

MINR Information Series

MINR Information Series No. 3

Spatial Data Base for Natural Resource Management in Meghalaya

***Meghalaya Institute Of
Natural Resources***

(MINR)



Meghalaya Basin Development Authority (MBDA) , Shillong

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Spatial Data Base for Natural Resource Management in Meghalaya

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Spatial Data Base for Natural Resource Management in Meghalaya

Introduction: Natural resources are distributed in a widespread manner in spatial context. Various land use practices over a long period of time in any area create a mosaic of land use and land cover. As economic development takes place along with development of infrastructure, industrialization and growth of economic activities coupled with increase in population; natural resources face ever increasing pressure. Natural resources are also the source of all the production processes and livelihood activities. It has become more important than ever that natural resources are managed scientifically making use of the available technological tools so that sustainability and efficient use of natural resources are ensured. Remote sensing, GIS and GPS techniques offer great help in policy inputs, planning and management of natural resources.

Meghalaya, which is a mountainous state, is rich in forest cover and biodiversity, natural resource management based on geospatial data based is even more important for taking care of fragile ecosystem and striking balance between conservation and development. The Natural Resource Management generally involves use of multidisciplinary spatial data which are important in studying and analyzing any NRM in the State.

Natural Resource Management (NRM) is the core of the missions and programmes of Meghalaya Basin Development Authority (MBDA). GIS Lab in MBDA has been setup to provide geospatial support to its various programmes and generate data and analysis for NRM. A spatial database is one of the important activities initiated in the GIS Lab, MBDA. It is a continuing activity aiming at creation of comprehensive statistical database relevant to NRM with incremental additions and updation. A set of following spatial layers have been identified to start with.

A set of 27 layers has been identified initially they are as follows:

1. Administrative Boundaries- including state, district and blocks boundaries of Meghalaya.
2. Digital Terrain Model (DTM)
3. Slope
4. Aspect
5. Drainage
6. Geology
7. Mineral map resources
8. Micro watersheds
9. Soils types.
10. Road Network
11. Village locations
12. Forest cover
13. Forest Types
14. Recorded forest area (Reserved Forests, Protected Forests, National Parks and sanctuaries)
15. Mosaic of High Resolution Satellite Images (IIRS P6 LISS-IV)
16. Mosaic of Satellite Images (Landsat-7 TM)
17. Mosaic of Toposheets and Google Earth at scale of 1:50,000

18. Land Use Land Cover
19. Schools and Colleges
20. Location of springs
21. Rainfall
22. Temperature
23. Weather Stations
24. Water bodies
25. Ground truth coverage (Photographs)
26. Sacred Groves
27. Community Nurseries

Following spatial layers have already been created and they are being continuously enriched and improved. Information on the other remaining layers is also being gathered from different sources. Brief description of the layers already added to the spatial database is given as follows:

1. Administrative Boundaries:

Administrative boundaries include 3 layers i.e., State Boundary, District Boundaries and C D Block Boundaries.

Meghalaya is situated in the North-Eastern part of India and it is bounded in the north and east by Assam plain and in the south and west by Bangladesh plains. In the north it is bounded by Kamrup and Goalpara districts of Assam and on the east by Karbi Anglong and North Cachar. The southern border is the international border between India and Bangladesh which is about 496 km long.

Meghalaya is located between 25°1'27.706"E to 26°07'45.213"E latitude and 89°49'27.078"N to 92°45'23.299"N longitude with an altitude ranging from 50 to 1961 meters covering an area of 22,429 Km². The State is divided into eleven administrative districts which are further sub-divided into thirty nine Blocks as shown in the following Table-1.

Table-1: List of Districts and C. D. Blocks in Meghalaya

Sl. No.	Districts	District Hq	Blocks
1	East Jaintia Hills	Khliehriat	Saipung & Khliehriat
2	West Jaintia Hills	Jowai	Laskein, Thadlaskein & Amlarem
3	East Khasi Hills	Shillong	Mylliem, Pynursla, Mawsynram, Shella Bholaganj, Mawkyrwat, Laitkroh, Mawphlang & Mawkynew
4	Ri Bhoi	Nongpoh	Umsning, Umling & Jirang
5	West Khasi Hills	Nongstoin	Mairang, Mawthadraishan , Nongstoin & Mawshynrut
6	South-West Khasi Hills	Mawkyrwat	Mawkyrwat & Ranikor
7	North Garo Hills	Resubelpara	Resubelpara & Kharkutta
8	East Garo Hills	Williamnagar	Songsak, Rongjeng & Samanda
9	South Garo Hills	Baghmara	Chokpot, Baghmara, Gasaupara & Rongra
10	West Garo Hills	Tura	Tikrikilla, Dadenggre, Selsella, Rongram, Gambegre & Dalu
11	South-West Garo Hills	Ampati	Betasing & Zigzak

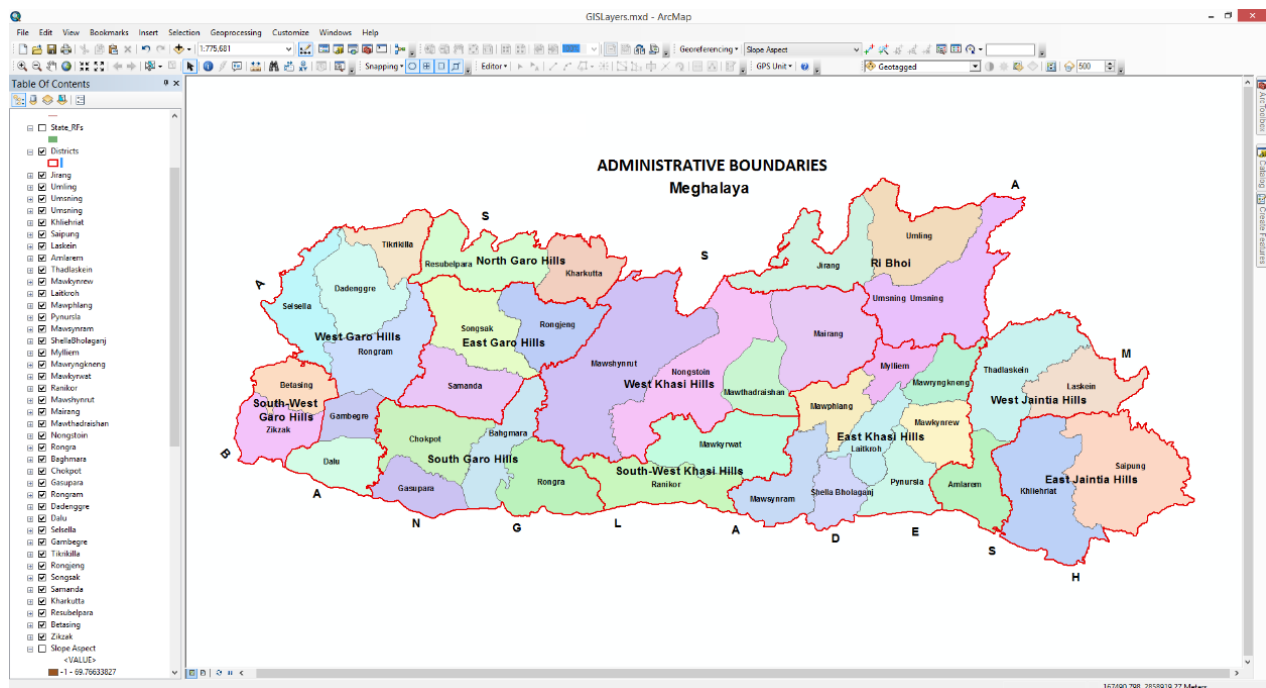


Fig-1: Administrative Boundaries

2. Digital Terrain Model (DTM):

The Digital Terrain Model (DTM) has been downloaded from Bhuvan (NRSC, 2015). The DTM has been created by NRSC using CARTOSAT-I data and it is based on 30 meters contour interval. Using DTM, seven altitude zone classes of the state have been created as depicted in the Fig- 2. The percentage area figures of the altitude classes are presented in the following Table-2.

Table-2: DTM class with area coverage in percent

Elevation (meters)	Area cover (%)
Below 100	17.79
100 – 200	7.56
200 – 300	8.51
300 – 400	8.23
400 – 500	5.92
500 – 1000	27.25
Above 1000	24.73

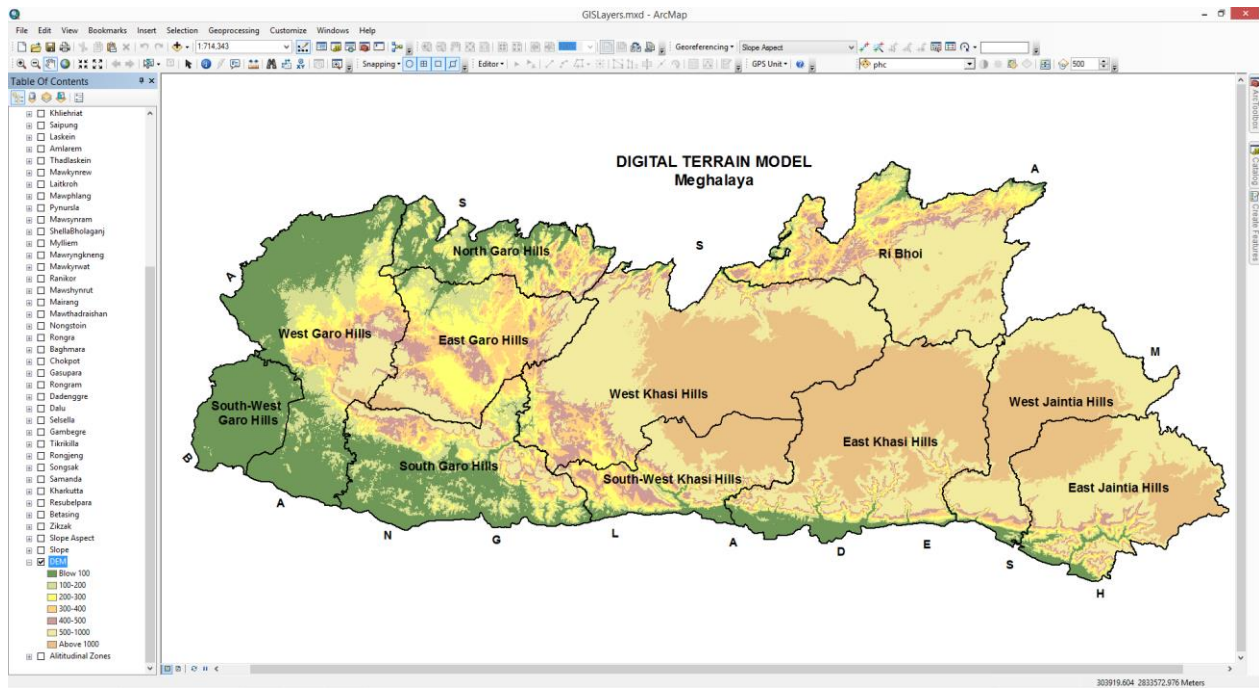


Fig-2: Digital Terrain Model

3. Slope:

The slope map has been generated from the DTM by Seven categories of slope have been created and depicted in Fig-3. The percentage area figures of slope categories are presented in the following Table-3:

Table-3: Slope category with area coverage in percent

Slope (°)	Category	Area (%)
Below 5	Flat to almost flat	14.9
5 – 10	Gentle	21.27
10 – 15	Moderate	21.65
15 – 20	Moderately Steep	17.32
20 – 30	Steep	18.78
30 – 45	Very Steep	5.77
Above 45	Extremely Steep	0.31

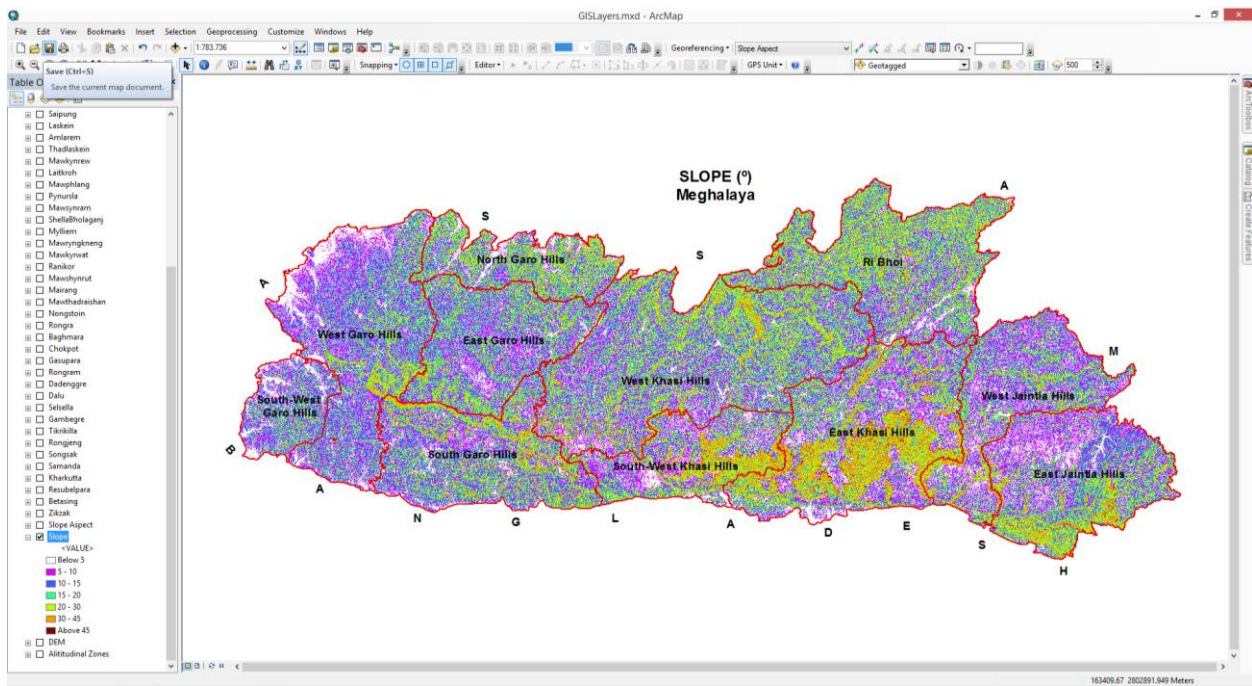


Fig-3: Slope

4. Aspect:

The Aspect map has been generated from the DTM by GIS Lab, MBDA. From the DTM, nine categories of aspect has been identified and shown in Fig-4.

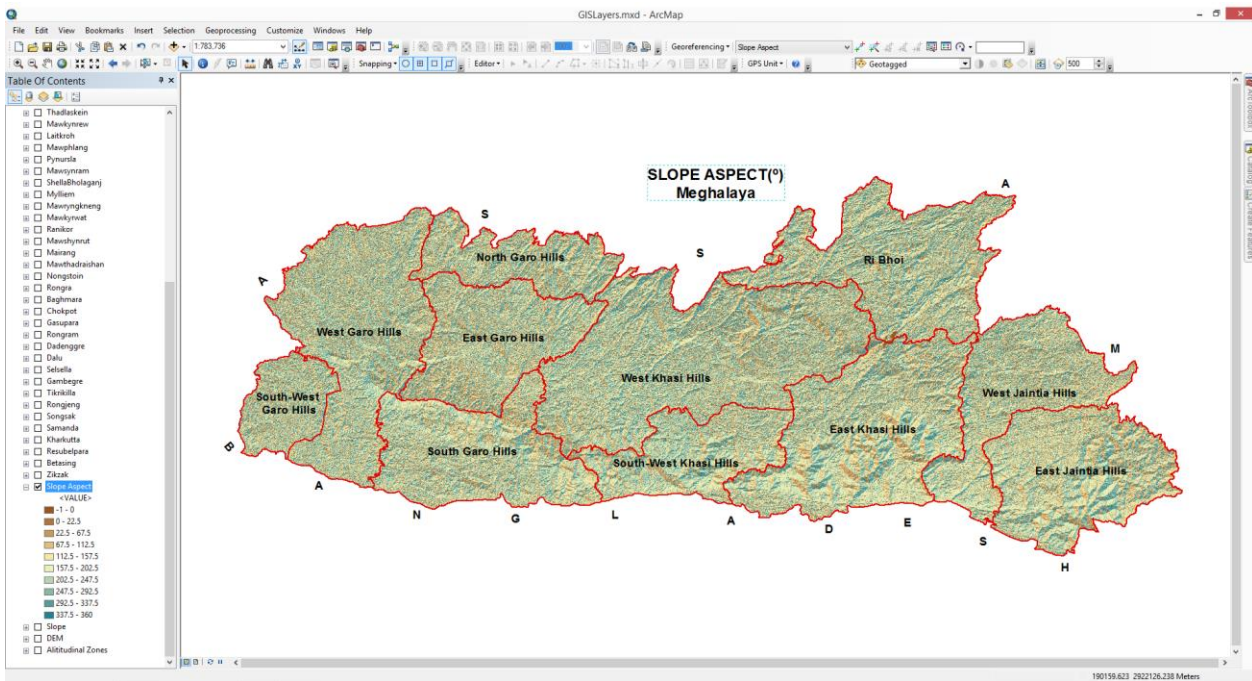


Fig-4: Aspect

5. Drainage:

The drainage lines have been digitized from Survey of India Toposheet at the of scale 1:250,000, by GIS Lab, MBDA Following Horton-Strahler (1964) method, the ordering of streams in Meghalaya has been done where all streams up to 5th order (Table-4) have been digitized and it is shown in Fig-5. The drainage divide runs in east-west direction which separates the north and south flowing rivers. Rivers which flows to the north drains into Brahmaputra River in Assam and rivers which flow to the south drains to Surma River in Bangladesh.

Table-4: Stream ordering, stream number and stream length

Sl. No.	Stream Order	Number of Streams	Length of Stream (km)
1	First	4717	12406.386
2	Second	1249	3564.931
3	Third	299	1611.181
4	Fourth	58	625.715
5	Fifth	14	269.231
	Total	6337	18477.444

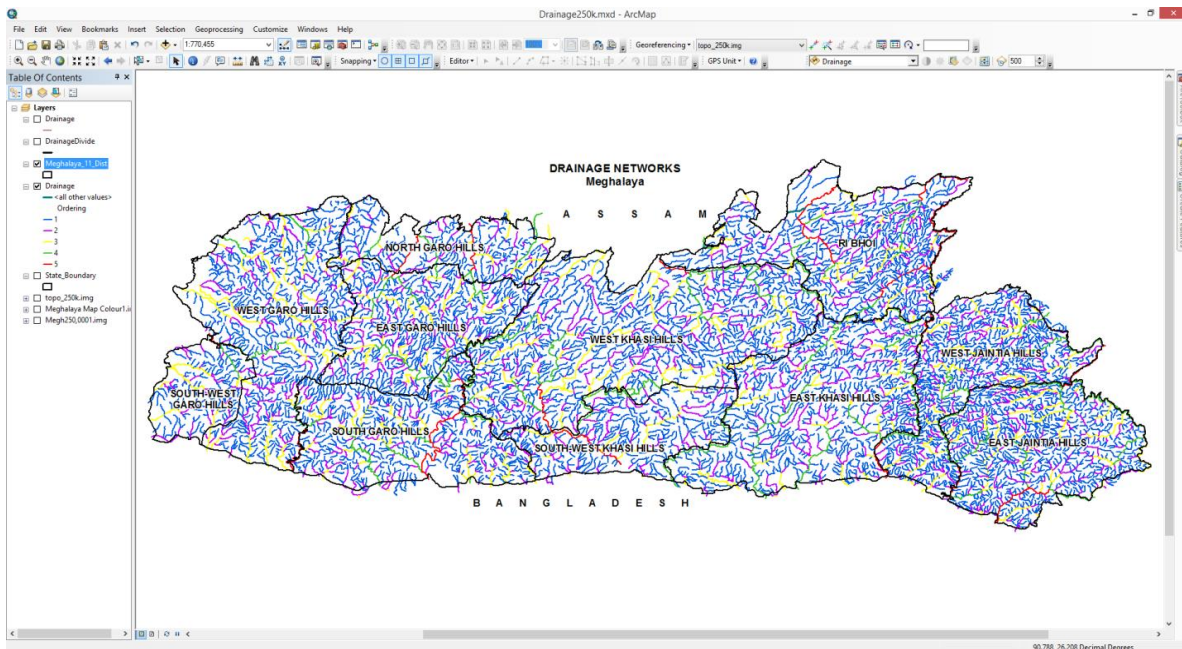


Fig-5: Drainage Network

6. Micro Watersheds:

The Meghalaya micro watersheds is based on the mapping done by NESAC, Umiam. It has been divided into 2776 number of micro watersheds as shown in Fig-6. Out of these 1648 number of micro watersheds fall in the northern slope and 1128 number fall in the southern slope of the State.

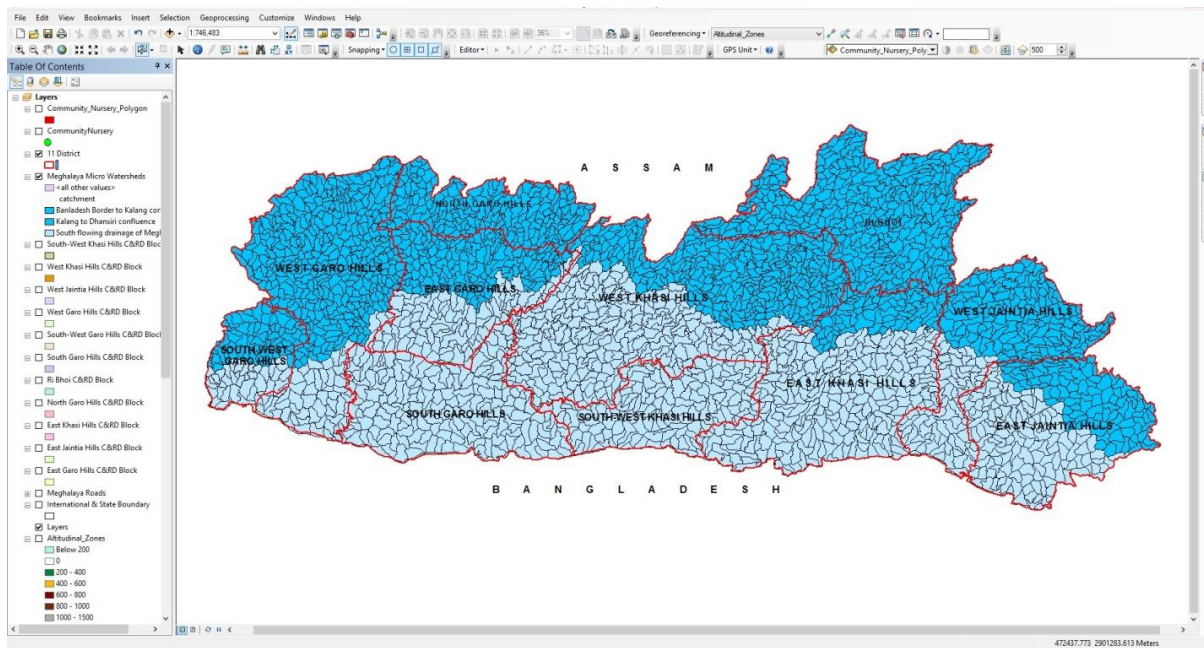


Fig-6: Meghalaya micro watersheds

7. Soil Types:

Soil types of Meghalaya has been digitized from soil map prepared by NBSS & LUP at the scale of 1:250,000. They have divided soils of Meghalaya into 24 units having its own unique characteristics (Table-5 & Fig-7). Soils types in Meghalaya are dominated by lateritic group. Soil in the southern part of Khasi Jaintia, is mostly coarse-loamy type with few cm in depth. It can be considered as inceptisols (young soil) because forming processes could not form into mature soil due to erosion. Towards the north of Khasi Jaintia Hills and Garo Hills, fine loamy surface soils with moderate erosion are found.

Table-5: Description of Soil Types of Meghalaya with area covered (km²)

Mapping Units	Description	Soil Taxonomy	Area (km ²)
01	Deep, excessively drained, fine soils on moderately sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Moderately deep, excessively drained, coarse-loamy soils on gently sloping hill tops with very severe erosion hazard and strong stoniness	Typic Kanduidults Typic Dystrochrepts	2032.529
02	Deep, excessively drained, fine soils on gently sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: deep, poorly drained, fine-loamy soils on very gently sloping valleys with very slight erosion hazard and groundwater table below one meter depth of the surface.	Typic Haplohumults Humic Haplaquepts	552.803
03	Deep, excessively drained, fine soils on moderately sloping side-slopes of hills having loamy surface with moderate erosion hazard and slight stoniness; associated with: Moderately deep, excessively drained, loamy-skeletal soils on gently sloping hill tops with very severe erosion hazard and strong stoniness	Typic Kandihumults Typic Dystrochrepts	872.772
04	Deep, excessively drained, fine soils on moderately steep side-slopes of hills having loamy surface with moderate erosion hazard and strong stoniness; associated with: Moderately deep, excessively drained, loamy-skeletal soils on very gently sloping hill tops with very severe erosion hazard and strong stoniness	Typic Kandihumults Typic Dystrochrepts	543.581
05	Deep, excessively drained, fine soils on moderately sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Moderately deep, excessively drained, fine loamy soils on gently sloping hill tops with very severe erosion hazard and strong stoniness	Typic Kandihumults Typic Dystrochrepts	1080.566

06	Moderately shallow, excessively drained, fine loamy soils on moderately steep side-slopes of hills having loamy surface with severe erosion hazard and strong stoniness; associated with: Moderately shallow, excessively drained, loamy-skeletal soils on gently sloping hill tops with very severe erosion hazard and slight stoniness	Umbric Dystrochrepts Umbric Dystrochrepts	129.079
07	Moderately deep, excessively drained, coarse-loamy on very steeply sloping with very severe erosion hazard and strong stoniness; associated with: Moderately deep, excessively drained, coarse-loamy soils on steeply sloping hill tops with severe erosion hazard and strong stoniness	Umbric Dystrochrepts Typic Udorthents	1673.141
08	Moderately deep, excessively drained, loamy-skeletal soils on moderately steep side-slopes of hills having sandy surface with very severe erosion hazard and strong stoniness; associated with: Shallow, excessively drained, loamy-skeletal soils on moderately steep side-slopes hill tops of hills with very severe erosion hazard and strong stoniness	Typic Dystrochrepts Lithic Udorthents	210.660
09	Deep, excessively drained, fine-loamy soils on moderately sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: deep, excessively drained, fine soils on moderately sloping side-slopes of hills with moderate erosion.	Umbric Dystrochrepts Typic Kanduidults	1050.952
10	Deep, excessively drained, fine soils on moderately steep side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Deep, somewhat excessively drained, fine loamy-soils on moderately steep side-slopes of hills with slight erosion hazard.	Typic Kandihumults Typic Haplumbrepts	1281.627
11	Deep, excessively drained, fine soils on moderately steep side-slopes of hills having clayey surface with slight erosion hazard; associated with: Moderately deep, excessively drained, loamy-skeletal soils on moderately steep side-slopes of hills with severe erosion hazard and moderate stoniness	Typic Kandihumults Umbric Dystrochrepts	756.599
12	Deep, excessively drained, fine soils on moderately steep side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Moderately deep, excessively drained, fine-loamy soils on gently sloping hill tops with very severe erosion hazard and strong stoniness	Typic Kandihumults Typic Dystrochrepts	1546.569
13	Deep, somewhat excessively drained, fine soils on gently sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Moderately deep, excessively drained, fine soils on moderately steep side slopes of hills with moderate erosion hazard	Typic Kandihumults Dystric Eutrochrepts	2328.308
14	Deep, somewhat excessively drained, fine soils on moderately sloping side-slopes of hills having loamy surface with moderate erosion hazard; associated with: Deep excessively drained, fine soils on moderately sloping side-slopes of hills with moderate erosion hazard	Typic Paleudults Dystric Eutrochrepts	467.164
15	Deep, moderately well drained, fine soils on very gently sloping upland having loamy surface with slight erosion and slight flood hazards; associated with: Deep, well drained, fine soils on moderately sloping side-slopes of hills with moderate erosion hazard	Aquic Eutrochrepts Typic Kandihumults	372.593
16	Deep, well drained, fine-loamy soils on gently sloping valleys having loamy surface with slight erosion hazard; associated with: Deep, imperfectly drained, fine soils on nearly level plains with slight erosion and slight flood hazards	Humic Hapludults Aeric Haplaquepts	136.614
17	Deep, well drained, fine soils on very gently sloping plains having loamy surface with slight erosion hazard and ground water table between two to five meters of the surface; associated with: Deep, poorly drained, fine soils on nearly level valley bottom with very slight erosion hazard and ground water table below one meter depth of the surface	Umbric Dystrochrepts Cumulic Humaquepts	132.393
18	Deep, very poorly drained, fine soils on nearly level valley having clayey surface with very slight erosion ground water table between one to two meters of the surface and moderate flood hazards; associated with: Deep, poorly drained fine soils on nearly level valley with slight erosion ground water table between one to two meters of the surface and slight flood hazards	Typic Haplaquepts Aeric Haplaquepts	1323.980
19	Moderately deep, excessively drained, fine-loamy soils on steeply sloping side-slopes of hills having loamy surface with very severe erosion hazard and strong stoniness; associated with: Deep, excessively drained, fine soils on moderately sloping hill tops with very severe erosion hazard and slight stoniness	Typic Dystrochrepts Umbric Dystrochrepts	622.209
20	Deep, excessively drained, loamy-skeletal soils on steeply sloping steep side-slopes of hills having loamy surface with severe erosion hazard and strong stoniness; associated with: Deep, excessively drained, coarse-loamy,	Typic Haplumbrepts Umbric Dystrochrepts	835.264

	soils on steeply sloping side-slopes of hills with very severe erosion hazard and moderate stoniness		
21	Moderately deep, excessively drained, fine-loamy soils on steeply sloping side-slopes of hills having loamy surface with severe erosion hazard and moderate stoniness; associated with: Deep, excessively drained fine soils on steeply sloping side-slopes of hill with severe erosion hazard and strong stoniness	Ultic Hapludalfs Typic Kandudluts	1392.530
22	Moderately deep, excessively drained, coarse-loamy soils on steep side-slopes of hills having loamy surface with moderate erosion hazard and slight stoniness; associated with: Moderately deep, excessively drained, fine soils on moderately sloping side-slopes of hills with severe erosion hazard and slight stoniness	Typic Udorthents Typic Kanhapludults	2492.758
23	Moderately deep, excessively drained loamy-skeletal soils on moderately steep side-slopes of hills having loamy surface with very severe erosion hazard and strong stoniness; associated with: Moderately shallow, excessively drained, coarse loamy soils on moderately steep sloping side-slopes of hill with very severe erosion hazard and strong stoniness	Pachic Haplumbrepts Typic Udorthents	467.098
24	Deep, well drained, fine soils on very gently sloping valleys having loamy surface with moderate erosion; associated with: Deep, imperfectly drained, fine-loamy soils on very gentle sloping valleys with slight erosion hazard, ground water table below one meter of the surface and with slight flooding hazard	Umbric Dystrochrepts Aeric Haplaquepts	148.911

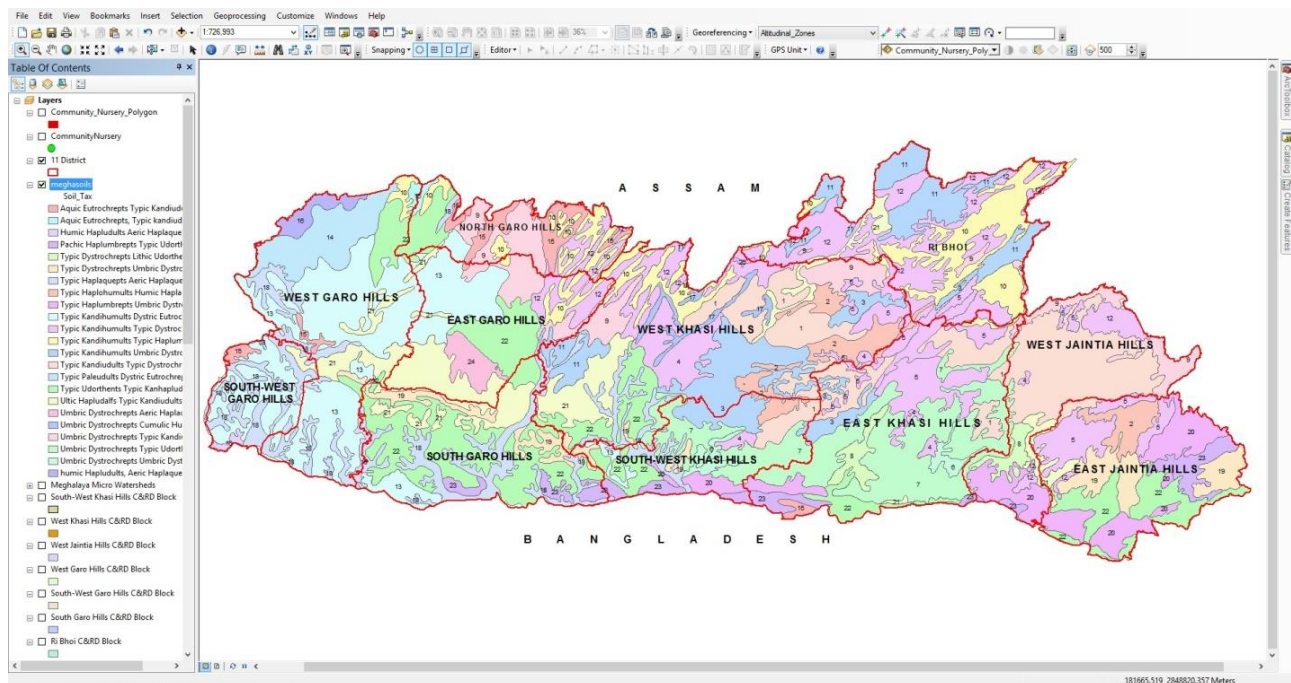


Fig-7: Soil types of Meghalaya

8. Roads:

A detailed road map of the State is based on the mapping done by Information Technology Department, Government of Meghalaya. Addition and updating of roads is carried out by GIS Lab, MBDA. At present there are four National Highway; NH-40 it connects Jorabat, Byrnihat, Nongpoh, Umsning Barapani, Shillong, Jowai with the total distance of 216 kms. NH-44: it connects Nongstoin, Shillong, Meghalaya-Assam border having a distance of 277 kms. NH-51: it is shared both by Assam and Meghalaya and it connects Assam, Bajengdoda/Tura, Kherapara, Burengapara at the distance of 127 kms. A two lane Shillong bypass has been constructed from Barapani to Mawryngkneng. There are also other various state highways, district roads and other roads types present in this layer (Fig-8).

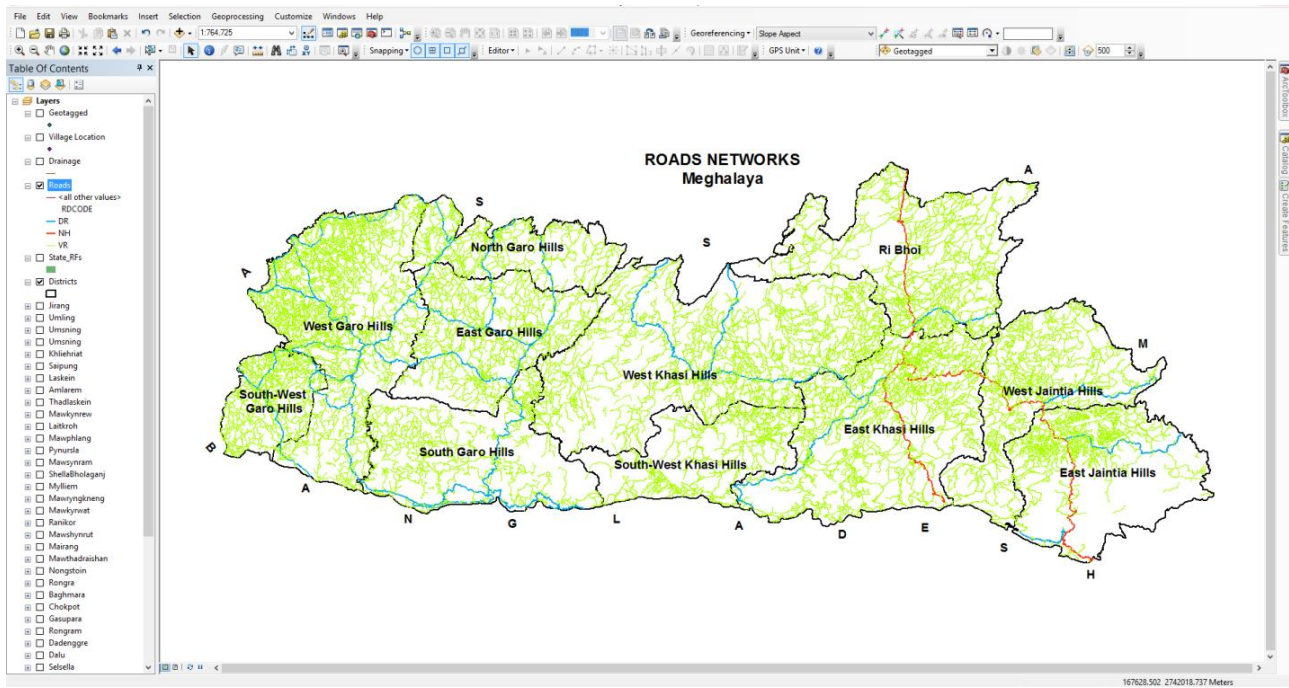


Fig-8: Road Network

9. Village location:

The village location layer is based on the mapping done by NESAC, Umiam. There are around 5437 number of villages identified in the whole of Meghalaya so far (Fig-9). These village location needs verification and addition and it is done by the GIS Lab, MBDA.

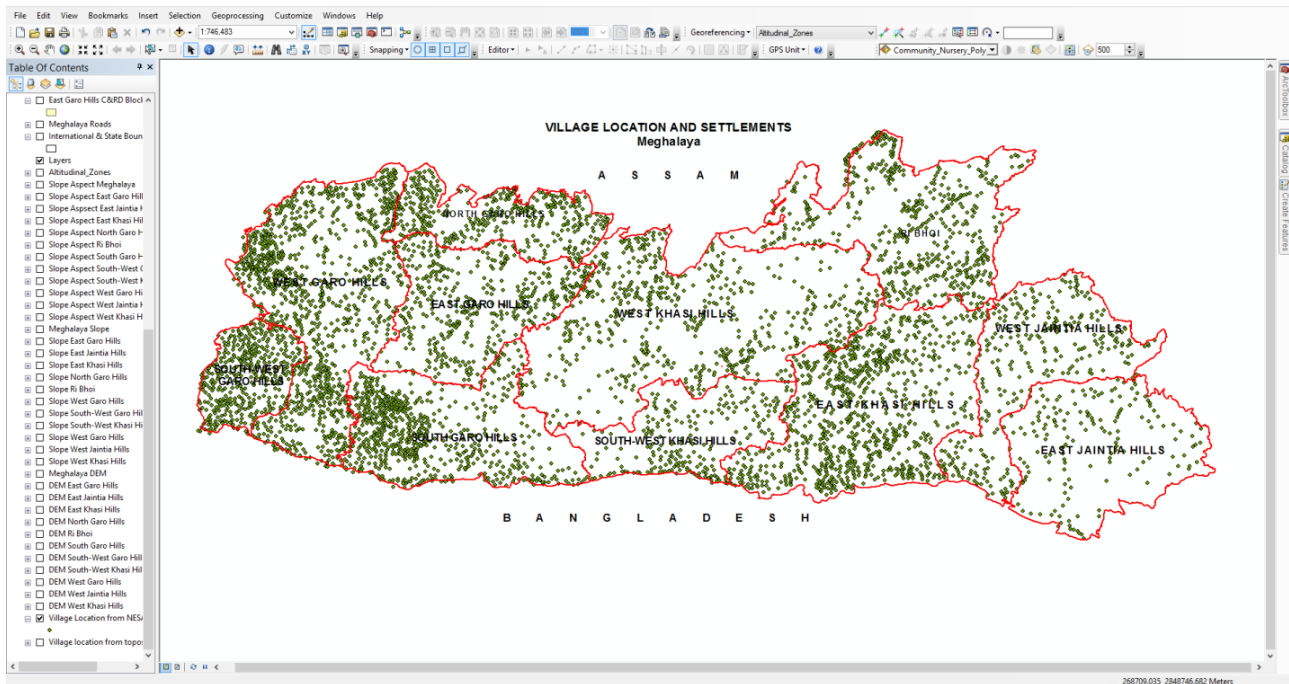


Fig-9: Village Location

10. Forest cover:

The source of forest cover map 2013 is Forest Survey of India, Dehradun. Forest cover of the State has been classified in five classes (Fig-10). Areas under each class is shown in the following Table-6: Forest Types along with area coverage (Km²)

Categories	Area km ²
Very Dense Forest	416
Moderately Dense Forest	7992
Open Forest	6473
Scrub	485
Non Forest	4669

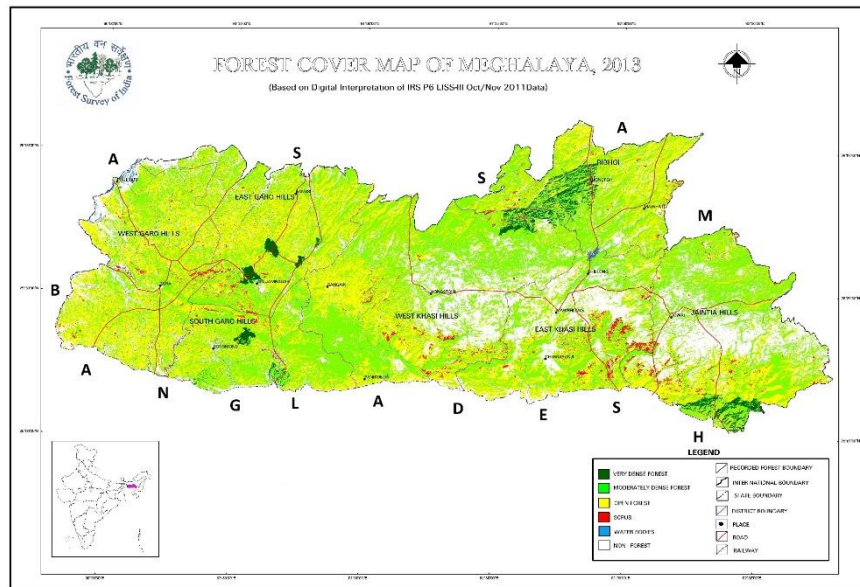


Fig-10: Forest Cover

11. Forest Types:

The Forest Survey of India has identified 7 Forest types in Meghalaya according to Champion and Seth classification (1968) (Fig-11). They are

- i. 1B/C3 Cachar Tropical Evergreen Forest: This type is mostly seen in the southern part of the State along India Bangladesh border.
- ii. 1/2S1 Pioneer Euphorbiaceous Scrub: This forest type is found only in patches in parts of East Khasi Hills, southern part of West Khasi Hills and West Garo Hills.
- iii. 2B/C1a Assam Alluvial Plains Semi-Evergreen Forest: It is found mainly in the south-east part of Garo Hills.
- iv. 2/2S1 Secondary Moist Bamboo Brakes: It is found in patches in southern Jaintia Hills, central parts of Garo Hills and south-east Garo Hills.
- v. 3C/C1 a (ii) Khasi Sal: It is found in Ri Bhoi district and most part of Garo Hills region.
- vi. 3C/C3 (b) East Himalayan Moist Mixed Deciduous Forest: It is found mostly in Garo Hills, parts of West Khasi Hills and Ribhoi District.

vii. 9/C2 Assam Sub Tropical Pine Forest: It is found in the central part of the plateau of Khasi-Jaintia Hills.

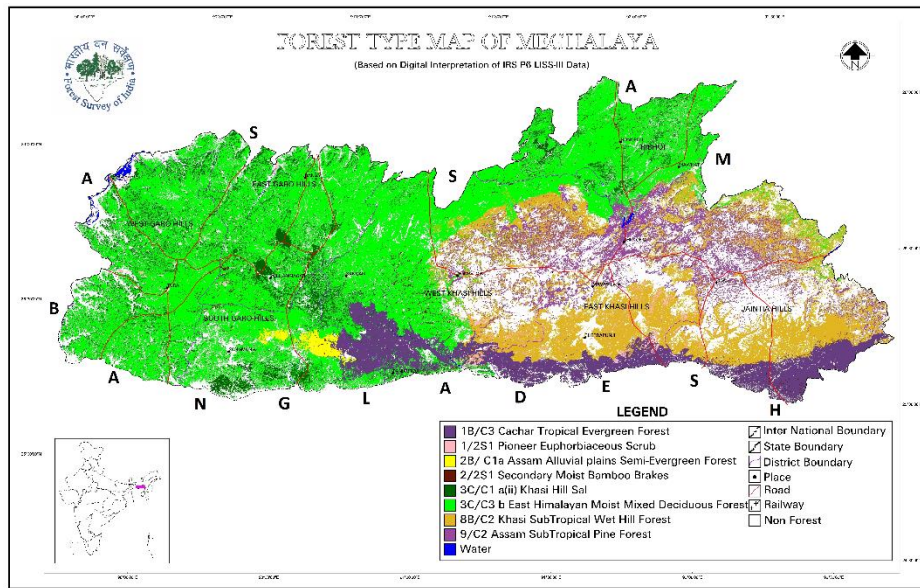


Fig-11: Forest types

12. Land use Land cover:

The Land use land cover map of Meghalaya is being prepared by the GIS Lab, MBDA with the primary objective of planting catchment area afforestation. The map is based on IRS P6 LISS-IV images. Mapping of East Khasi Hills District has been done Land use land cover map has been divided into seven classes: Dense forest canopy of 40-70% above, Open Forest canopy of 10-40%, Grassland with canopy >10%, Barren/scrub land with canopy >10%, Agricultural land, Settlement & Water bodies (Fig-12).

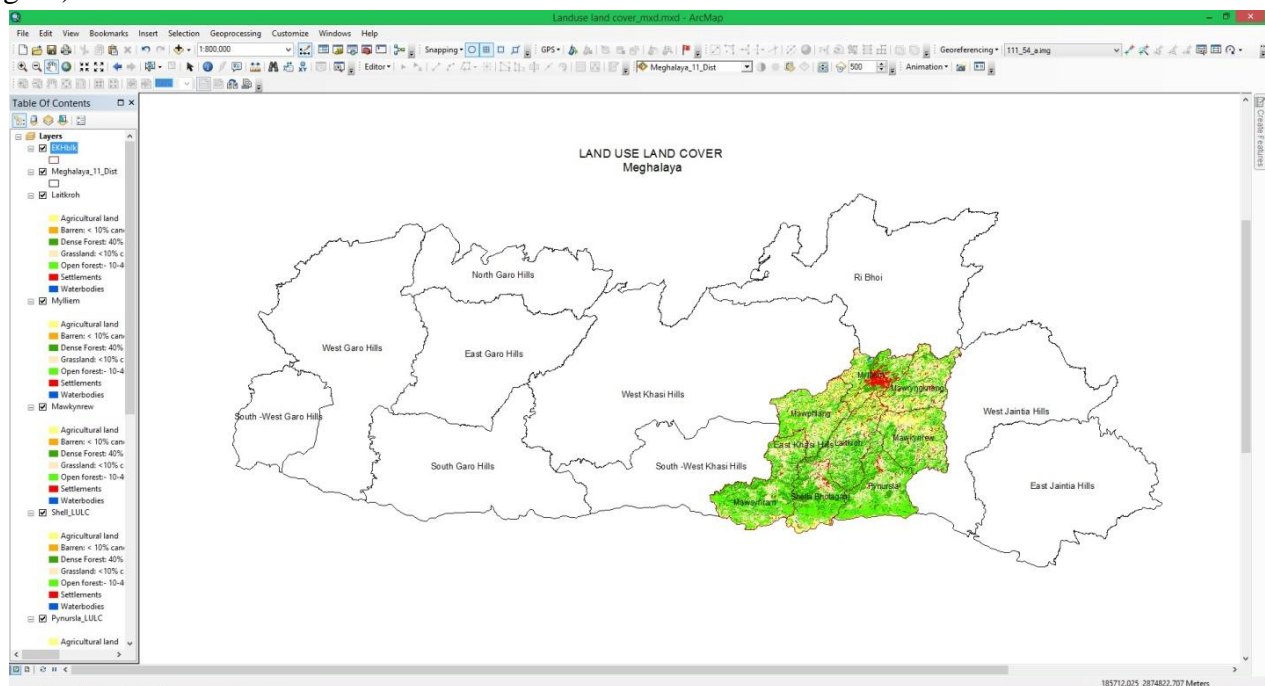


Fig-12: Land Use Land Cover

13. Mosaic of Toposheet with Google Earth Image:

Mosaic of toposheets at the scale of 1:50,000 and 1:25,000 has been prepared in the GIS Lab, MBDA. There are areas in the southern part of the state where Survey of India toposheets are not available as they are restricted. To make up for the high resolution details for all the gap areas an innovative approach has been followed wherein a State wide mosaic of all available toposheets on 1:25,000, 1:50,000 and georeferenced Google earth (high resolution) images downloaded for the gap areas (Fig-13).

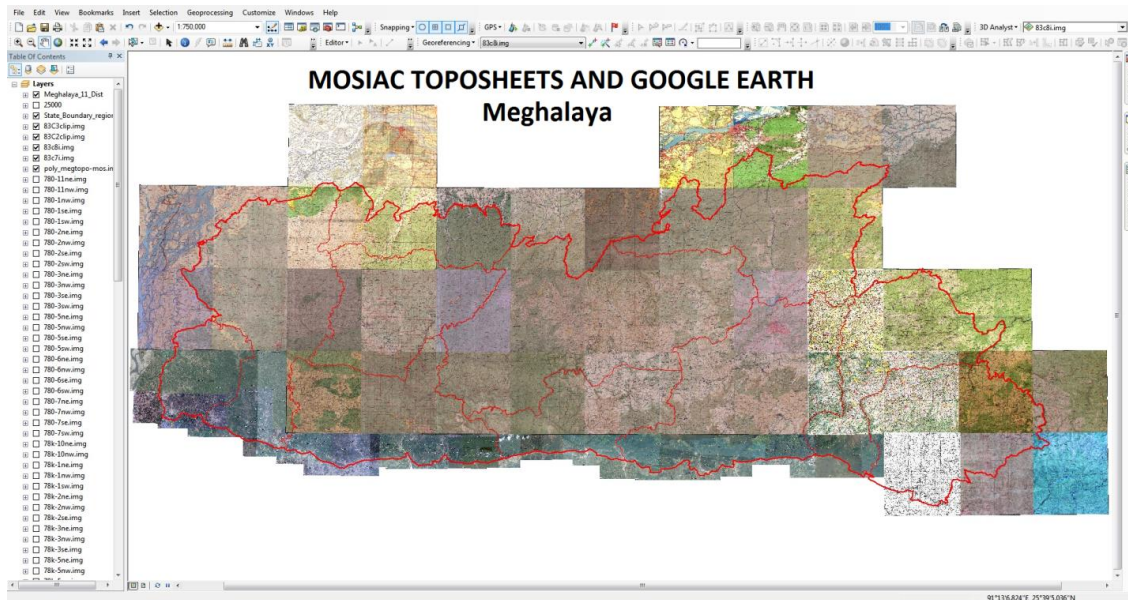


Fig-13: Mosaic Toposheets with Google Earth

14. Mosaic of Land Sat TM7 satellite Image of Meghalaya:

Landsat7 TM of 30m resolution dated Feb 2015 has been downloaded from United States Geological Survey (USGS) website. All these scenes have been mosaic in the GIS Lab, MBDA where it covers the whole area of Meghalaya state (Fig-14).

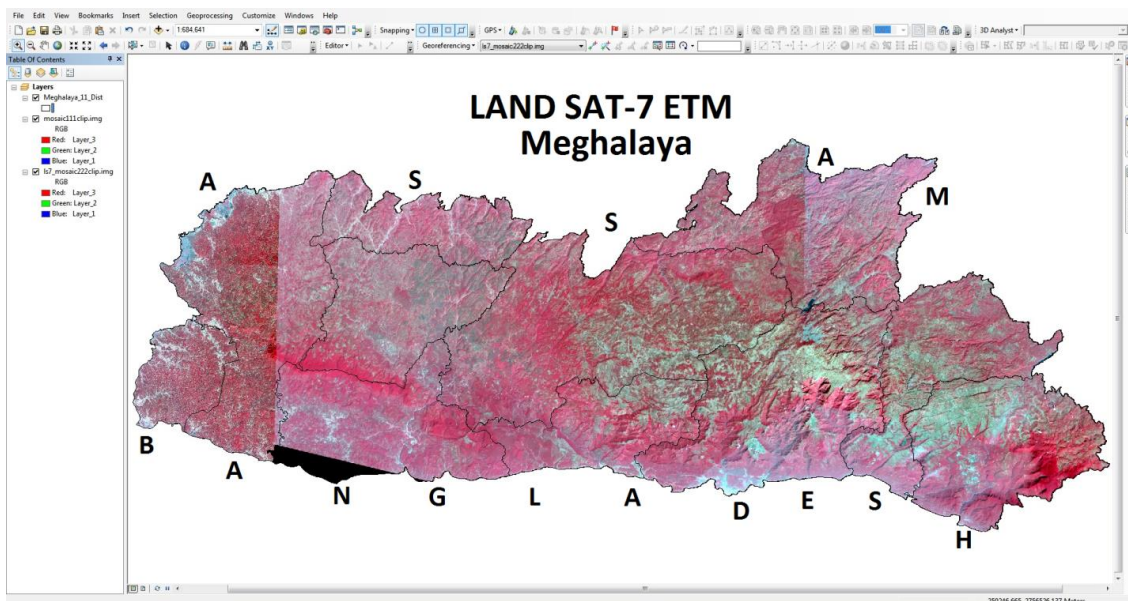


Fig-14: Mosaic of Land Sat TM7 satellite Image

15. Mosaic of IIRS P6 LISS-IV satellite Image of parts of Meghalaya:

IIRS P6 LISS-IV of 5.8m resolution acquired date Jan 2013 has been procured from NRSC, Hyderabad where it covers most parts of Khasi and Jaintia Hills (Fig-15). The mosaic will be extended to cover other parts of State also.

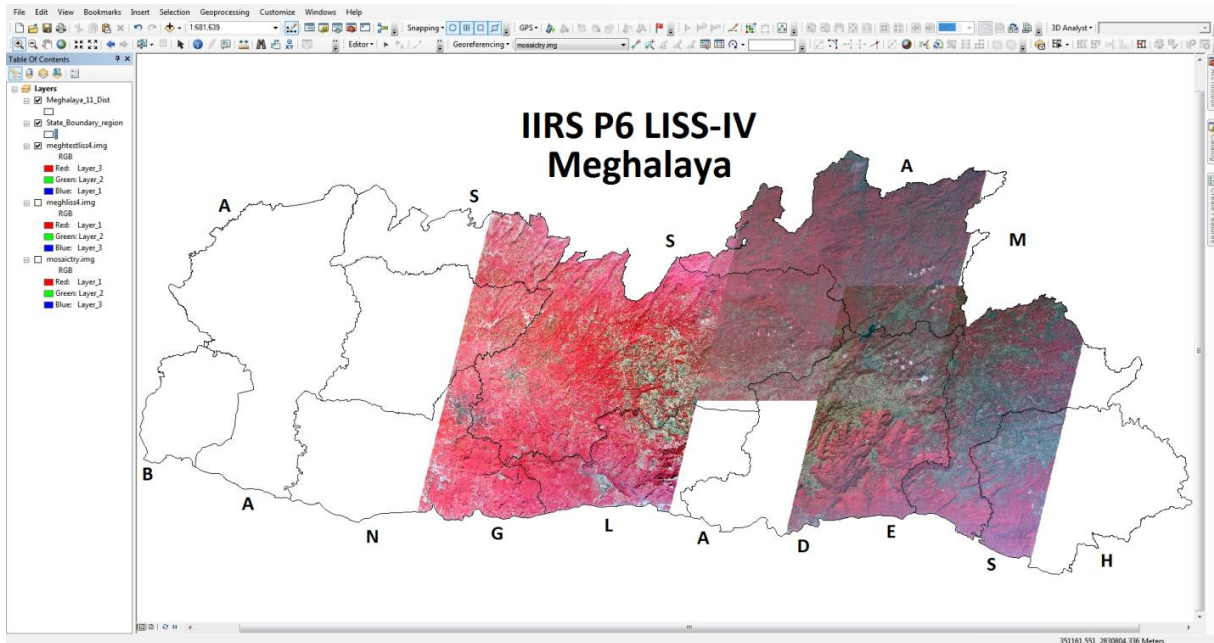


Fig-15: Mosaic of IIRS P6 LISS-IV satellite Image

16. Location of Schools and College:

Mapping of schools and colleges is also taken up by the GIS Lab, MBDA. More schools and colleges needs to be added in this existing layer (Fig-16).

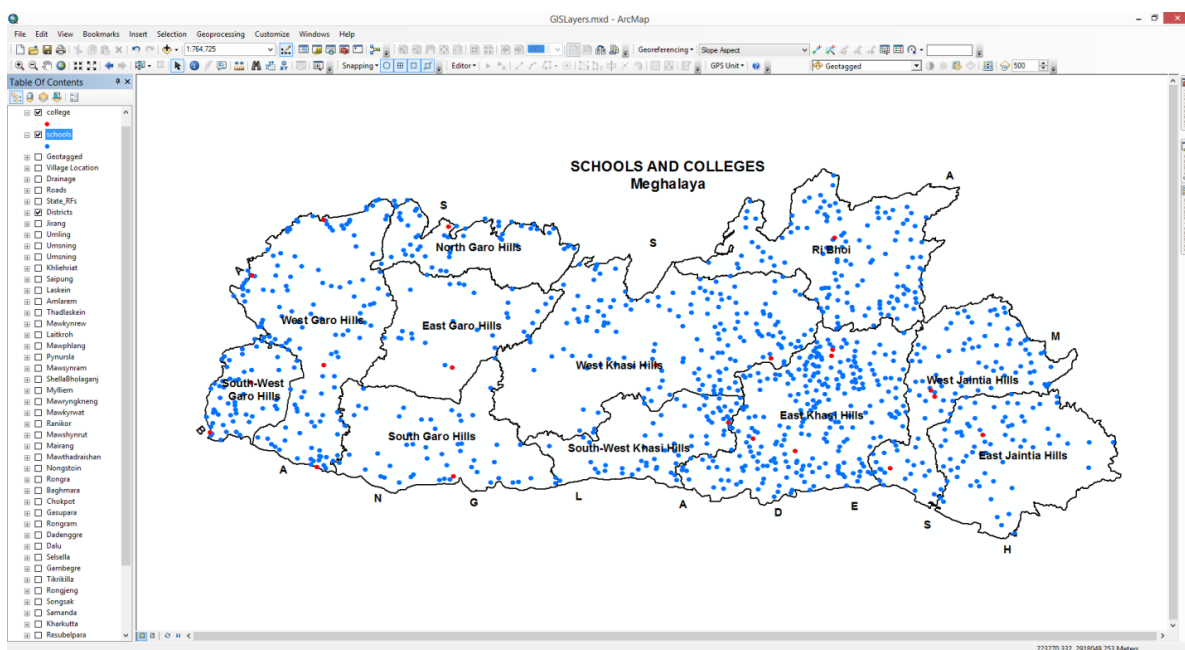


Fig-16: Schools and Colleges

17. Springs:

Mapping of springs in Meghalaya has been done by MINR, MBDA where most of the springs has been map with the help of GPS. There are 637 springs mapped so far in Meghalaya and it is still under progress. These GPS has been plot in the GIS platform by GIS Lab, MBDA (Fig-17). More springs will be updated from time to time.

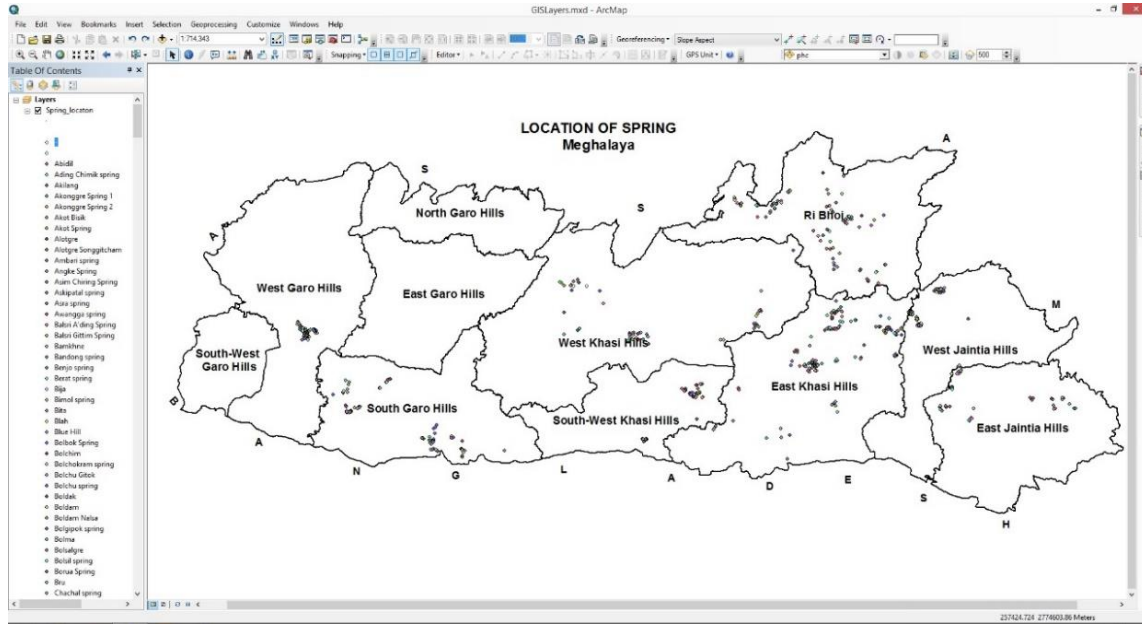


Fig-17: Springs

18. Community Nursery:

The NRM Team under Mission Green have set up 61 Community Nurseries throughout the state of Meghalaya. Community Based Organizations (CBOs) have been established in the state under the overall supervision and guidance of NRM Team, MBDA. A point location and activity of the nurseries with photographs along with other important information has been feed in the attribute table (Fig-18).



Fig-18: Community Nurseries