

Development of decadal land cover database for Nepal

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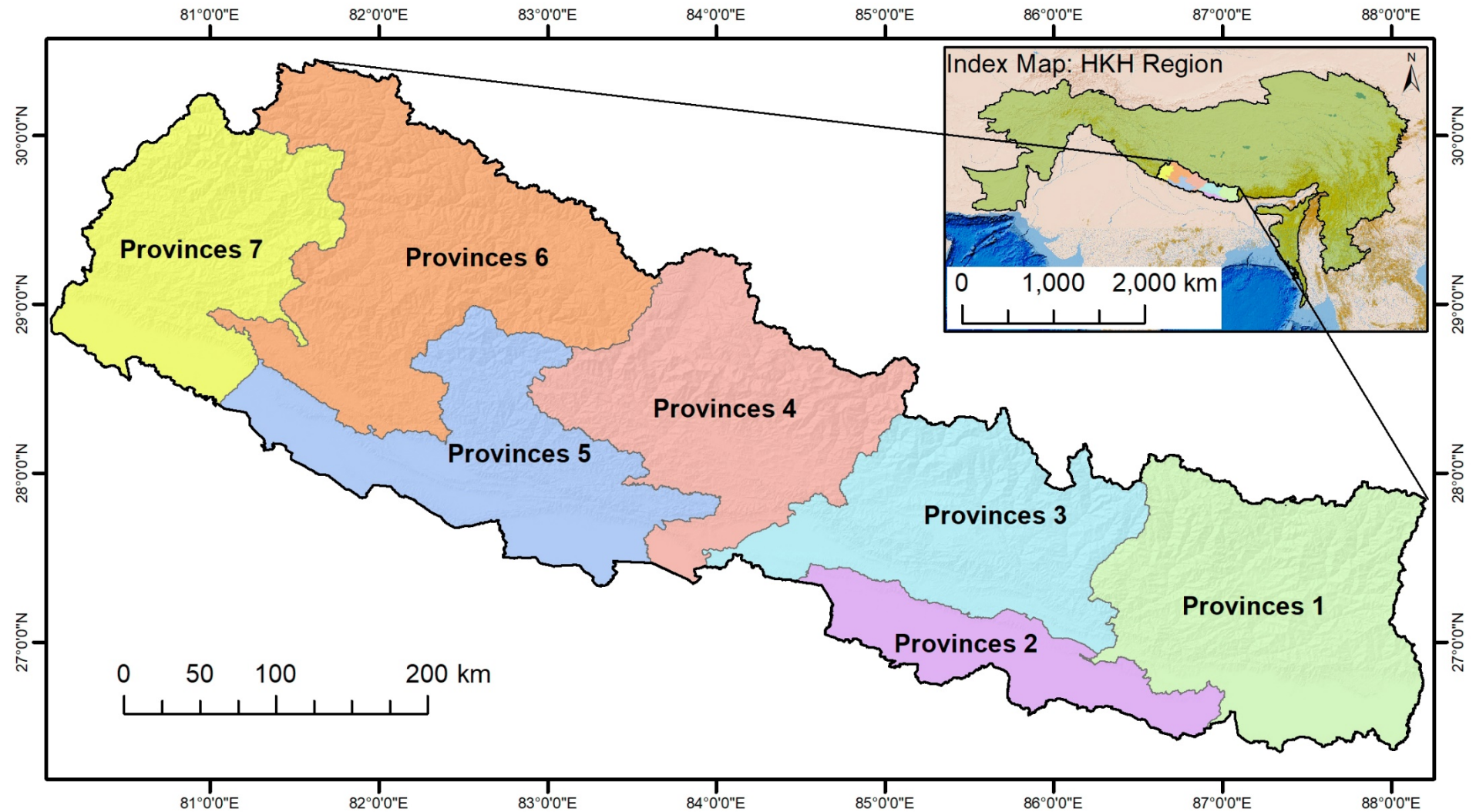
USAID
FROM THE AMERICAN PEOPLE



ICIMOD

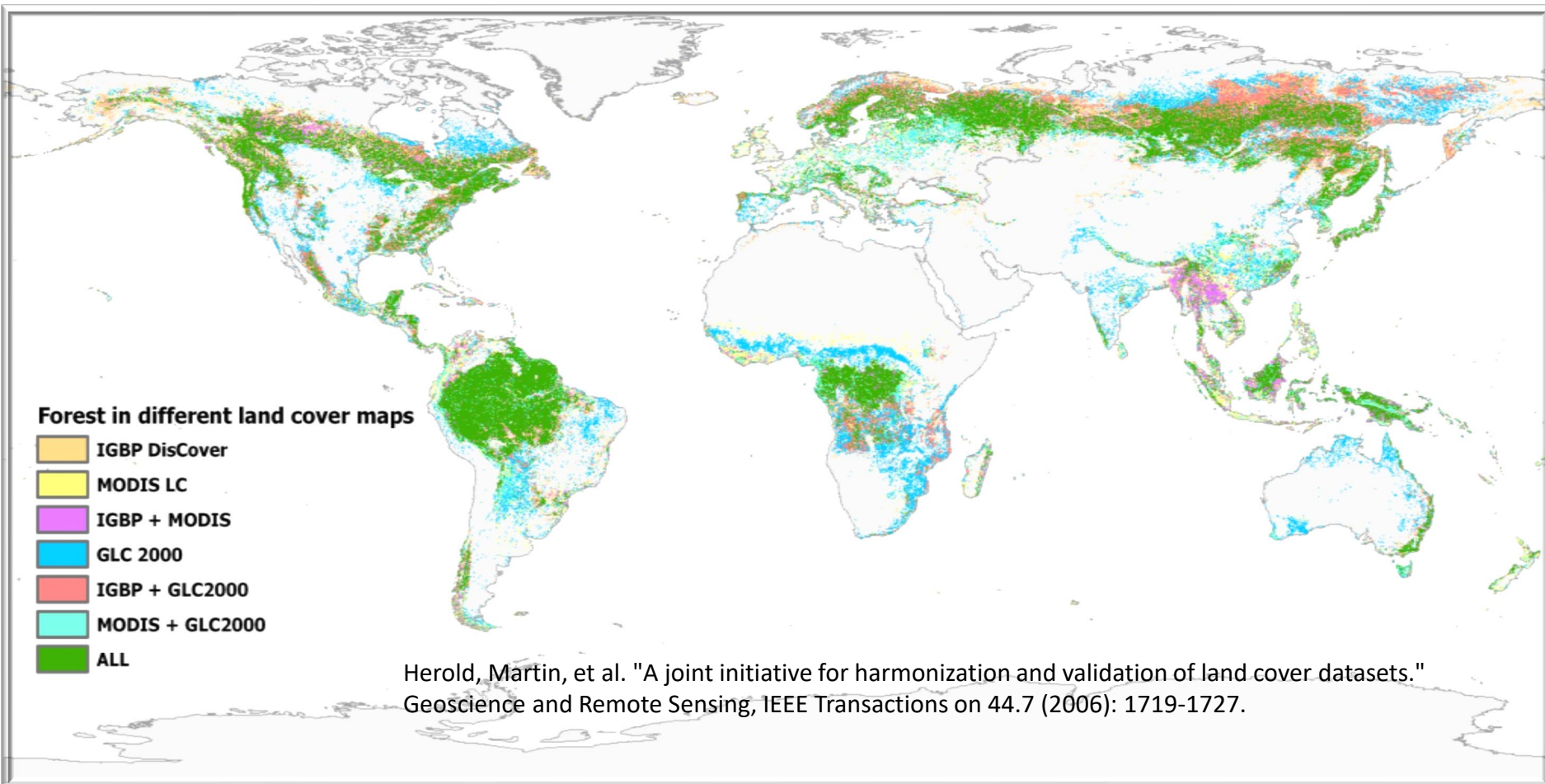


Background of Land cover mapping



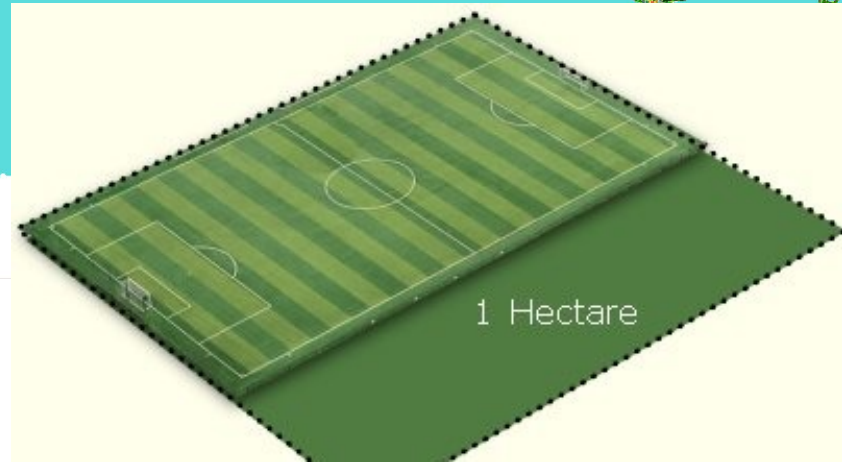
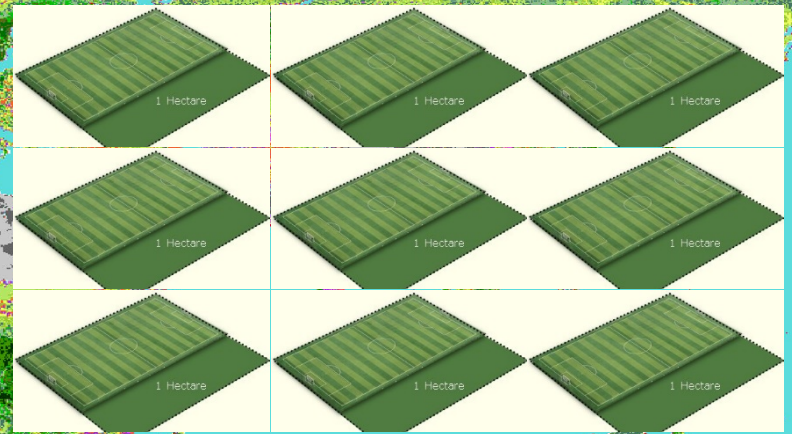
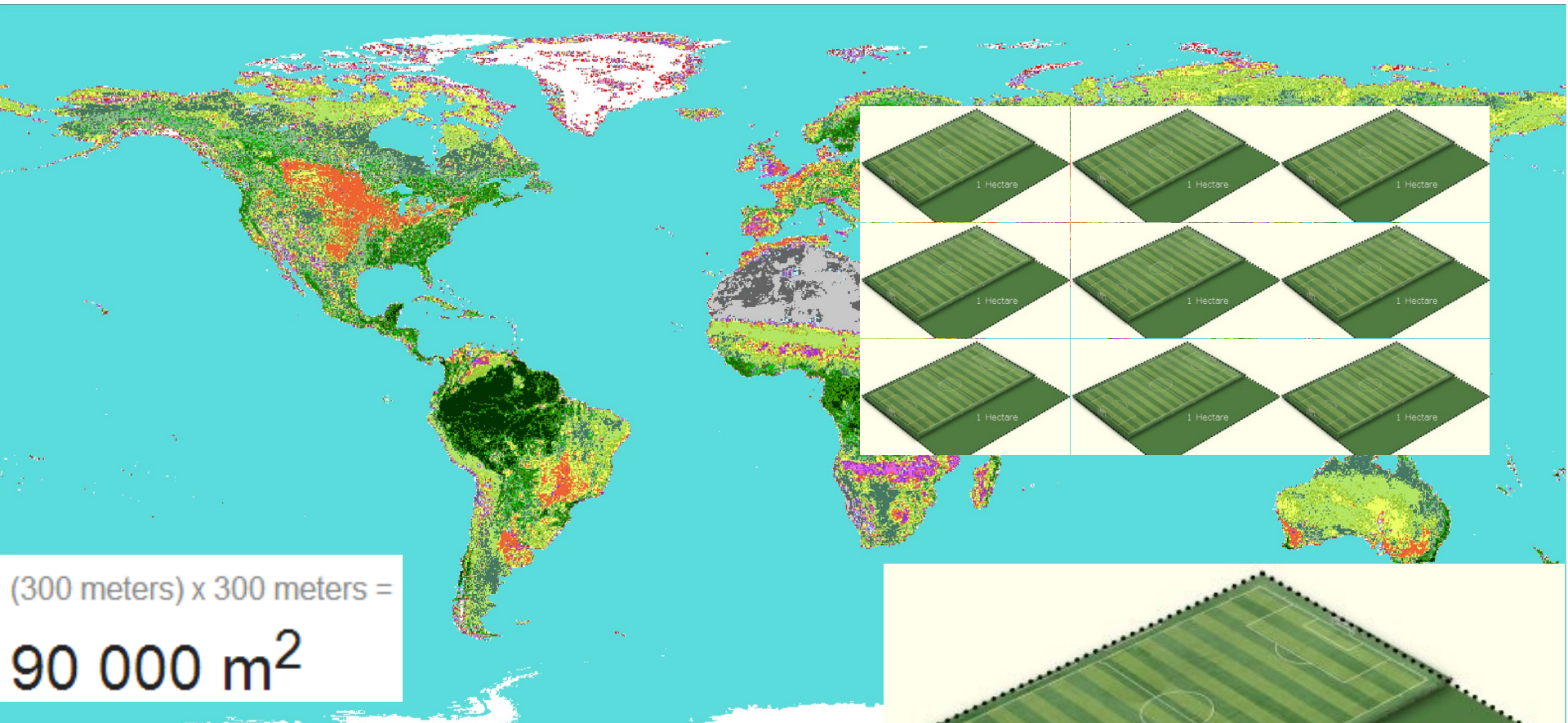
Available land cover images in the Global/HKH/Nepal region

Forest land in global land cover datasets



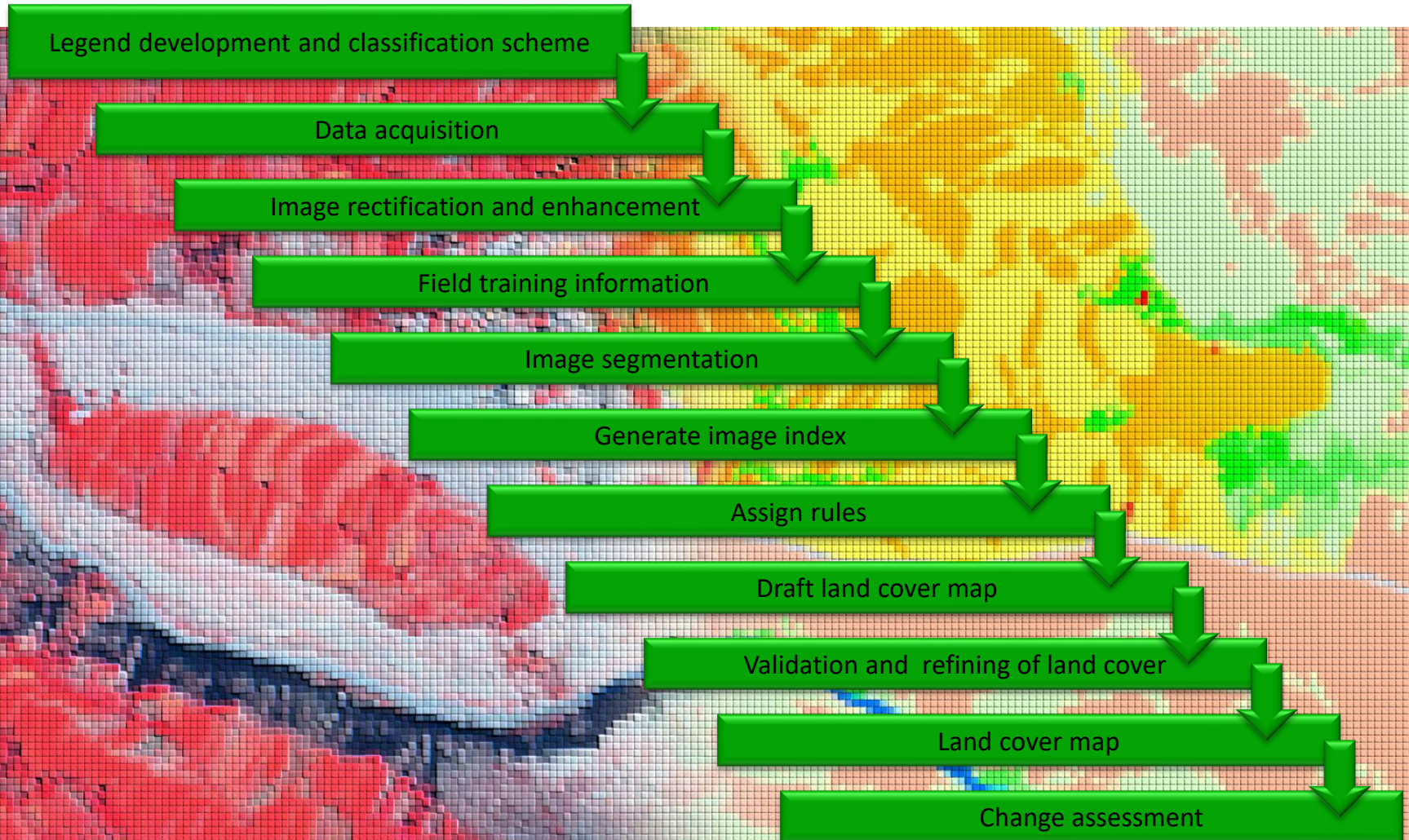


MODIS land cover products for the HKH region



Area		↕
9	=	90000
Hectare		Square meter

Steps of land cover mapping



Consultative Workshops for Harmonization Legend development



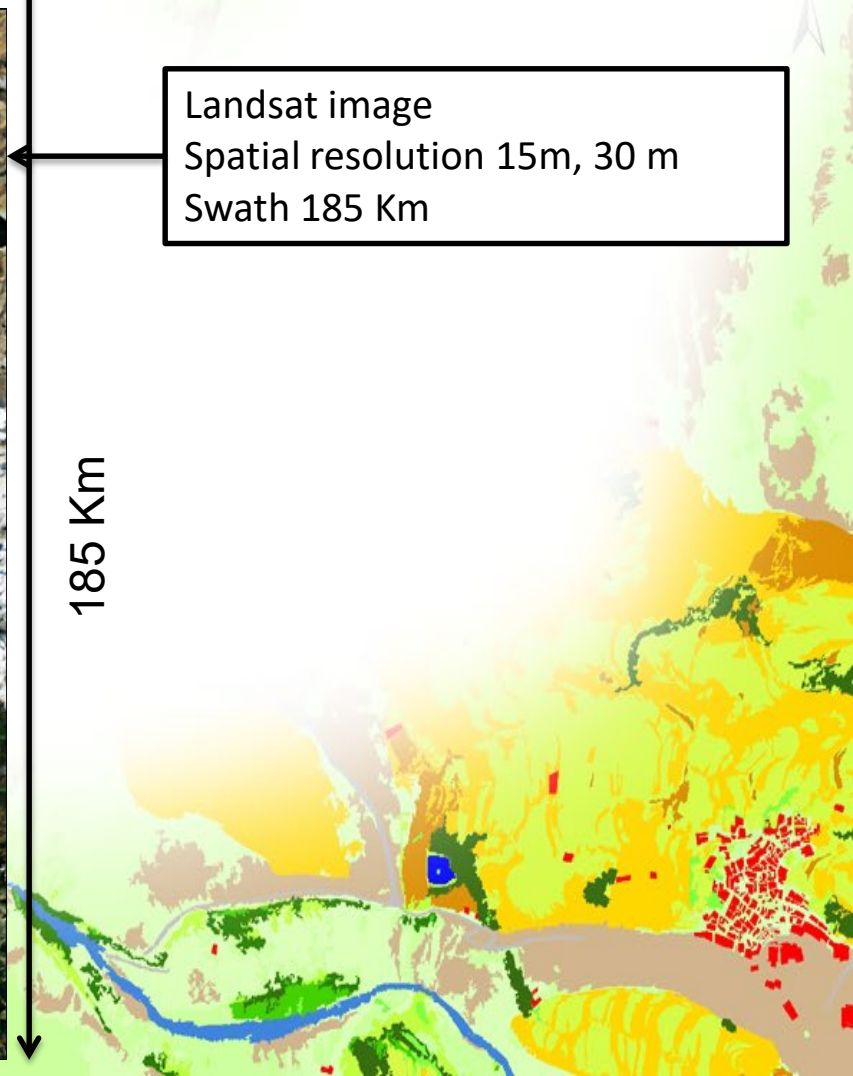
Data acquisition

185 Km

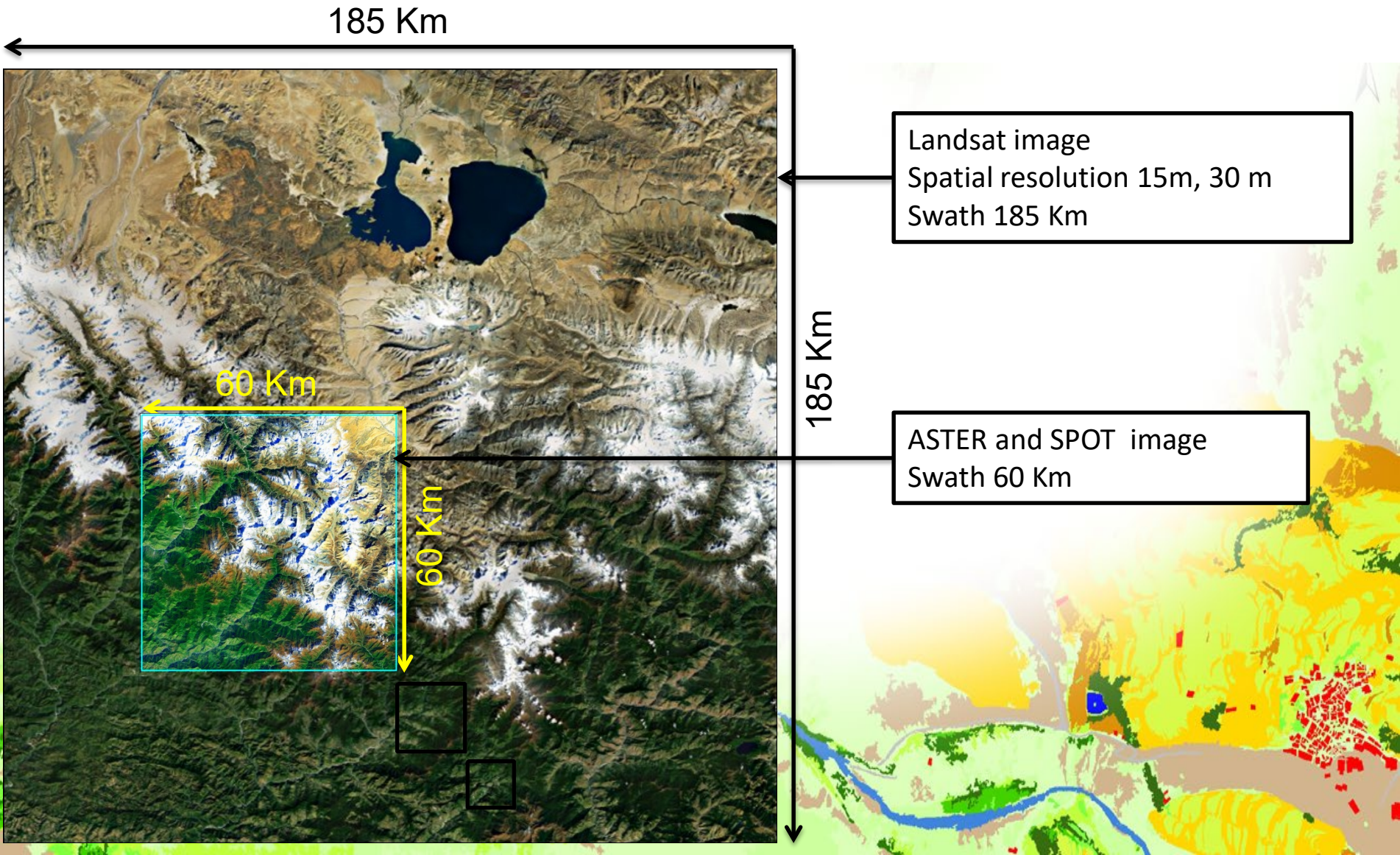


Landsat image
Spatial resolution 15m, 30 m
Swath 185 Km

185 Km



Data acquisition



Object-based Image Analysis [\[edit\]](#)

Object-Based Image Analysis (OBIA) – also Geographic Object-Based Image Analysis (GEOBIA) – "is a sub-discipline of [geoinformation science](#) devoted to (...) partitioning [remote sensing](#) (RS) imagery into meaningful image-objects, and assessing their characteristics through spatial, spectral and temporal scale".^[2]

The two main processes in OBIA are (1) segmentation and (2) classification. Traditional image segmentation is on a per-pixel basis. However, OBIA groups pixels into homogeneous objects. These objects can have different shapes and scale. Objects also have statistics associated with them which can be used to classify objects. Statistics can include geometry, context and texture of image objects. The analyst defines statistics in the classification process to generate [land cover](#)

Each of these application areas has spawned separate subfields of digital image analysis, with a large collection of specialized algorithms and concepts—and with their own journals, conferences, technical societies, and so on.

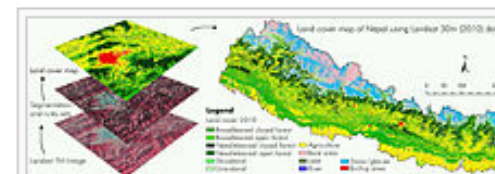
Land cover mapping [\[edit\]](#)

Land cover and land use change detection using remote sensing and geospatial data provides baseline information for assessing the climate change impacts on habitats and biodiversity, as well as natural resources, in the target areas.

Application of land cover mapping [\[edit\]](#)



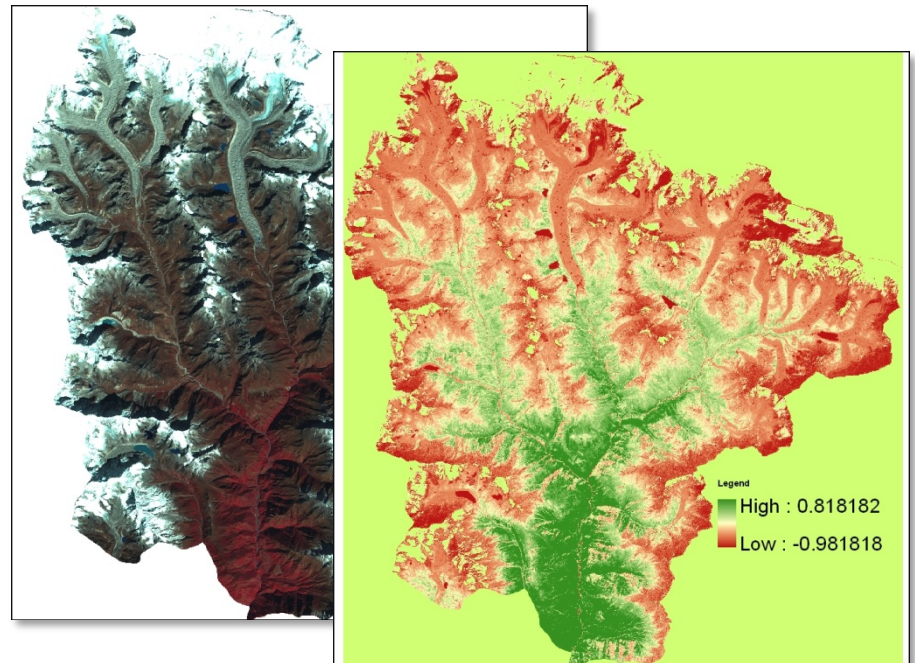
Image segmentation during the object base image analysis



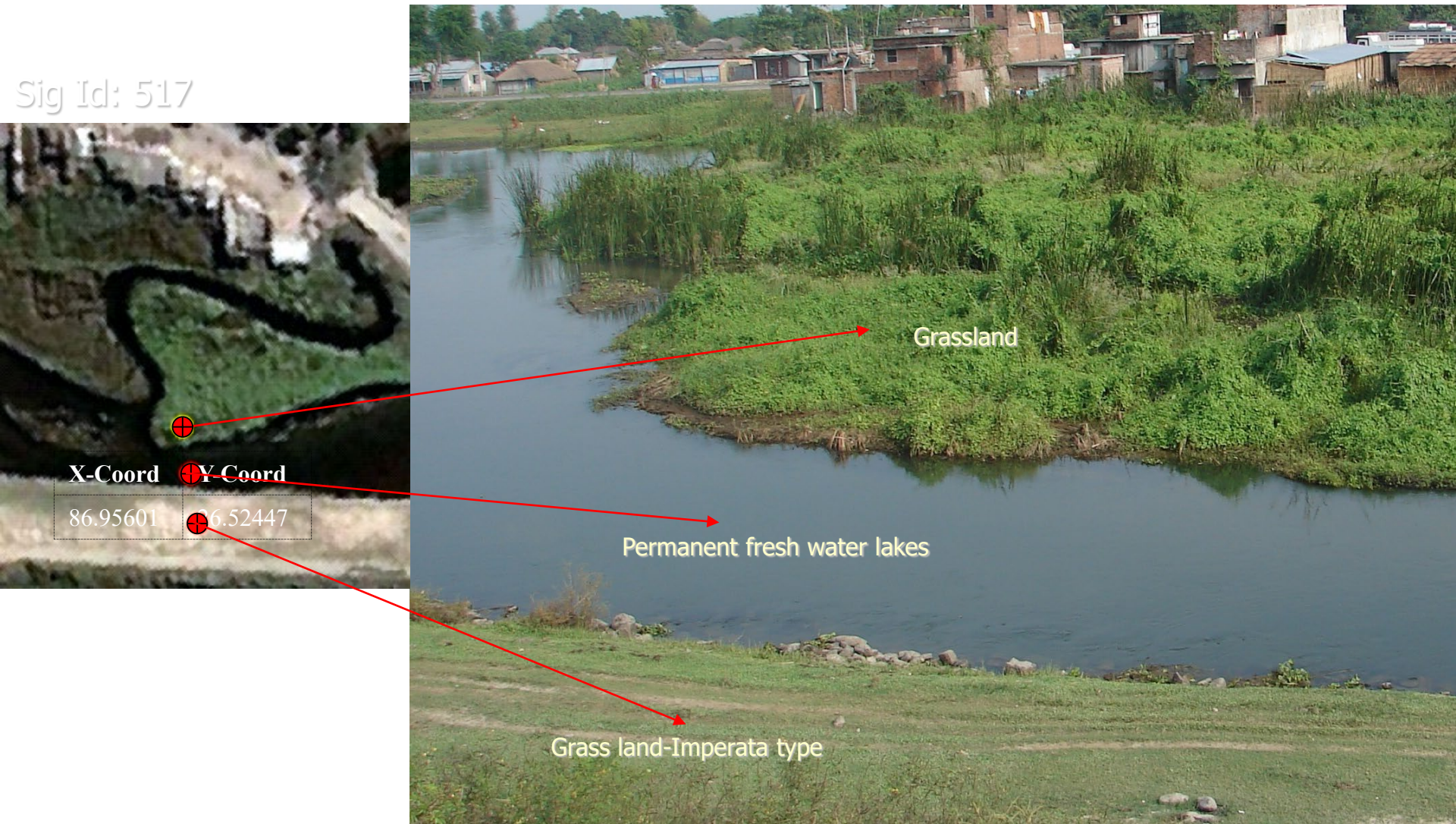
Process of land cover mapping using TM images

Generating arithmetic Feature

- ❑ The Normalized Difference Vegetation Index (NDVI) is a standardized index allowing to generate an image displaying greenness (relative biomass)
- ❑ Index values can range from -1.0 to 1.0, but vegetation values typically range between 0.1 and 0.7.
- ❑ NDVI is related to vegetation is that healthy vegetation reflects very well in the near infrared part of the spectrum.
- ❑ It can be seen from its mathematical definition that the NDVI of an area containing a dense vegetation canopy will tend to positive values (say 0.3 to 0.8) while clouds and snow fields will be characterized by negative values of this index.
$$\text{NDVI} = (\text{NIR} - \text{red}) / (\text{NIR} + \text{red})$$



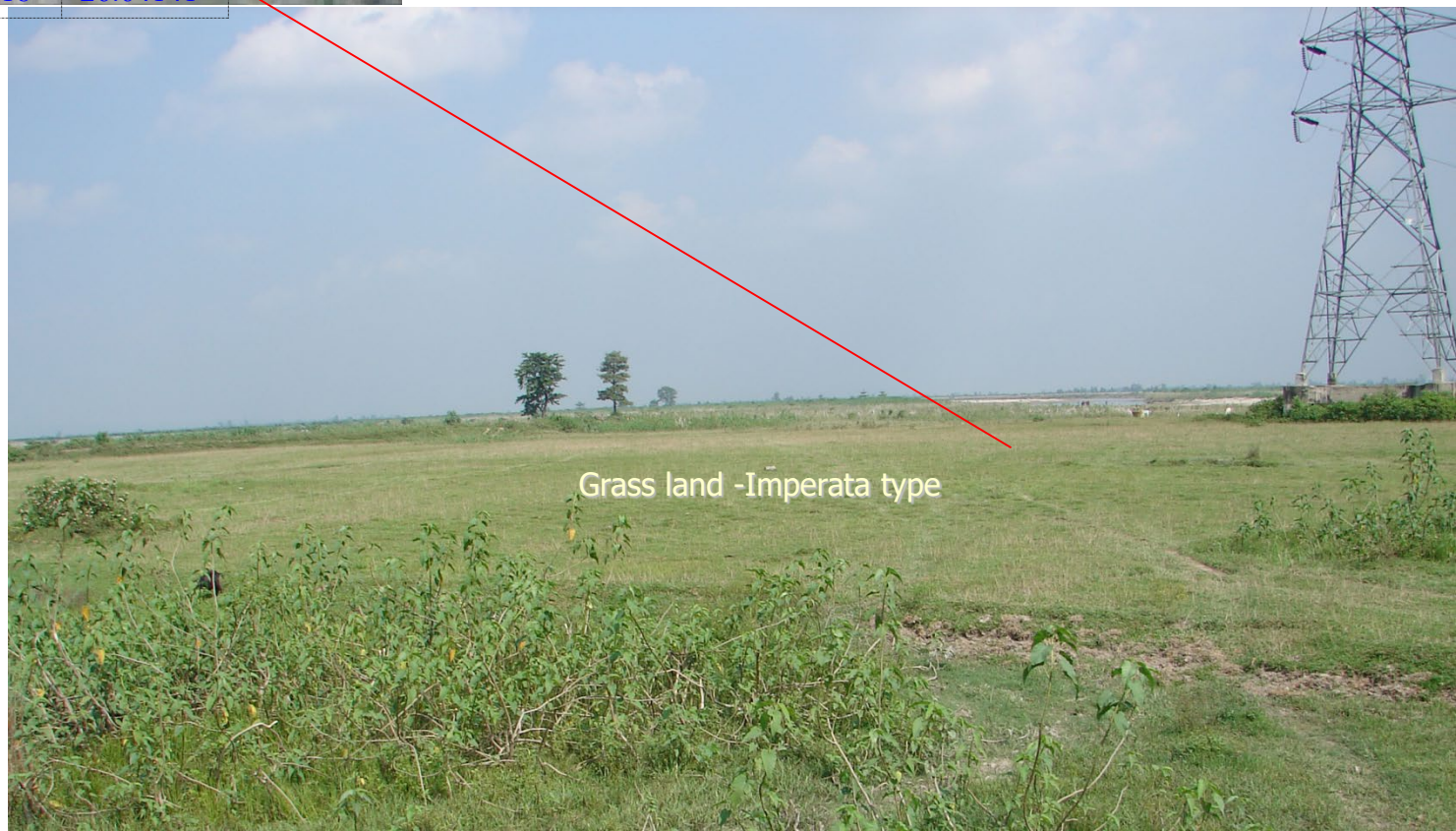
Field samples collection



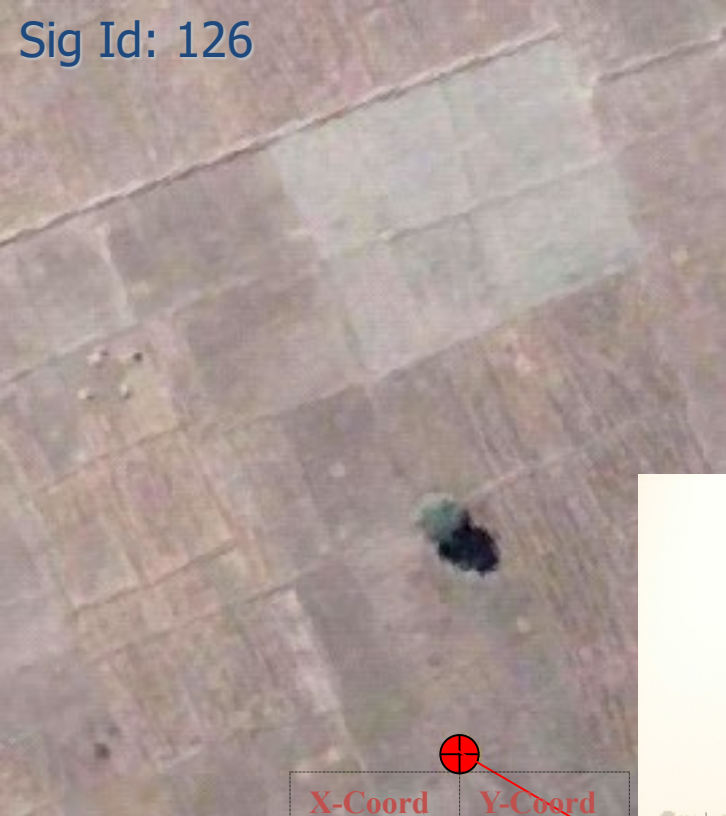
Sig Id: 112



X-Coord	Y-Coord
86.94518	26.64141



Grass land -Imperata type



X-Coord	Y-Coord
86.93070	26.64202



Agriculture -(Paddy land)

16 4:31PM

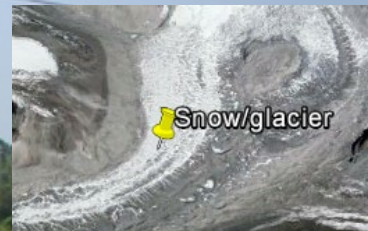
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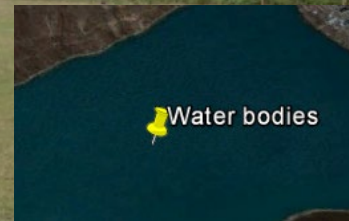
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Grass land -Imperata type



Snow/glacier



Water bodies



Agriculture



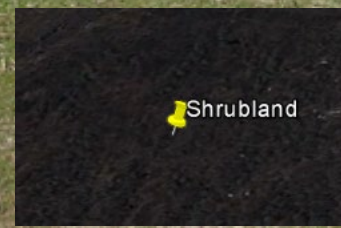
Built-up area



Barren area



Grassland

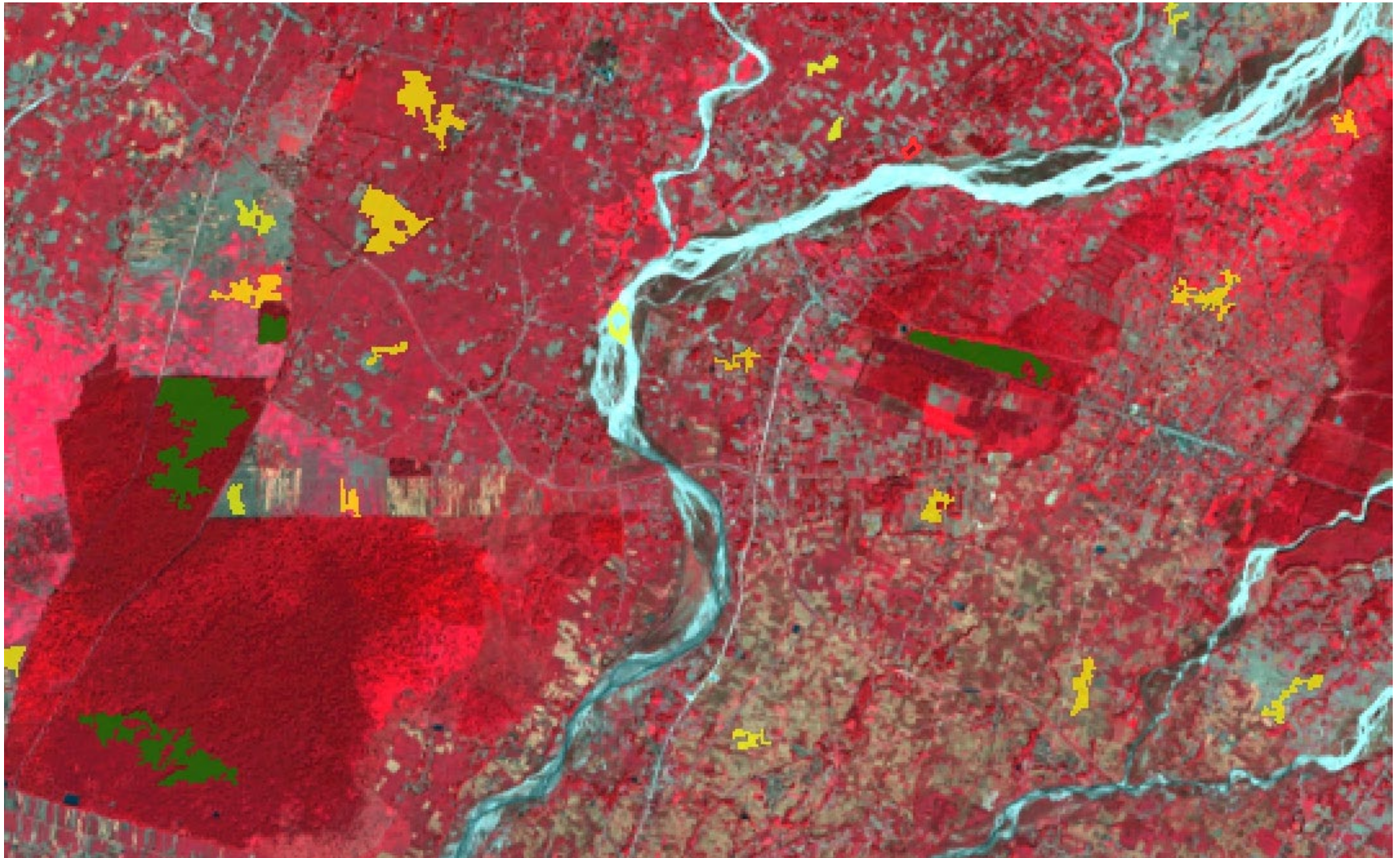


Shrubland

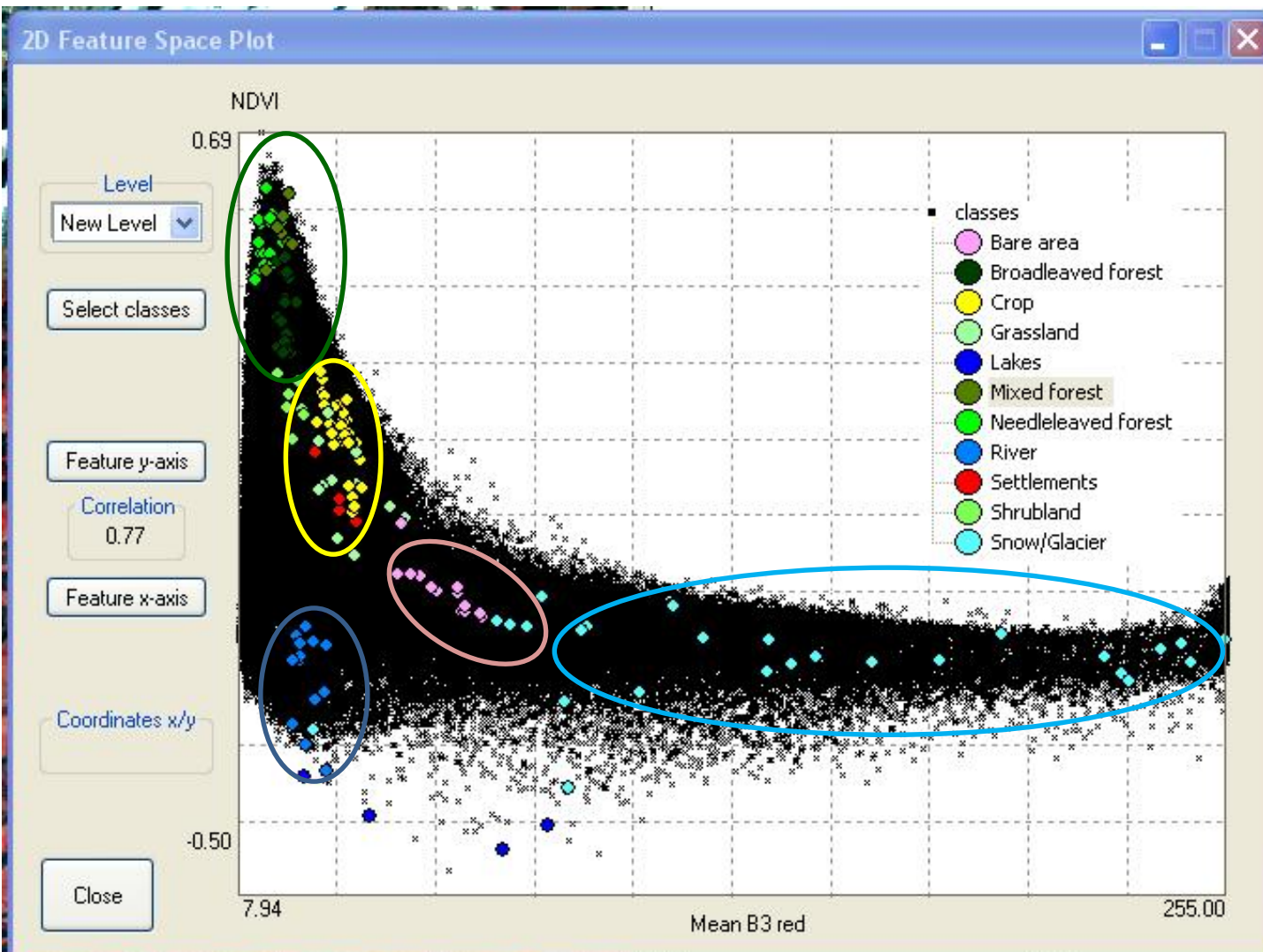


Forest

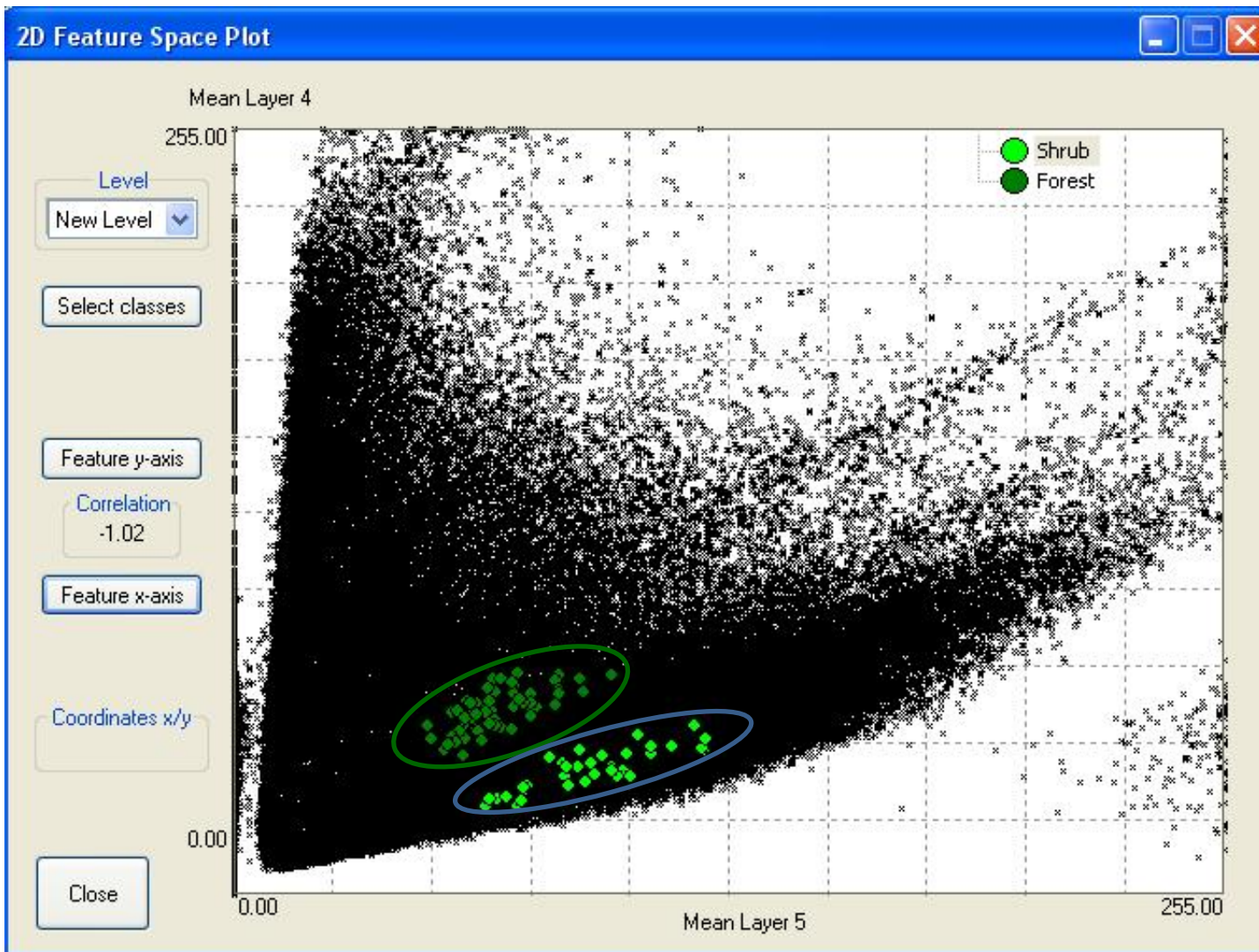
Training sets/ sample collection



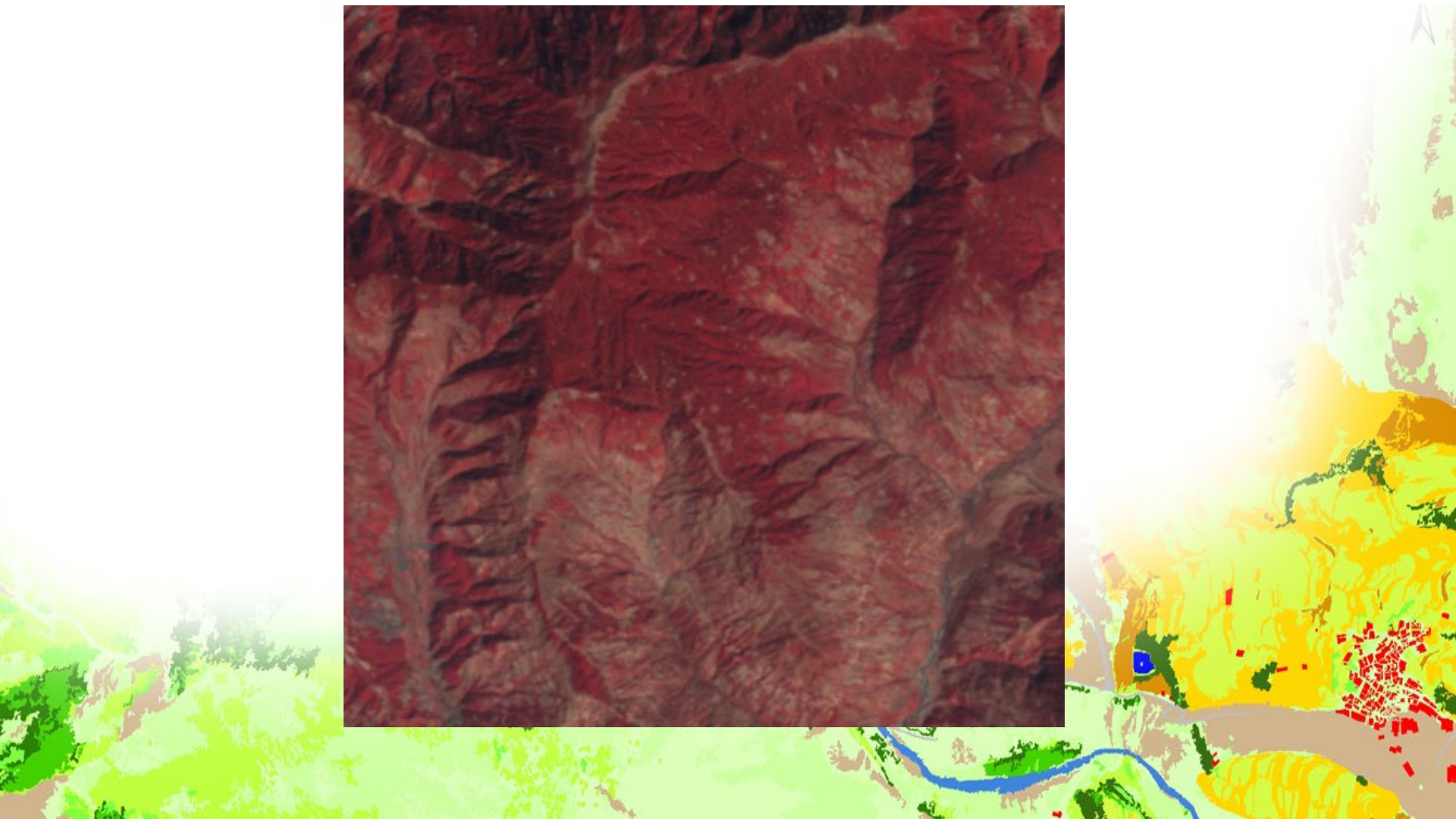
Comparing features using the 2D feature space plot



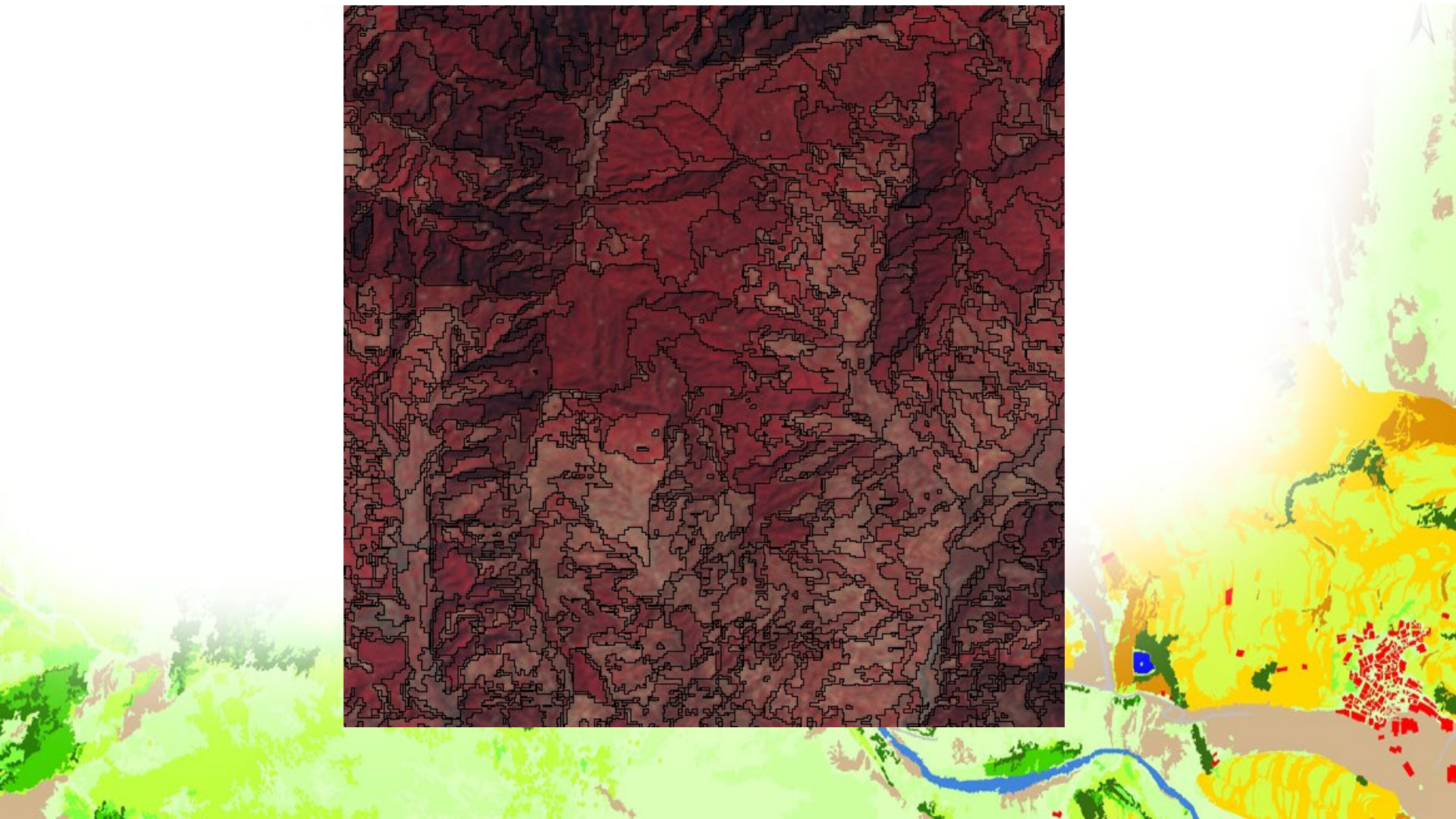
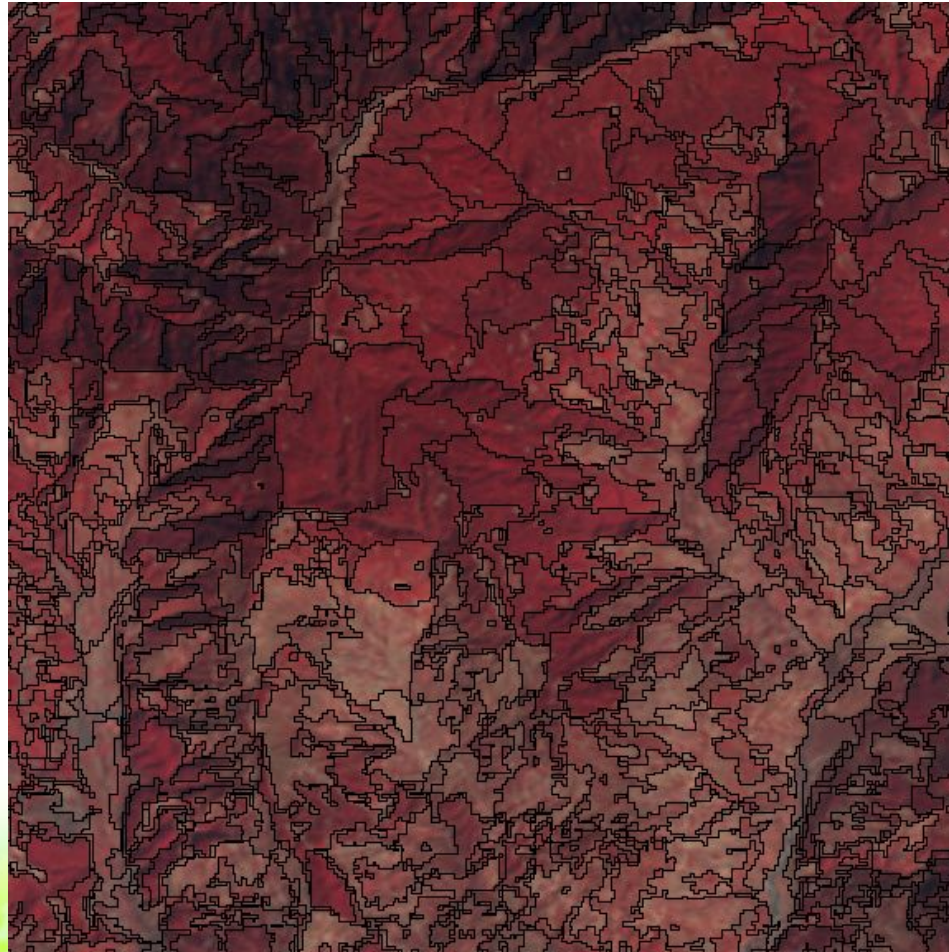
Comparing features using the 2D feature space plot



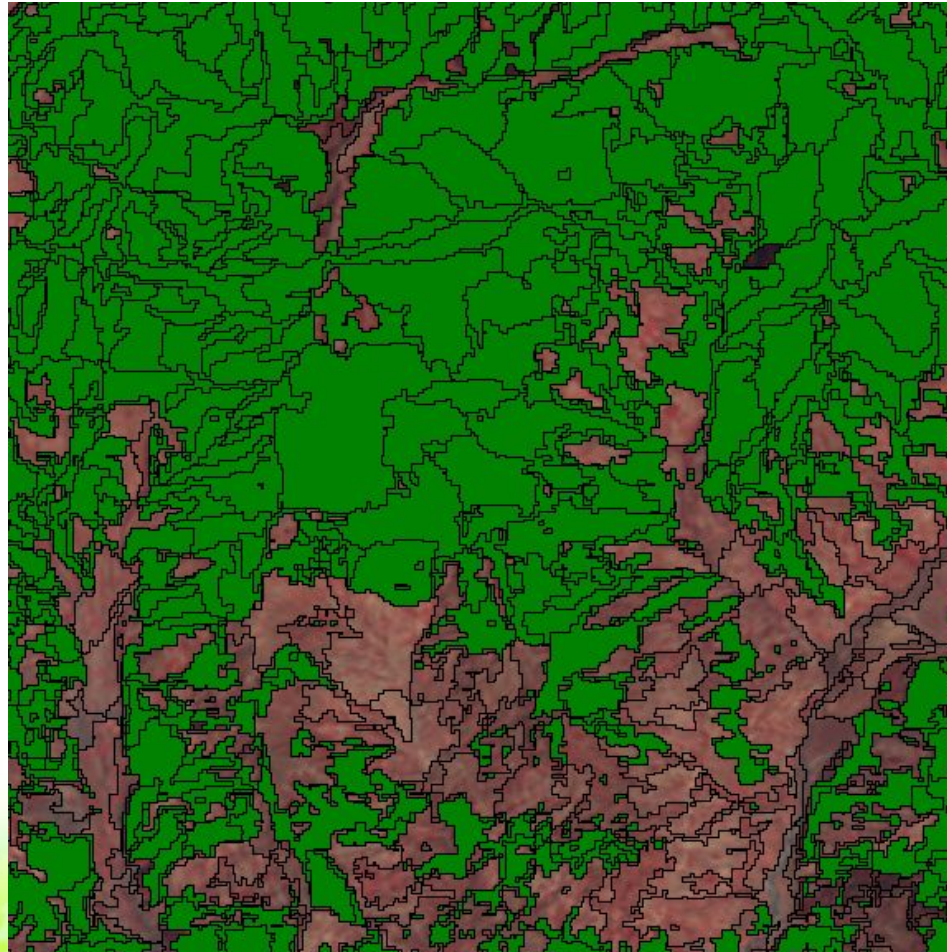
Investigation of classified land cover



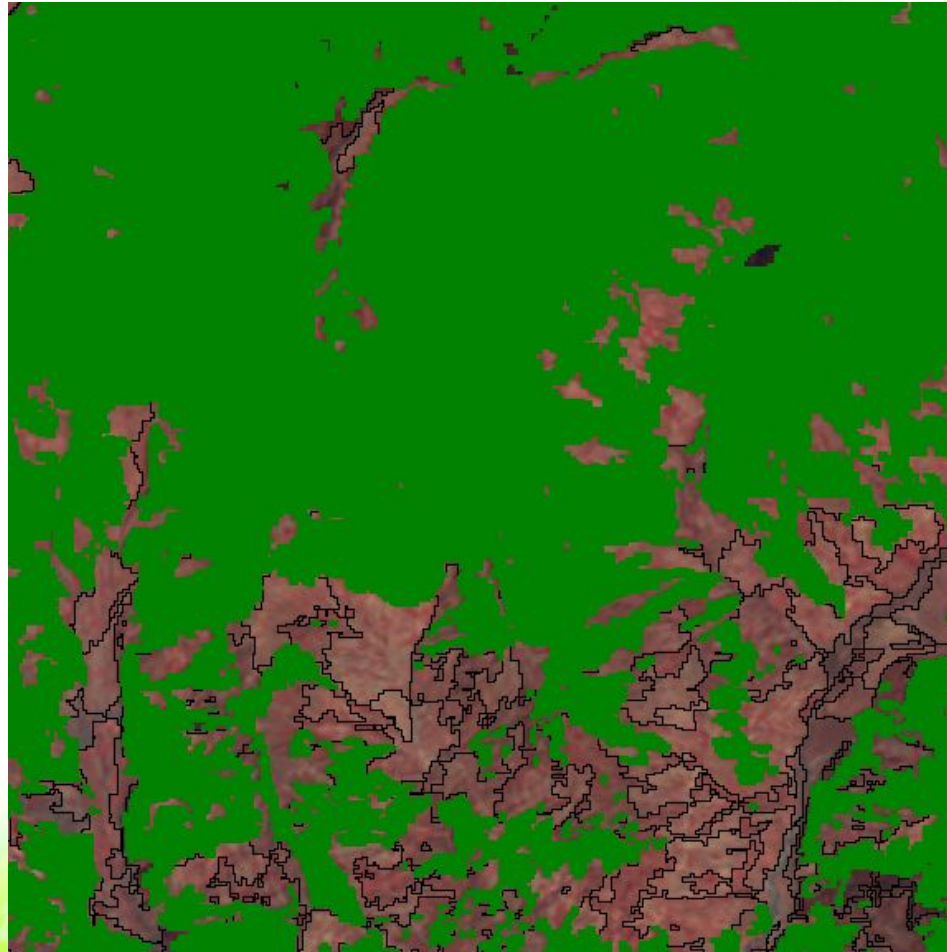
Investigation of classified land cover



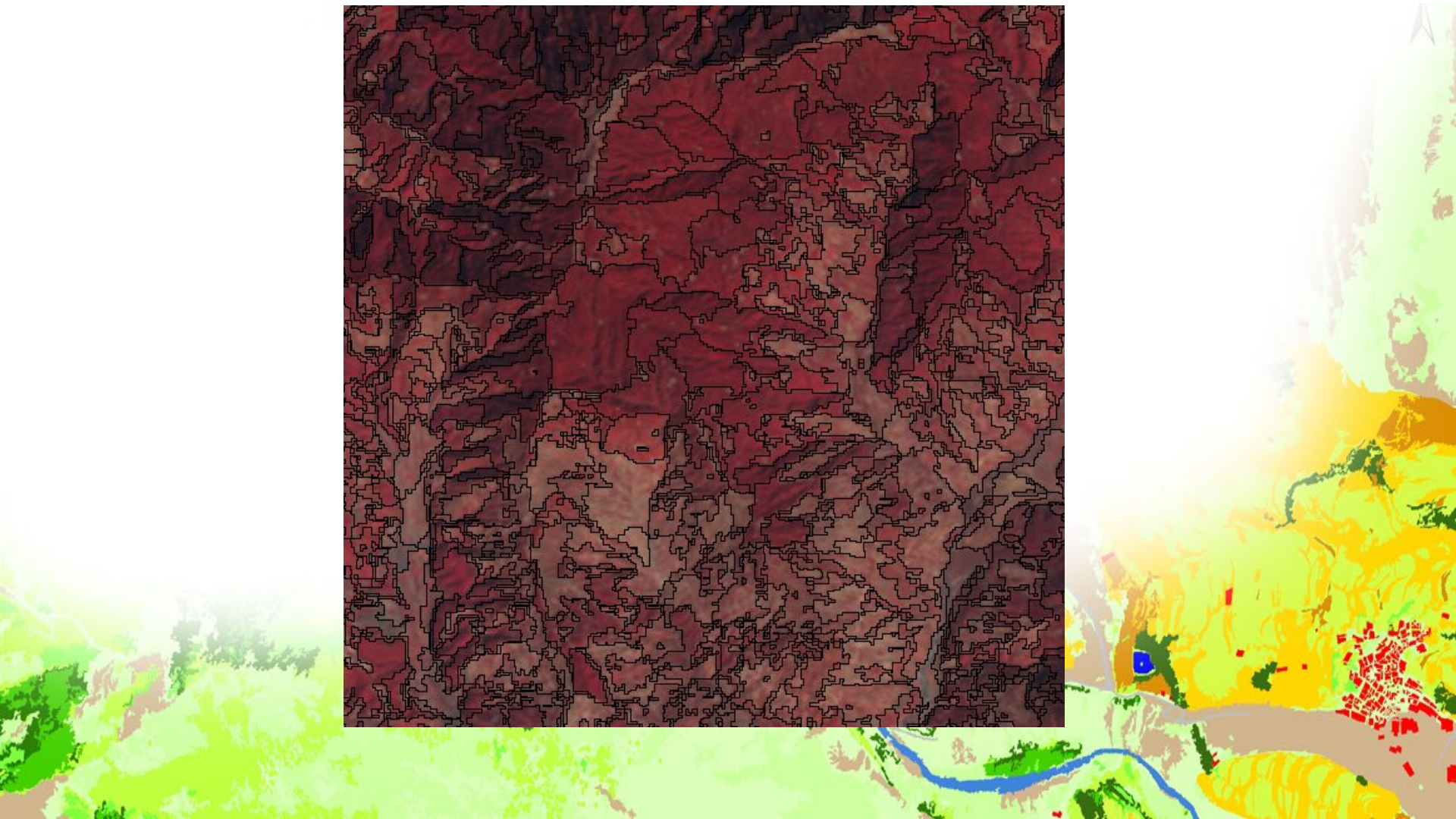
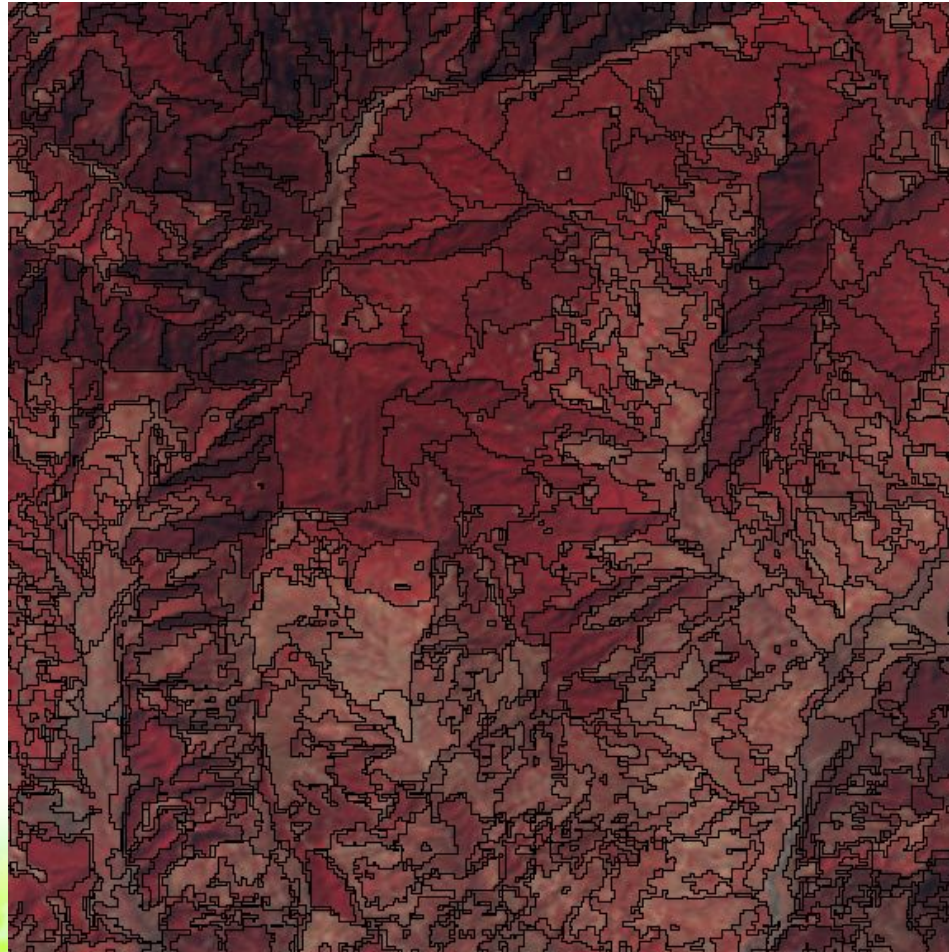
Investigation of classified land cover



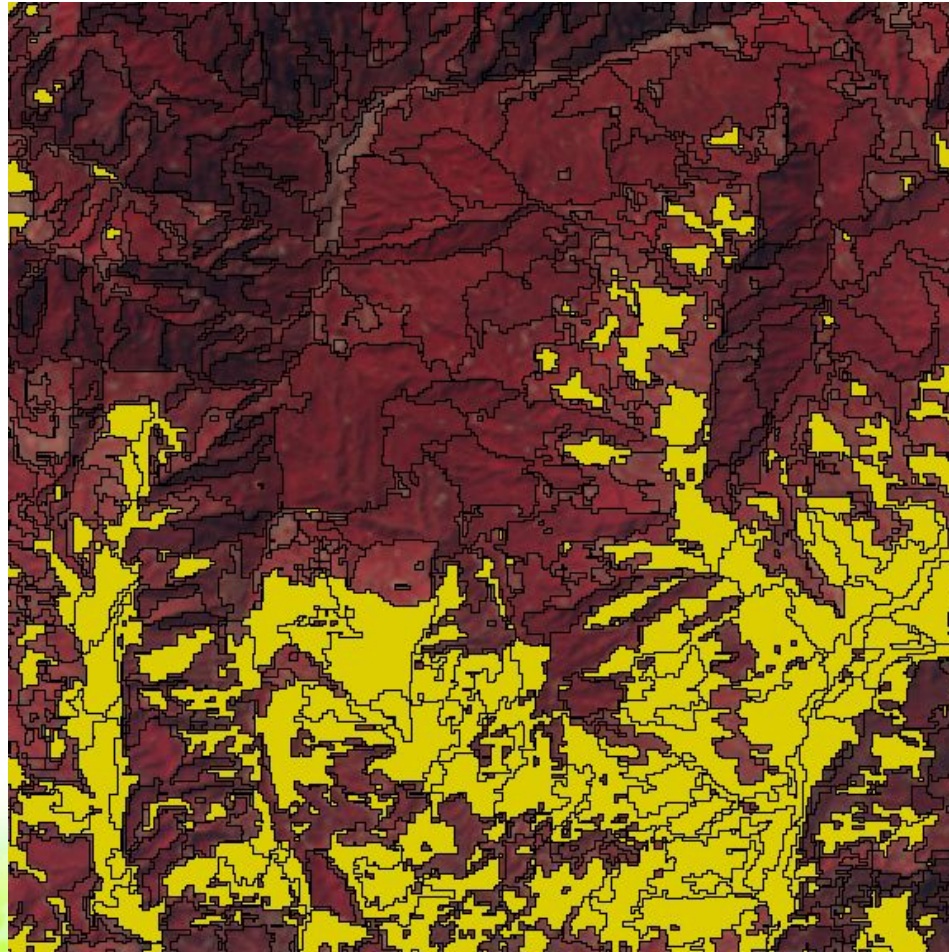
Investigation of classified land cover



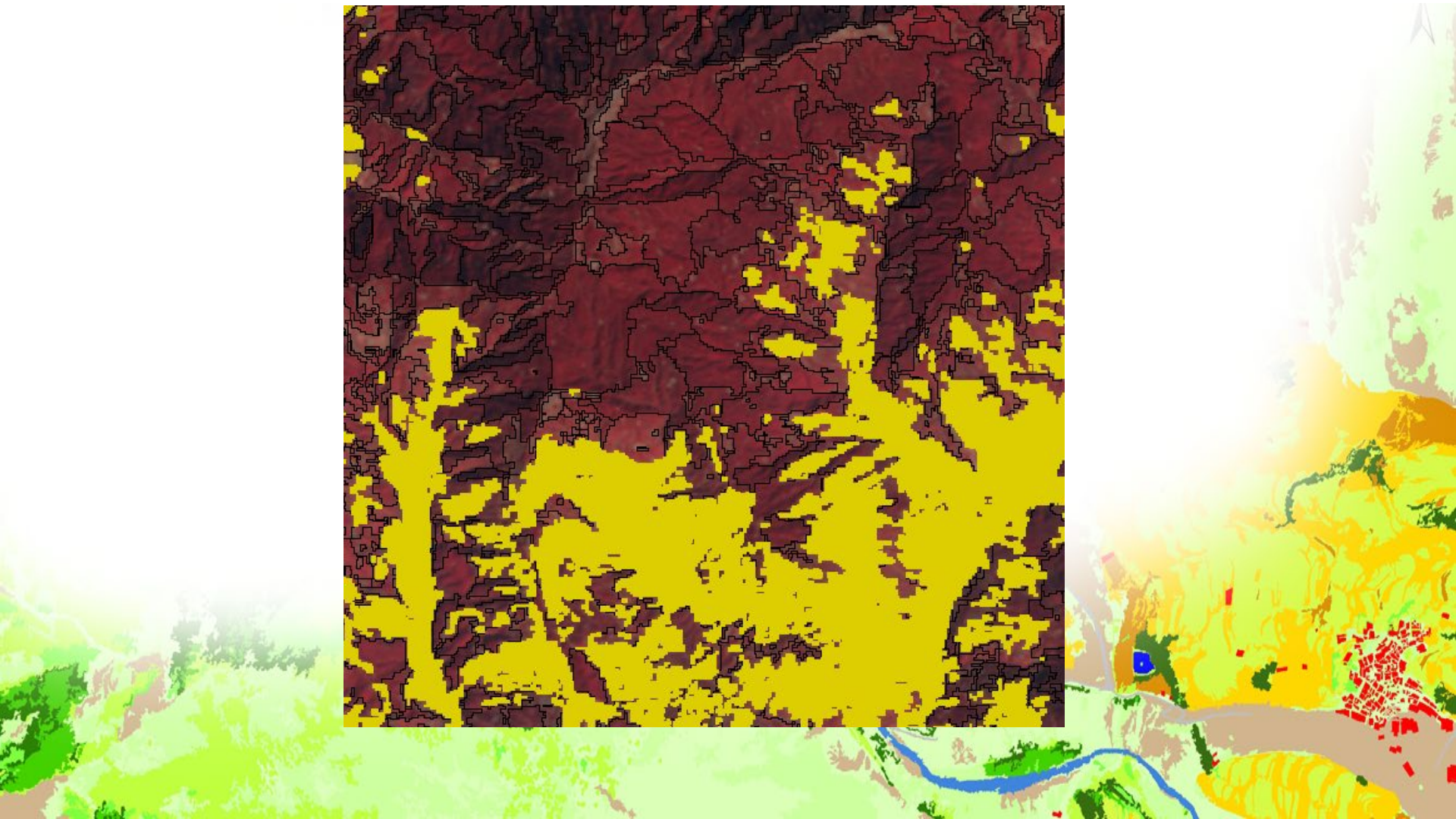
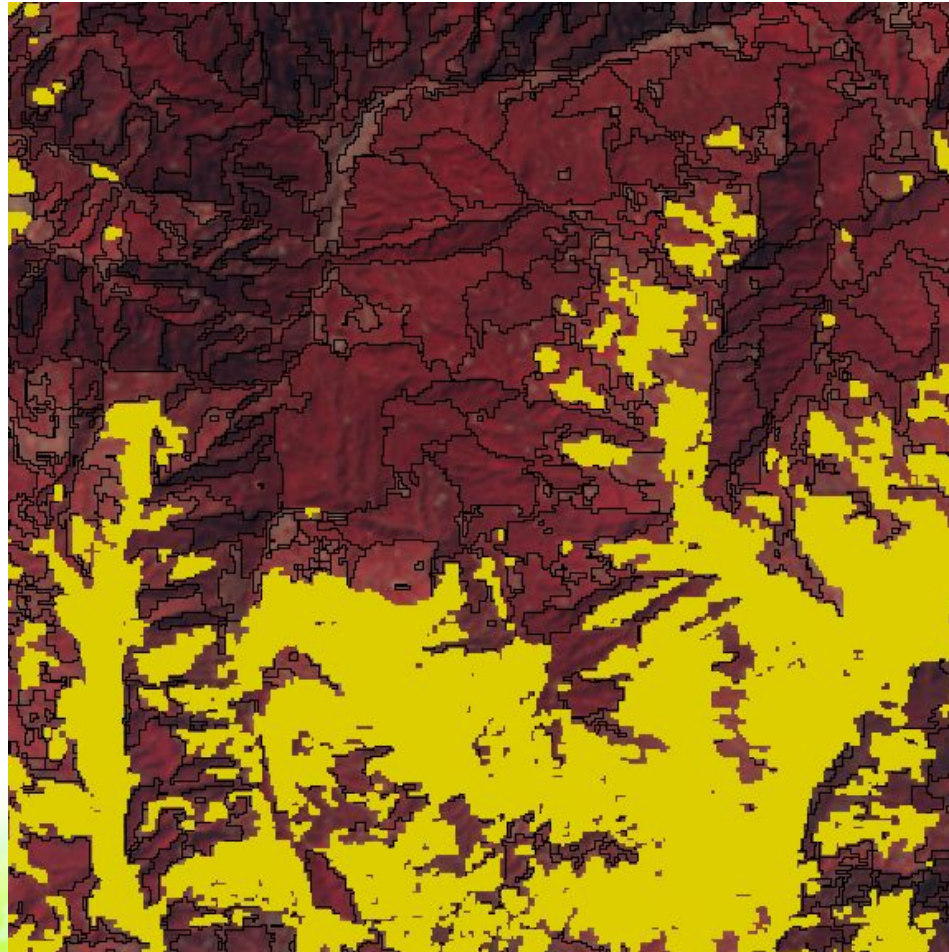
Investigation of classified land cover



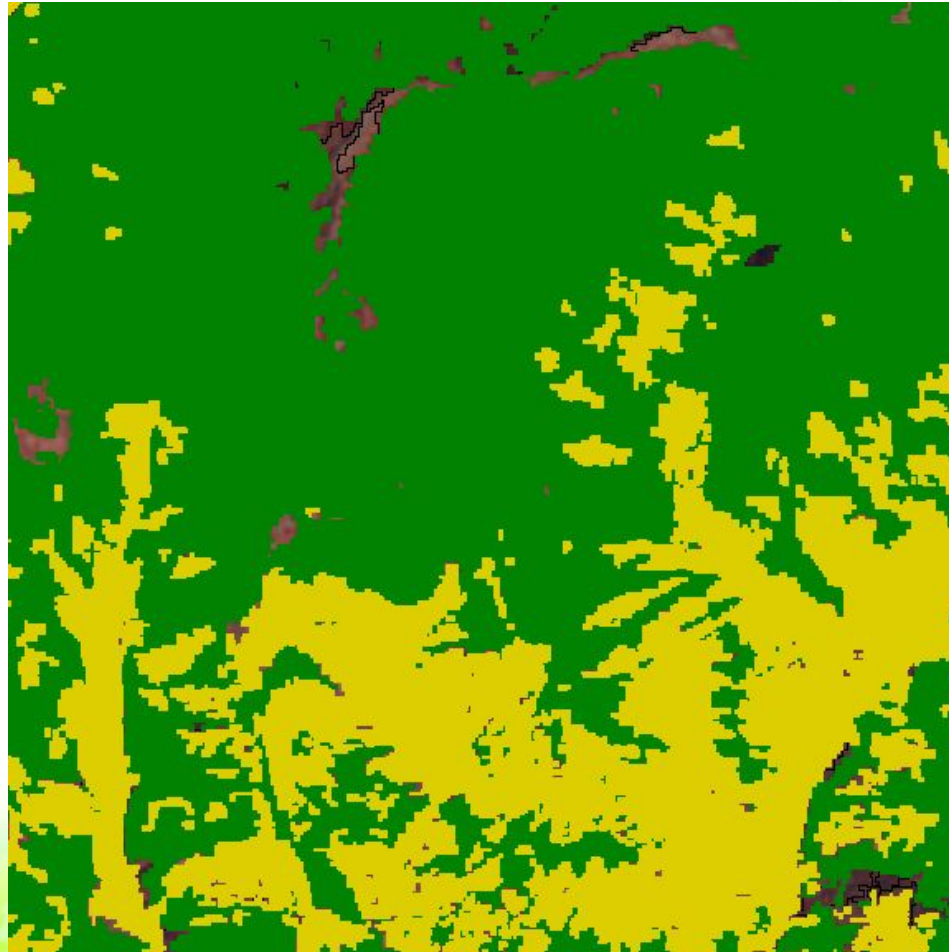
Investigation of classified land cover



Investigation of classified land cover

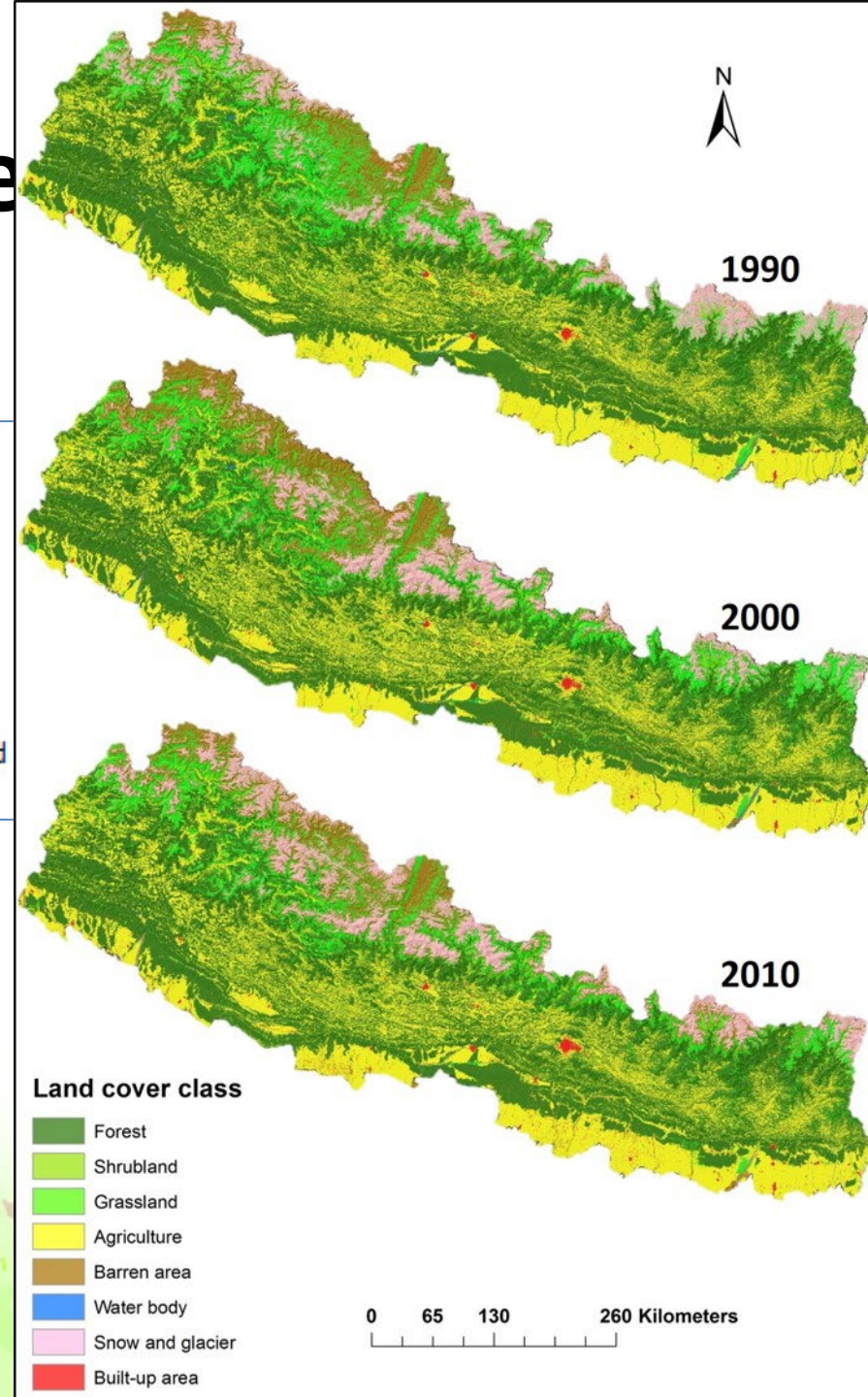


Investigation of classified land cover



Rule

- Built Up Area
 - ← unclassified with $NDVI \leq 0.408$ at Level-1: Built Up Area
 - ← Built Up Area with Brightness ≤ 280 at Level-1: unclassified
 - ← Built Up Area with Brightness ≥ 460 at Level-1: unclassified
 - ← Built Up Area with Mean B1_Green ≤ 50 at Level-1: unclassified
 - ← Built Up Area with Mean B2_Red ≤ 40 at Level-1: unclassified
 - ← Built Up Area with Mean Hue ≤ 30 at Level-1: unclassified
 - ← Built Up Area with Mean B3_NIR ≥ 200 at Level-1: unclassified
 - ← Built Up Area with Max. pixel value B1_Green ≤ 72 at Level-1: unclassified
 - ← Built Up Area with Mean DEM ≥ 2000 at Level-1: unclassified



Land cover of Nepal

Land cover class																		
Forest	1,900	1,705	1,744	19,468	18,097	17,987	26,282	23,608	24,170	14,285	13,682	13,968	4,764	4,390	4,170	63,048	61,482	62,039
Agriculture	39	46	24	3,800	4,655	4,693	15,378	17,898	17,238	3,660	3,832	4,045	14,661	14,576	14,380	40,145	41,007	40,380
Grassland	11,836	10,798	971	3,660	4,108	1,540	722	862	481	285	386	88	785	592	350	17,336	16,746	3,430
Shrubland	934	918	9,600	1,577	1,592	4,098	549	598	950	74	163	245	150	195	520	3,467	3,466	15,413
Barren area	8,660	11,740	10,174	191	310	408	233	185	272	335	605	295	646	1,214	1,447	10,855	14,054	12,596
Built-up area	0	0	1	1	1	3	151	192	241	55	59	73	122	171	226	423	423	544
Waterbody	67	54	68	71	68	65	188	160	151	192	159	172	294	284	329	741	725	785
Snow and glacier	11,039	9,214	11,893	127	64	101										11,166	9,278	11,994
Total	34,475			28,895			43,503			18,886			21,422			147,181		



Quality assurance of land cover map

Most common questions from the remote sensing expert about land cover



What is the accuracy of land cover

Have you done land cover validation



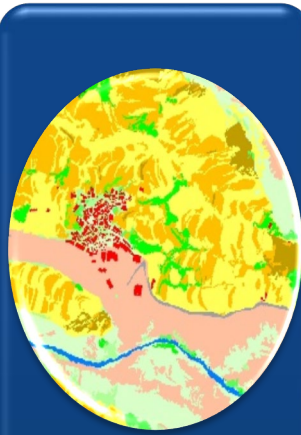
Quality assurance of land cover map



Selection of
quality TM
image



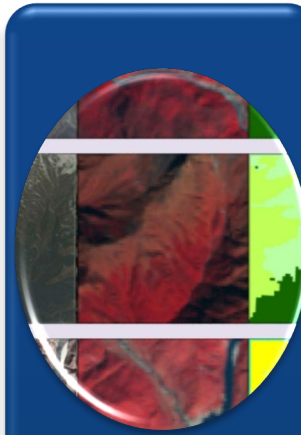
Quality of
image
objects



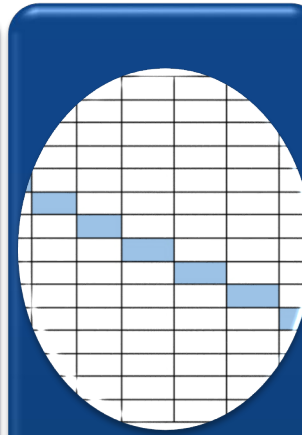
Investigation
of classified
land cover



Feedback
from the
experts



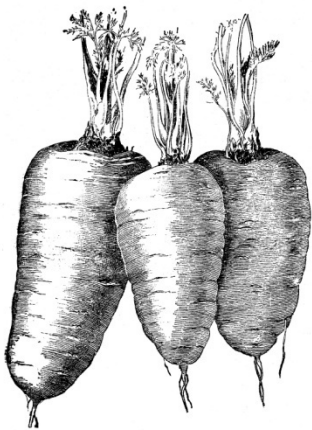
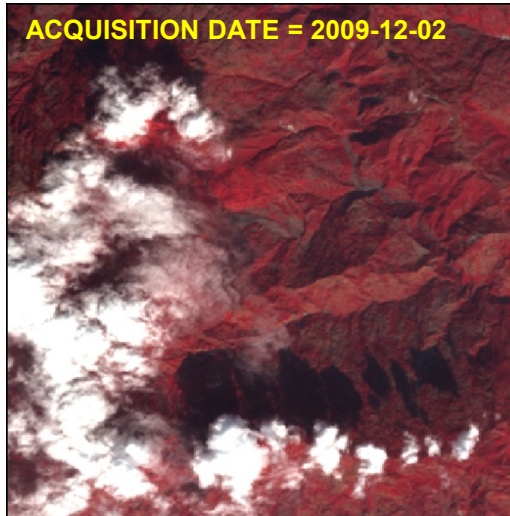
Verification
with Google
image

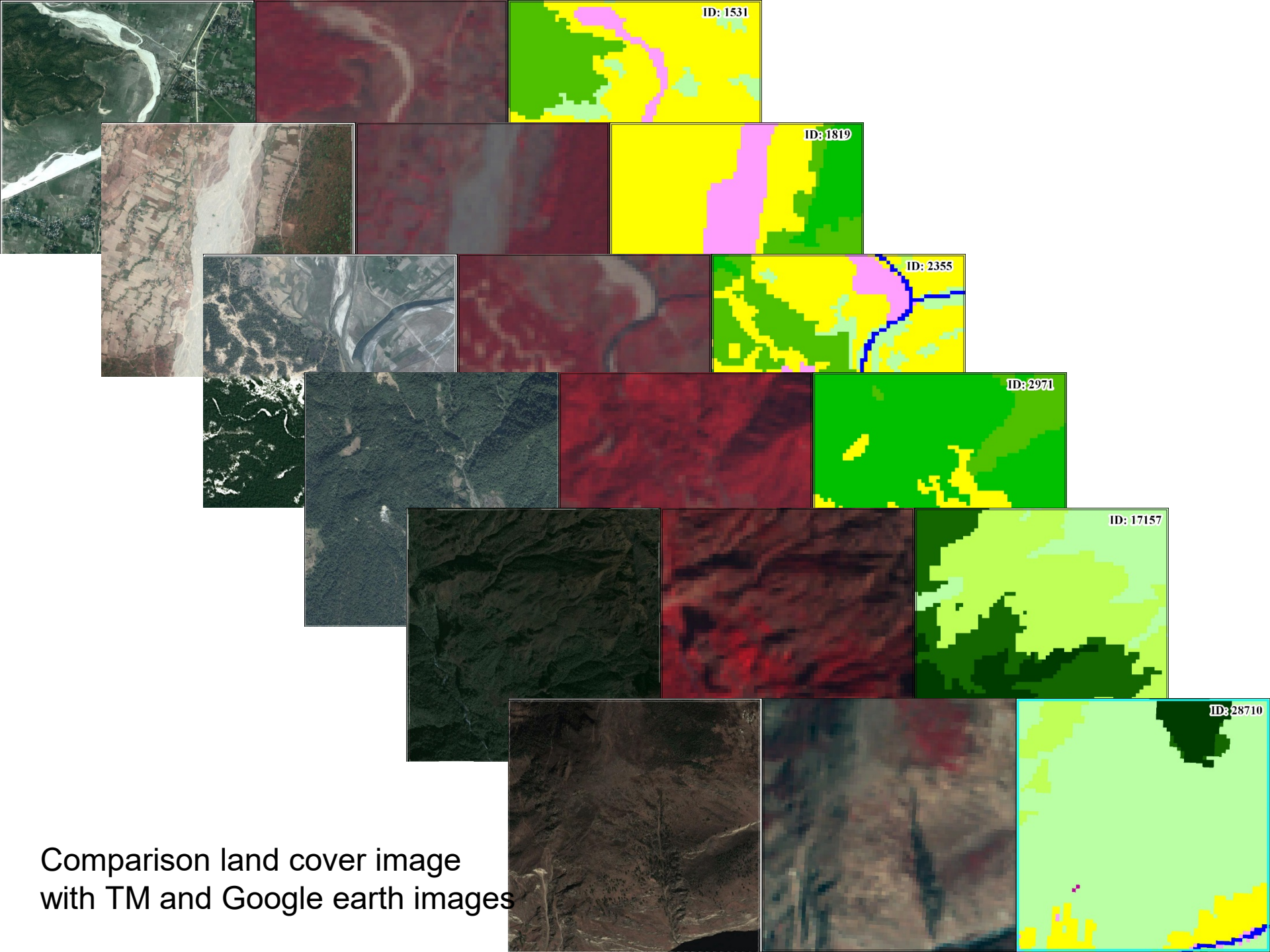


Accuracy of
Land cover
assessment



Selection of quality TM image





Comparison land cover image
with TM and Google earth images

Validation of developed land cover



Accuracy assessments determine the quality of the information derived from remotely sensed data. In this study, after land cover classification, a systematic 15 x 15 minute grid is used. Misclassified land cover is identified and overlaid on false colour composite Landsat imagery (1990, 2000 & 2010) along with high resolution satellite imagery by utilization of online Google Earth.





Accuracy assessment report of Nepal Land cover

Class	Forest	Agriculture	Grassland	Shrubland	Barren area	Built-up area	Water body	Snow and glacier	Total	User's Accuracy (%)
Forest	132	5	1						138	96
Agriculture	18	130	2	1			1		152	86
Grassland	4	2	28		2				36	78
Shrubland	3	3	2	6		1			15	40
Barren area	1		4		33			3	41	80
Built-up area		1				8			9	89
Water body		1			1		13	1	16	81
Snow and glacier			3					40	43	93
Total	158	142	40	7	36	9	14	44	450	
Producer's Accuracy (%)	84	92	70	86	92	89	93	91		

Total number of samples	450
No. of accurate samples	390
Overall Accuracy (%)	86.67



Accuracy assessment report of Nepal Land cover

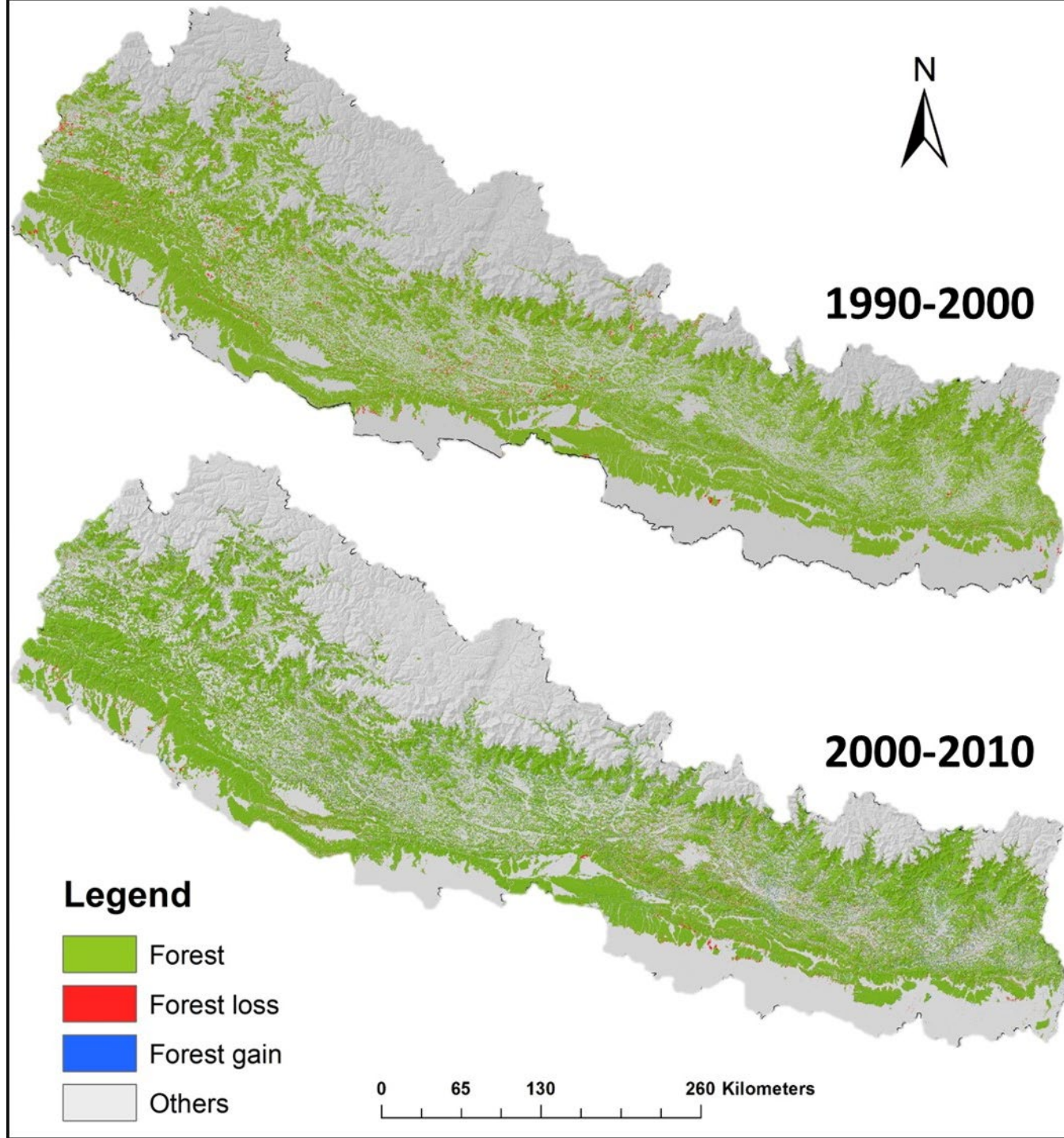
	Forest	Agriculture	Grassland	Shrubland	Barren area	Built-up area	Water body	Snow and glacier	Total	User's Accuracy (%)
Forest	231	15	2						248	93
Agriculture	45	250	3	1	4	1			304	82
Grassland	5	1	42						48	88
Shrubland	3	3		15					21	71
Barren area	1	1			32		1	1	36	89
Built-up area		7				13			20	65
Water body		2	1		4		15	1	23	65
Snow and glacier			1		1		2	46	50	92
Total	285	279	49	16	41	14	18	48	750	
Producer's Accuracy (%)	81	90	86	94	78	93	83	96		

Total number of samples	750
No. of accurate samples	644
Overall Accuracy (%)	85.87



Accuracy assessment report of Nepal Land cover

The accuracy assessment of forest change is conducted for four major strata: forest loss, forest gain, stable forest and stable non forest - out of which assessment of two strata forest loss and gain done. The accuracy assessment of forest loss and gain greater than 5 ha patches (2000 to 2010) assessed by using Google Earth' high resolution satellite imagery as primary source of reference data. Forest loss, Forest gain, Stable forest and Stable non forest. Due to unavailability of year 2000 high resolution satellite imager over Google Earth, from January 2000 and March 2003 time span taken as a baseline period.

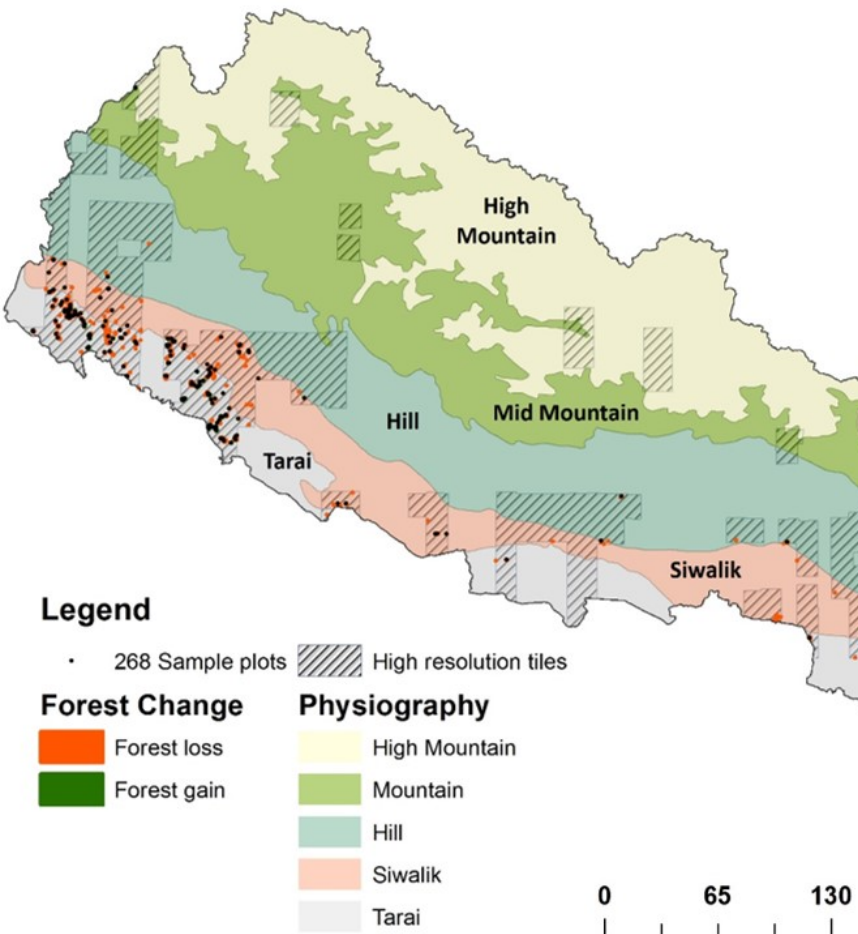




Accuracy assessment report of Nepal Land cover

Altogether 268 (202 forest loss and 66 forest gain) sample points within the tile area was distributed based on stratified random sampling method.

Tarai: 70%, Hill 25%, Mountain: 5%

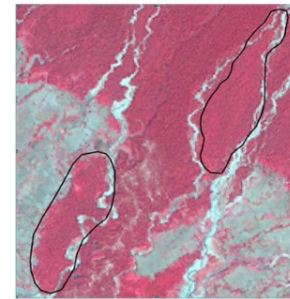


2000

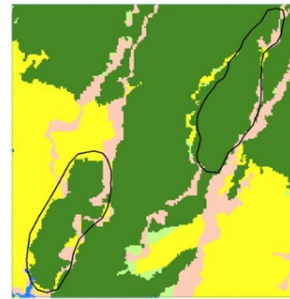
Google Earth



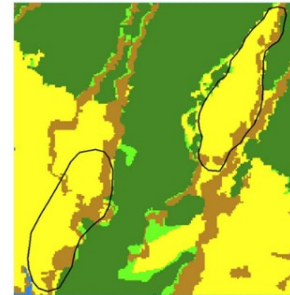
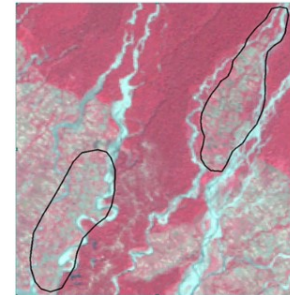
Landsat TM



Classified



2010

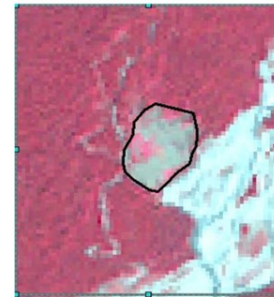


2000

Google Earth



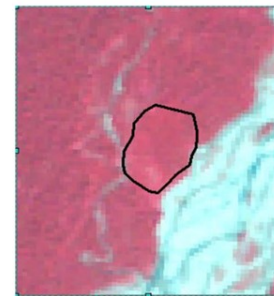
Landsat TM



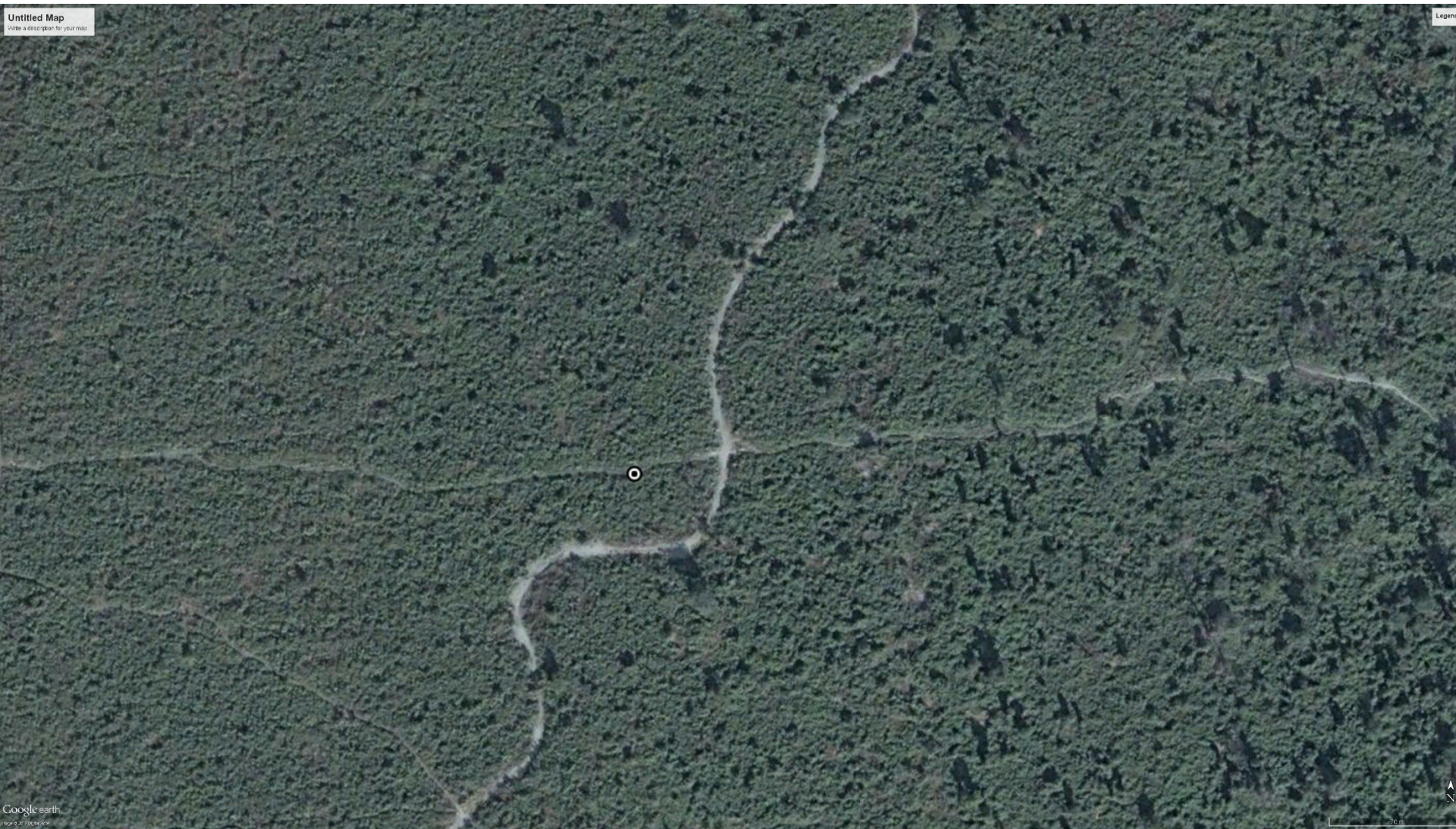
Classified



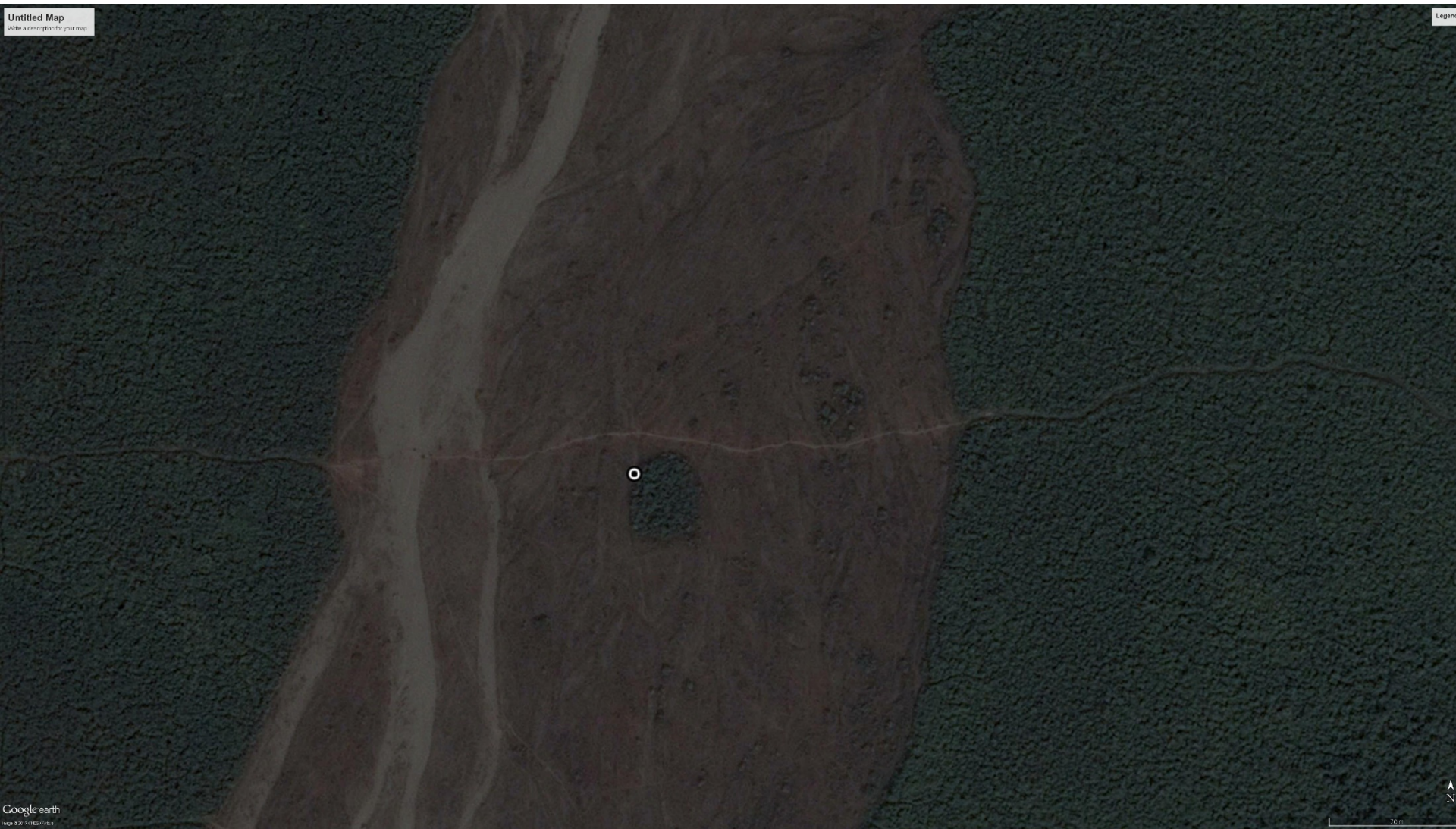
2010



Nepal land cover of 1990, 2000, and 2010



Nepal land cover of 1990, 2000, and 2010



Nepal land cover of 1990, 2000, and 2010



Nepal land cover of 1990, 2000, and 2010



Nepal land cover of 1990, 2000, and 2010

2003



Nepal land cover of 1990, 2000, and 2010

2017



Thank You

