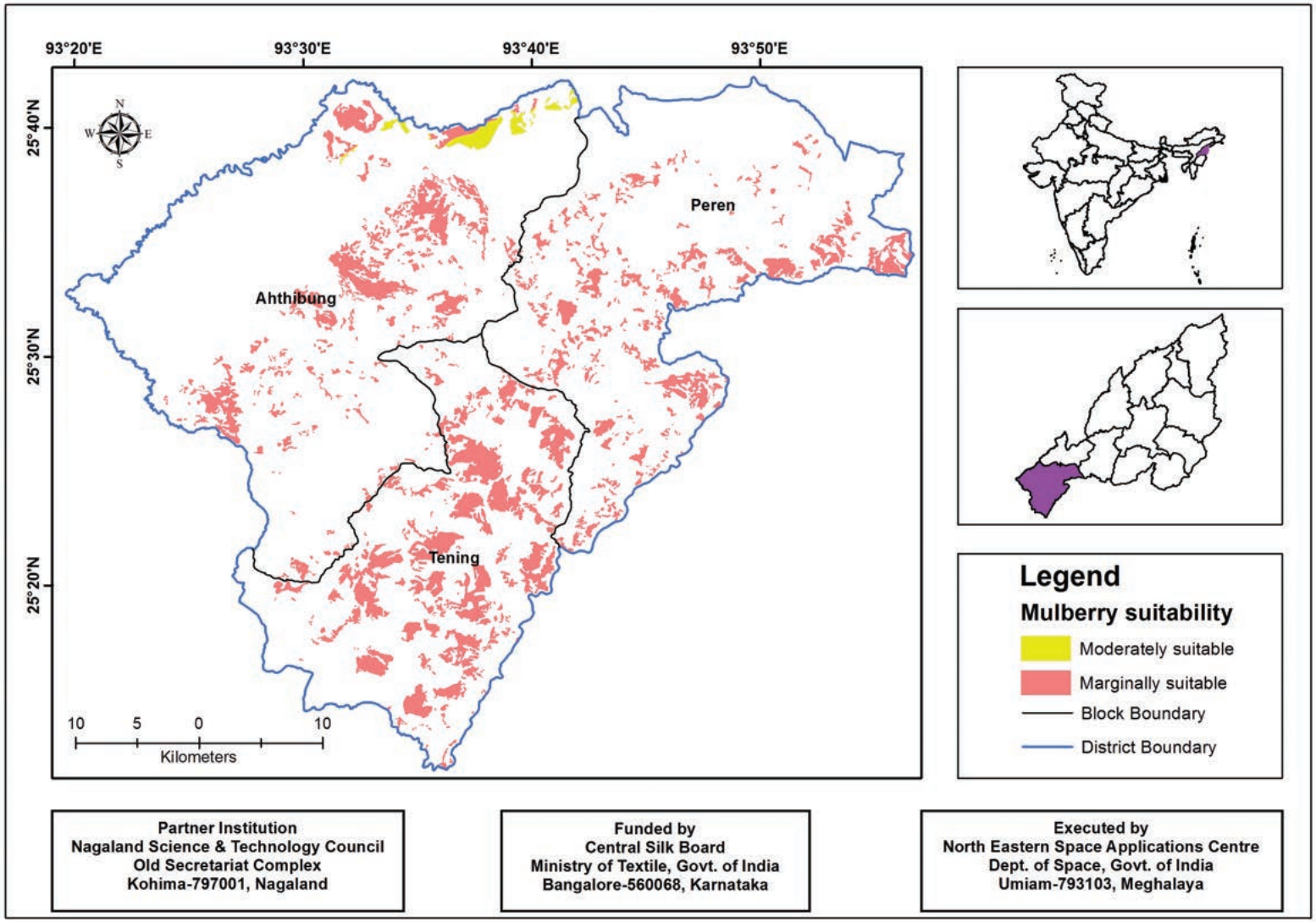


Fig 4.5.9: Suitable areas for Mulberry in Peren district of Nagaland

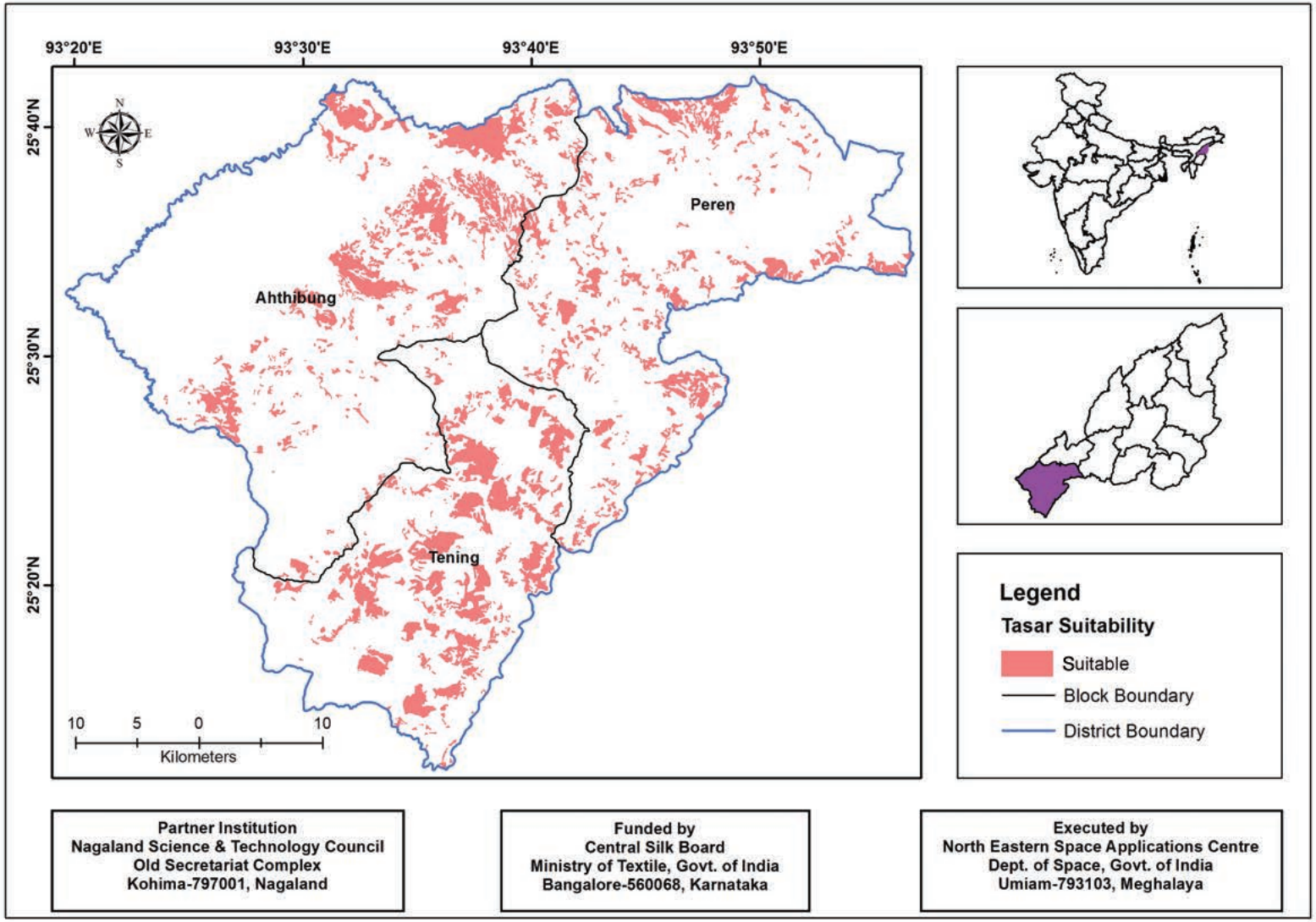


Fig 4.5.10: Suitable areas for Tasar in Peren district of Nagaland

SIKKIM

Sikkim, the tiny Himalayan state with a total geographical area of 7,089 sq.km, comprised of four districts viz. East, North, South and West having their headquarters in Gangtok, Mangan, Namchi and Geyzing respectively. Gangtok, the capital of Sikkim is located in the East District. Most of the population of Sikkim lives in the East and South Districts. The rivers and mountains are the main physical features that define the boundaries of the state of Sikkim with its neighbouring countries.

This state is bordered by the Nepal in the west, Bhutan in the east, Tibet in the north and West Bengal in the south. The summit of Kangchenjunga the world's third-highest peak is the state's highest point, situated on the border between Sikkim and Nepal.

The tropical and tundra climate is found in Sikkim. Some of the parts in the northern, eastern and western borders of Sikkim are covered with snow almost throughout the year because of high altitudes. For the most part, the land is unfit for agriculture because of the rocky, precipitous slopes. However, some hill slopes have been converted into terrace farms.

Sikkim is bestowed upon with congenial climate for the sericulture and enjoys practicing three types of sericulture viz. mulberry, eri and muga culture in parallel. State Directorate of sericulture is making consistent efforts in exploring sericulture potential through extension and developmental activities in potential villages across the state. South Sikkim district was selected for mapping of potential areas for Mulberry, Eri and Muga.

West Sikkim

West Sikkim is the second largest district in the Indian state of Sikkim with an area of 1,166 sq km. The headquarters of the district is at Gyalshing, also known as Geyzing. The town is connected to the capital Gangtok by a metalled road. Geyzing is also connected to the West Bengal towns of Darjeeling and Kalimpong via Jorethang. The town has a large Nepali population, and the Nepali language is the predominant language of the region.

West Sikkim lies between 27°-27°55" North latitudes and 88°-88°36" East Longitudes. Here rainy season extend from May to November and recorded in the past 100 cm of rainfall in august.The district is a favourite for the trekkers due to the high elevations. Here economy is mainly agrarian, despite most of the land being unfit for cultivation owing to the precipitous and rocky slopes.

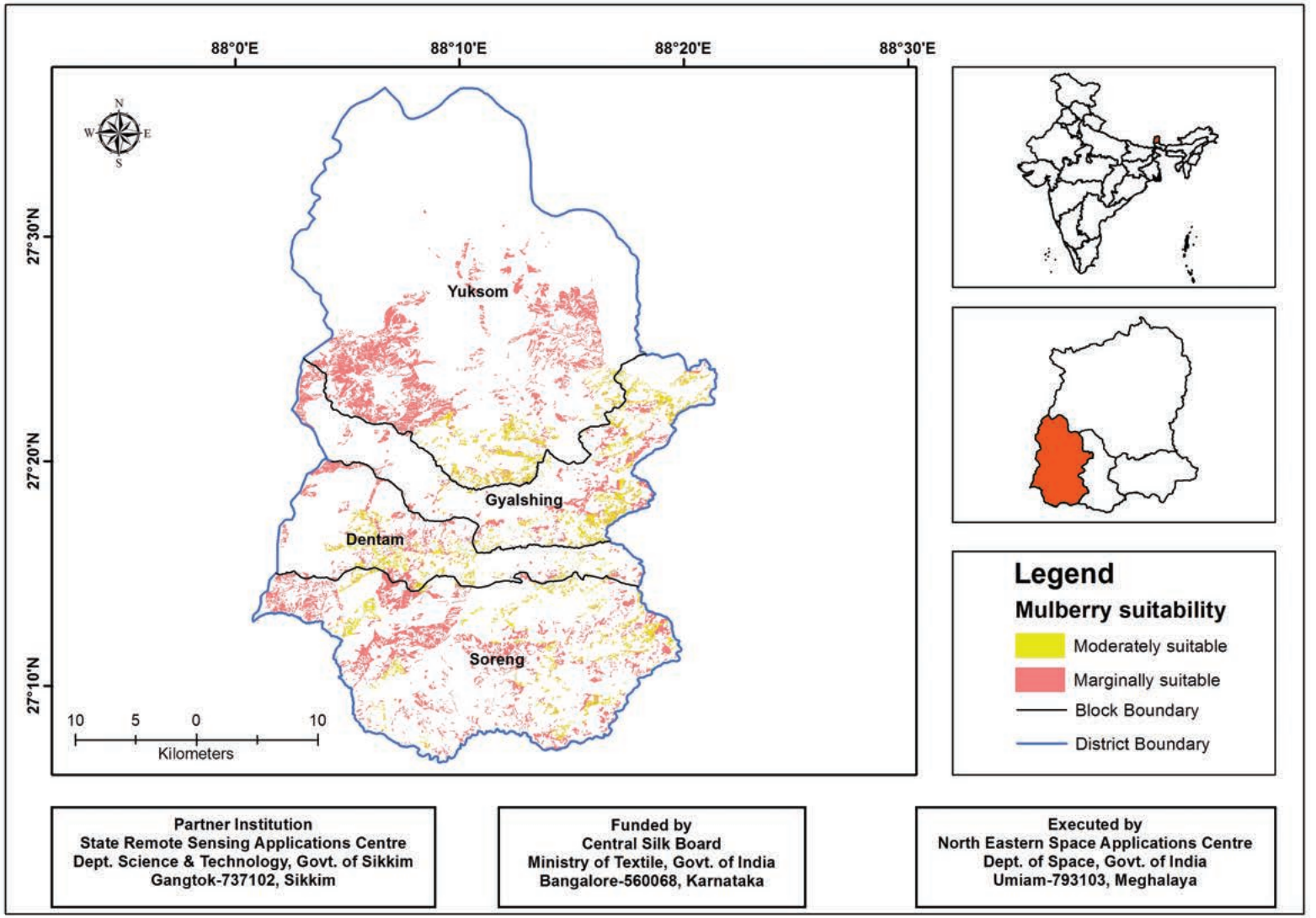


Fig 4.6.1: Suitable areas for Mulberry in West Sikkim district of Sikkim

Table 4.6.1: Suitable areas for Mulberry in West Sikkim district of Sikkim

Block	High	Moderate	Marginal	Total(ha)
Dentam	-	792.19	1853.52	2645.71
Gyalshing	-	1284.91	3997.01	5281.92
Soreng	-	1243.97	4444.41	5688.38
Yuksom	-	861.59	5343.68	6205.27
Total	**-**	**4182.66**	**15638.62**	**19821.28**

TRIPURA

Tripura is a state in Northeast India. The third-smallest state in the country, it covers 10,491 km2 and is bordered by Bangladesh to the north, south, and west, and the Indian states of Assam and Mizoram to the east. In 2011 the state had 3,671,032 residents, constituting 0.3% of the country's population. It extends from 22°56’N to 24°32’N latitude and 91°09’E to 92°20’E longitude. The state has a tropical savanna climate, and receives seasonal heavy rains from the south west monsoon. The physiography is characterised by hill ranges, valleys and plains.

In Tripura, sericulture as one of the agricultural pursuits is emerging gradually as a premier enterprise. It is projected that sericulture industry is capable of generating substantial and gainful employment in rural areas of the state through mulberry cultivation, silk worm rearing, reeling, twisting and weaving. The Sericulture Department of Government of Tripura has shipped certified silkworm seeds from Bangalore and West Bengal for providing good quality and high yielding strains of Mulberry silkworm. In Tripura, in earlier days Nistari, a multivoltine strain of silkworm was brought from West Bengal but now-a-days crossbreed strain of Bivoltine and Multivoltine are reared in the state.

Gomati

The Gomati District with its headquarter at Udaipur was created in the year 2012. Topographically, the Gomati district is marked by lush green and fertile Gomati valleys and the towering Debtamura hill range which straddles Udaipur and Amarpur subdivisions of the district with its exquisite sculptural works carved on panels of the hills. It is located at 23°50'09"N latitude 91°16'45"E longitude.

Sepahijala

The District consists of 3 (three) Sub-Divisions, 7(seven) Blocks, 2(two) Municipal Council and 1(one) Nagar Panchayat. The area of District is 1043.04 sq. km and population is 5,42,731. The main source of the livelihood of local people is agriculture. A large number of people have taken rubber plantation as a source of livelihood. It is located at 23°36'53"N latitude 91°19'39"E longitude

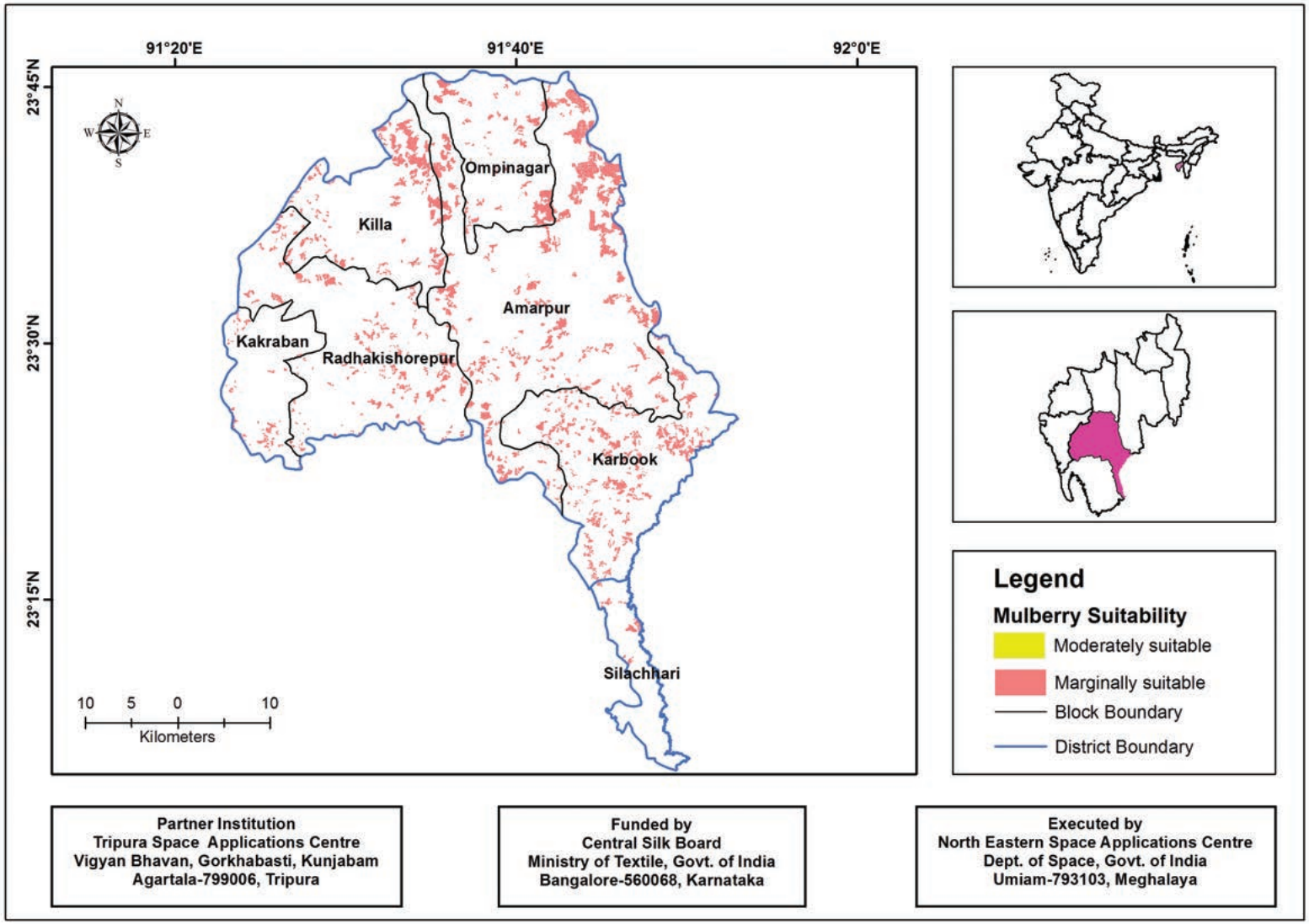


Fig 4.7.1: Suitable areas for Mulberry in Gomati district of Tripura

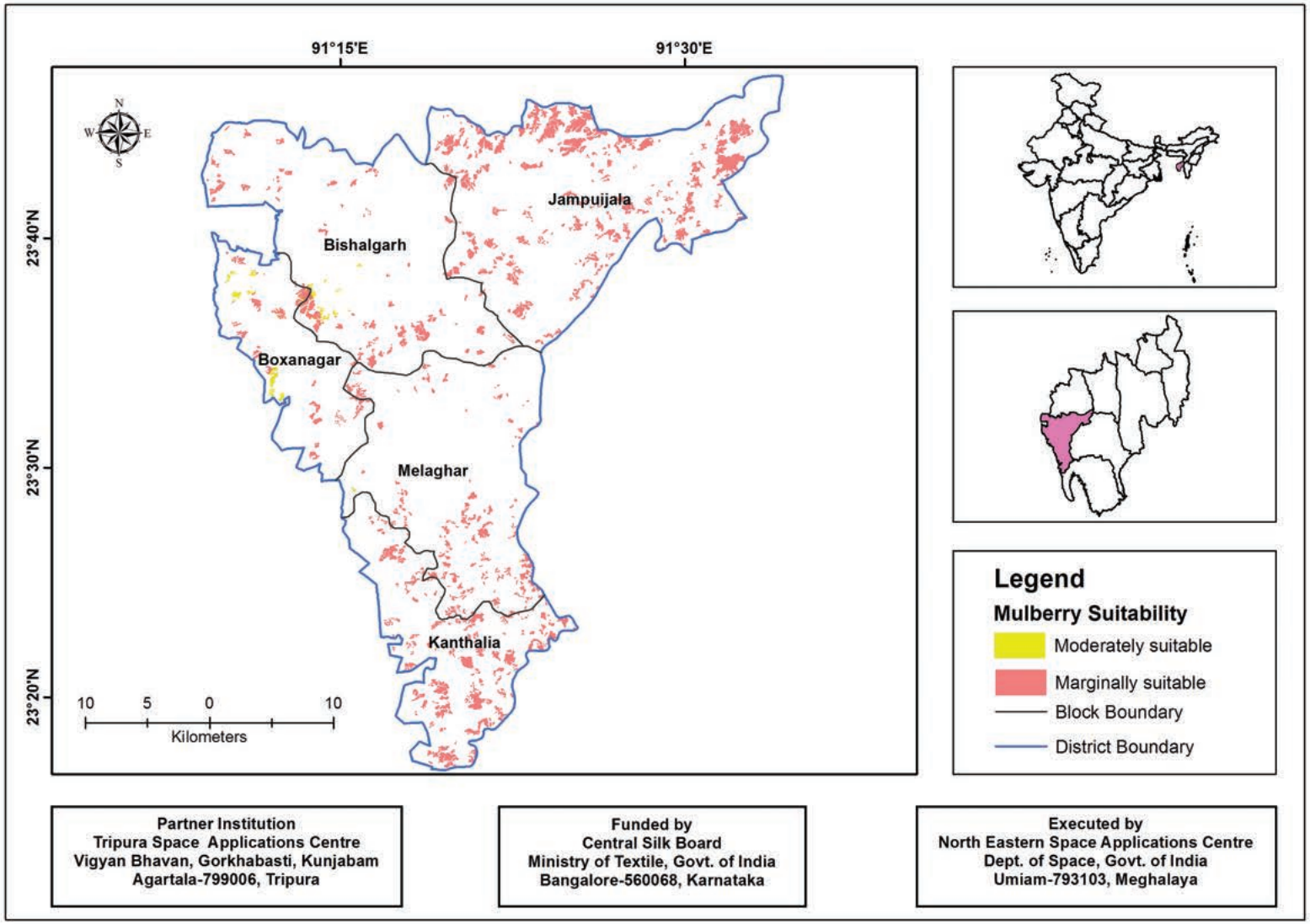


Fig 4.7.2: Suitable areas for Mulberry in Sepahijala district of Tripura

Table 4.7.1: Suitable areas for Mulberry in Gomati District of Tripura

Block	High	Moderate	Marginal	Total(ha)
Amarpur	-	-	7918.27	7918.27
Kakraban	-	-	414.61	414.61
Karbook	-	-	3119.91	3119.91
Killa	-	-	2816.1	2816.1
Ompinagar	-	0.2	1622.55	1622.75
Radhakishorepur	-	-	2136.82	2136.82
Silachhari	-	0.14	230.31	230.45
Total	**-**	**0.34**	**18258.57**	**18258.91**

Table 4.7.2: Suitable areas for Mulberry in Sepahijala District of Tripura

Block	High	Moderate	Marginal	Total (ha)
Bishalgarh	-	91.3	1221.67	1313
Boxanagar	-	195.3	575.93	771.23
Jampuijala	-	-	3870.24	3870.2
Kanthalia	-	-	1987.83	1987.8
Melaghar	-	6.92	1318.77	1325.7
Total	**-**	**293.52**	**8974.44**	**9268**

Central Silk Board
Ministry of Textiles, Government of India
Bengaluru-560068
www.csb.gov.in

North Eastern Space Applications Centre
Department of Space, Government of India
Shillong-793103
www.nesac.gov.in