

TRAINING REPORT



Training on Satellite Land Monitoring System (SLMS)

Organized by

National REDD+ Office,
Ministry of Climate Change,
Pakistan

13-15 March | **2018** | Islamabad

Introduction & Background

The Ministry of Climate Change is implementing REDD+ Readiness Preparation Proposal (R-PP) under the Readiness Fund of the Forest Carbon Partnership Facility of the World Bank. The project, under component 3.2 of the grant agreement, intends to build capacities of the relevant institutions, through **Training of Trainers** (TOTs), for building institutional capacities in implementing National and Sub-National Forest Monitoring Systems under REDD+.

In September 2017, National REDD+ Office sent a team of officers from provinces to Joensuu-Finland for getting training on latest tools and techniques of forest monitoring in the Satellite Land Monitoring System (SLMS) for REDD+. The trainees came back as master trainers of SLMS in Pakistan and facilitated a national level training conducted by National REDD+ Office at Pakistan Forest Institute, Peshawar Pakistan in November 2017. An international resource person from Arbonaut Oy was the lead trainer in that training.

Recently, National REDD+ Office has conducted another Training of Trainers (TOTs) on SLMS from 13-15 March 2018 at Grand Regency Hotel, Islamabad, in which the trainees of previous trainings were used as master trainers without using any international expert. This short training was aimed to address the core process in application of desktop based processing and analysis platform for land use and land use change assessment required for generating Activity Data (Forest / Land Cover Change Assessment) for REDD+.

Objectives

SLMS is one of the three pillars of Measurement, Reporting and Verification (MRV) as required by UNFCCC and is vital in establishing the National Forest Monitoring System (NFMS) for REDD+. The objectives of this training were:

1. To introduce the advanced tools and techniques of forest monitoring in SLMS, to the REDD+ stakeholders, including technical staff from Provincial Forest Departments and other relevant institutions of Pakistan
2. To build the capacities on Free and Open Source Software's (FOSS) for satellite land monitoring following the guidelines of Intergovernmental Panel on Climate Change (IPCC)
3. To exercise the methodology developed by international experts for operationalizing SLMS in Pakistan at National and Provincial levels

Training Participants and Agenda

25 individuals representing each provincial forest department, Survey of Pakistan, National Agriculture Research Centre, The Urban Unit (Punjab), Global Change Impact Studies Centre,

Space and Upper Atmospheric Research Commission (SUPARCO) and students conducting research under National REDD+ Internship Program from Institute of Geographical Information System, NUST, Institute of Space Technology and Department of Geo-information, Arid University, attended the 3 days' training and hands on sessions.

National Resource persons / Master Trainers from Pakistan included: a). Muhammad Afrasiyab, GIS / MRV Expert of the National REDD+ Office Pakistan, b). Mrs. Aqeela Mobeen, Punjab Forest Department and c). Mr. Atif Shahzad, GIS Manager at SUPARCO. Mrs. Aqeela Mobeen and Muhammad Afrasiyab had attended the Training of Master Trainers in Finland, whereas, Mr. Atif Shahzad got trained in second ToT on SLMS at Pakistan Forest Institute. The profile of the master trainers along with the content of the training covered by each have been attached as Annex-A. A three days attendance of the participants is also attached as Annex-B.

Proceedings of the Training

The training started with the recitation of verses from the Holy Quran by Mr. Mofassar Hussain Gilani, DFO, AJK, followed by a formal round of introductions.

Dr. Ghulam Akbar, National REDD+ Coordinator of the Ministry of Climate Change formally welcomed the participants and advised the participants to take extra interest in the latest tools and techniques of forest monitoring and shown firm commitment to conduct this training at every provinces and district of Pakistan for capacity building of the provincial forest departments in assessing forestry resources using latest techniques and international standards. With these remarks the technical session of the training was started with the first presentation of the day.

Introduction to the training modules and FOSS

By Muhammad Afrasiyab

The lecture gave the participants an overview of the Satellite Land Monitoring System in the context of Measurement Reporting and Verification System and international requirements for REDD+. Satellite Land Monitoring System (SLMS) integrates remote sensing method to assess activity data related to land use/land use change and forest degradation processes over large areas. SLMS is one of the three functions of Monitoring, Reporting and Verification (MRV) to continuously monitoring land by establishing National Forest Monitoring System (NFMS).

A brief overview of the training modules and objectives were described. The content of the SLMS training has been designed in six modules as under:

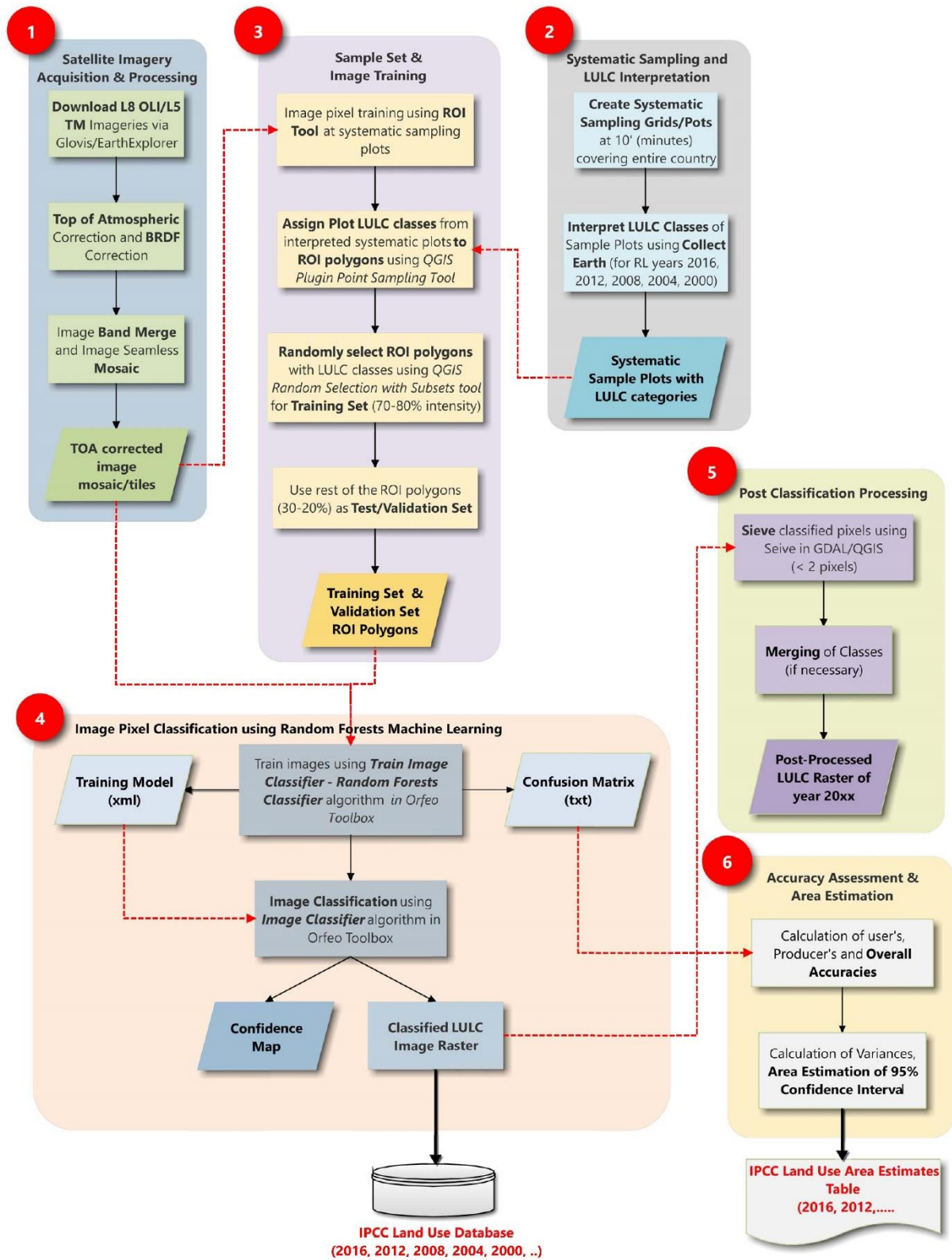


Figure 1 Detailed flowchart of the processes in SLMS

The modules cover a desktop based processing approach uses various FOSS tools to process, analyze and report remote sensing based spatial data products especially land use, land use changes and degradation. Afrasiyab also provided an overview of the following FOSS tools to be used for various processes in the six modules as shown in figure 1.

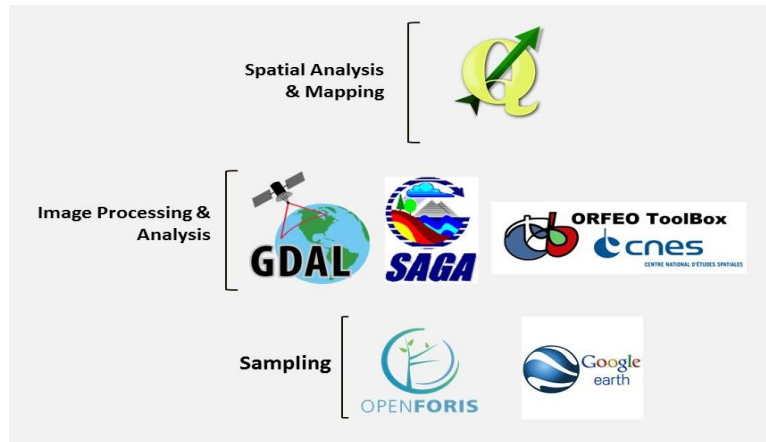


Figure 2. SLMS Open Source Desktop Tools

Participants were provided (easy to follow) manuals designed for the SLMS training along with data sets and software's in USB (The data and software's can easily be downloaded from internet).

Exercise 1: Satellite Imagery Acquisition and Processing

By Mr. Atif Shahzad and Mrs. Aqeela Mobeen

A lecture was delivered by Mr. Atif Shahzad to explain the step by step process in acquisition and preprocessing of free satellite data from various sources as under:

- USGS Glovis (<https://glovis.usgs.gov/next/#>)
- EarthExplorer (<https://earthexplorer.usgs.gov/>)
- USGS Landsat Look (<https://landsatlook.usgs.gov/viewer.html>)
- EOS Land Viewer (<https://lv.eosda.com>)

As an example three Landsat scenes of row / path 149-37, 149-36 and 150-36 of year 2016 were used during the exercise. A Level-1 Geo-TIFF Data Product of one Landsat scene is available in TAR format. This file needs to be unzipped twice to extract all the 11 bands, quality assessment raster and the metadata MTL file as shown in figure 3.

Name	Size	Packed Size	Modified	Mode	User
LC81500362016298LGN00_B1.TIF	123 486 018	123 486 208	2016-11-04 15:54	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B2.TIF	123 486 018	123 486 208	2016-11-04 15:54	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B3.TIF	123 486 018	123 486 208	2016-11-04 15:54	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B4.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B5.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B6.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B7.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B8.TIF	493 753 278	493 753 344	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B9.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B10.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_B11.TIF	123 486 018	123 486 208	2016-11-04 15:55	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_BQA.TIF	123 486 018	123 486 208	2016-11-04 15:56	0rw-rw-r--	gestalt-batch
LC81500362016298LGN00_MTL.txt	7 896	8 192	2016-11-04 15:56	0rw-rw-r--	gestalt-batch

Figure 3. Dataset in Landsat 8(OLI) image scene 150-36

Exercise on Satellite Image Preprocessing was led by Mrs. Aqeela Mobeen. Atmospheric correction is done to remove haze and other anomalies using Dark Object Subtraction (DOS) method and convert Surface Radiance to Top of Atmosphere (TOA) Reflectance in each image pixel. This process, however, do not remove the effects of terrain illuminations and shadows in the higher elevation regions. Bidirectional Reflectance Distribution Function (BRDF) corrections is applied to minimize/remove the effects of terrain on the pixels.

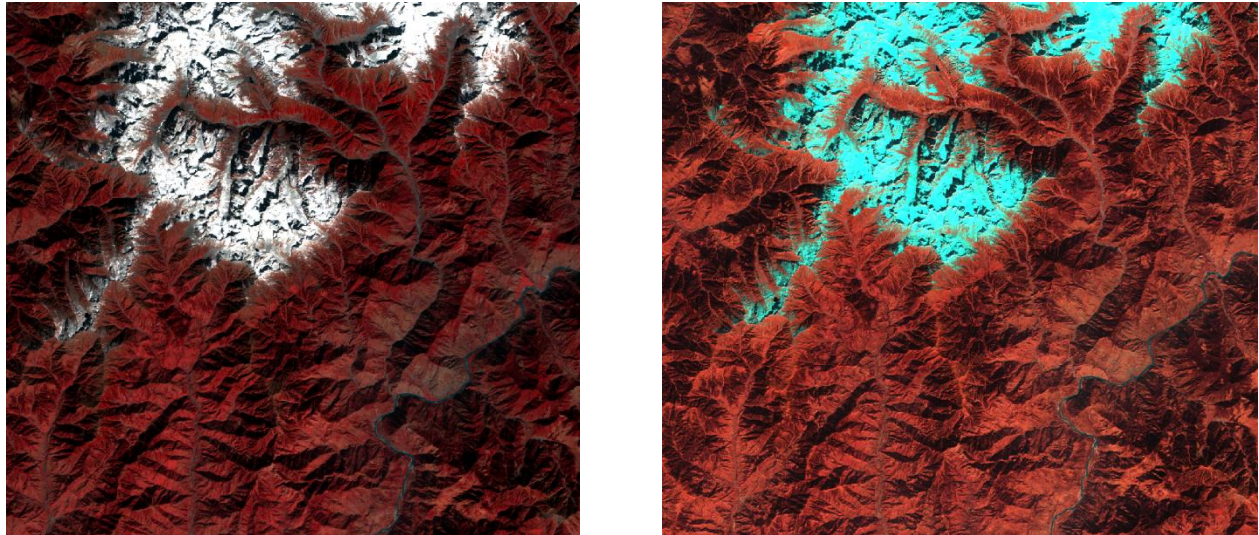


Figure 4 Landsat-8 scene (a) before topographic correction (b) after topographic correction

Exercise 2: Systematic Sampling and Landuse / Landcover Interpretation

By Muhammad Afrasiyab and Mrs. Aqeela Mobeen

In the lecture followed by exercise Muhammad Afrasiyab explained Systematic sampling grids generated for first phase (Phase I) sampling for IPCC Land Use classes to be used for preliminary wall-to-wall land use map preparation and forest inventory design. The systematic grids and the sample plots are created using Open Data and Open Source Tools and is a part of desktop based Satellite Land Monitoring System (SLMS) workflow.

The trainees learned, during the exercise, how to create systematic sampling grids / plots at 10 x 10 min, 5x5 min and 2.5 x 2.5 min intervals. For demonstration a 2.5 x 2.5 min sample design was created for Azad Jammu and Kashmir by each. Later on, the terrain parameters of aspect, slope and elevation were added to each of the plot using Digital elevation model (DEM) 30 m from SRTM.

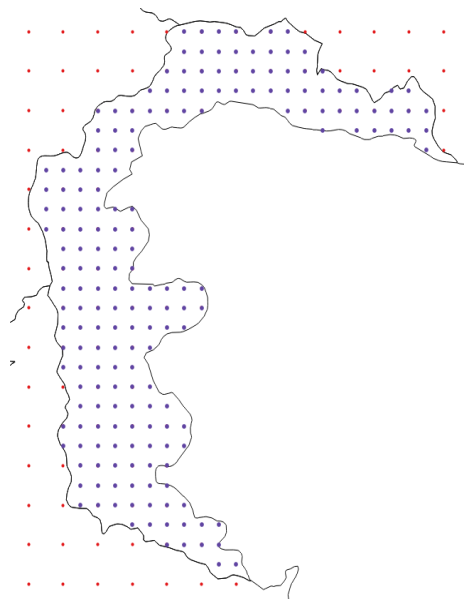


Figure 5. 2.5 x 2.5 min sample grid for AJ&K

Mrs. Aqeela Mobeen demonstrated how the Systematic sampling grids generated in the previous process can be visually interpreted for IPCC Land Use Classes (Forest, Cropland, Grassland, Wetland, Settlement, Other land) using very high-resolution Google Earth imageries using customized OpenForis Collect Graphical User Interface (GUI) data collection form. Basic IPCC defined Land use classes with various other parameters for Forest (canopy cover, disturbances etc.) were collected for two reference periods 2016 and 2012 in this exercise. These visually interpreted plots were also used as training sets for image classification.

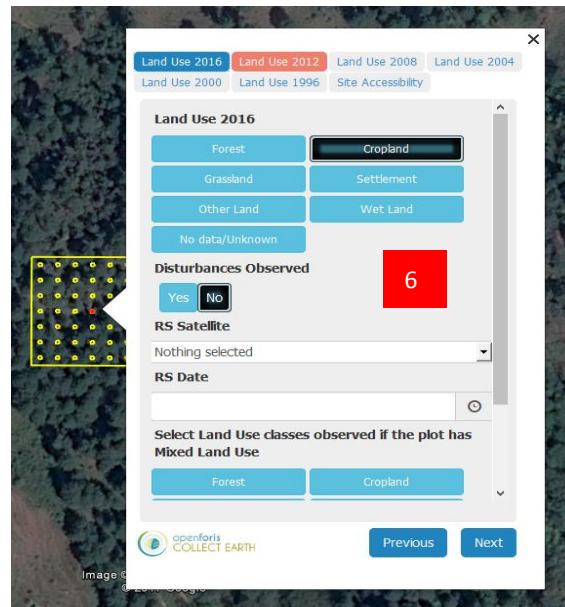


Figure 6 Visual interpretation of LU/LC using collect earth

Collect Earth (<http://www.openforis.org/tools/collect-earth/>) is a tool that enables data collection through Google Earth. In conjunction with Google Earth, Bing Maps and Google Earth Engine, users can analyze high and very high resolution satellite imagery for a wide variety of purposes, including:

- Support multi-phase National Forest Inventories
- Land Use, Land Use Change and Forestry (LULUCF) assessments
- Monitoring agricultural land and urban areas
- Validation of existing maps
- Collection of spatially explicit socio-economic data
- Quantifying deforestation, reforestation and desertification

Its user friendliness and smooth learning curve make it a perfect tool for performing fast, accurate and cost-effective assessments. It is highly customizable for the specific data collection needs and methodologies.

Exercise 3: Creating Training and Validation Data Set for Image Classification

By Mrs. Aqeela Mobeen and Mr. Atif Shahzad

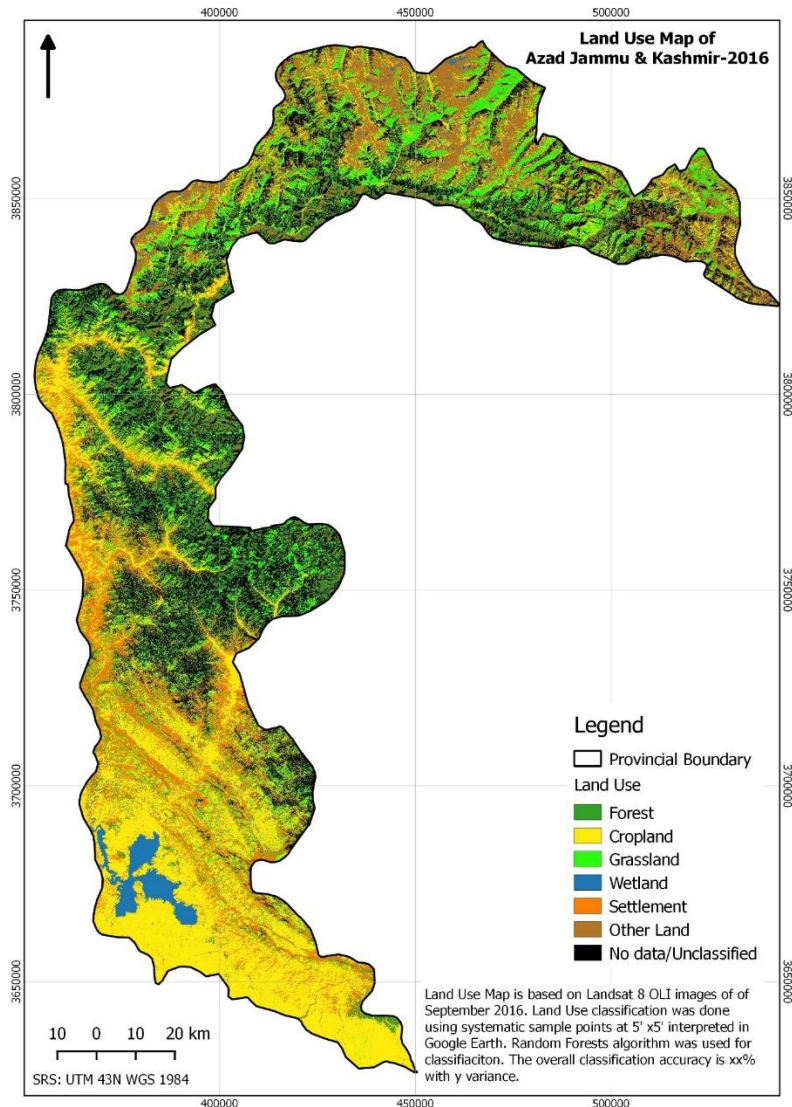
During this session the participants were taught how to create training and validating sets. Visually interpreted points with land use classes from previous exercise were used as 'seeds' for generating ROI sample sets to develop training and validation subsets. The training sets were used for training image pixels for Random Forests classification. The validation sets were later on used in exercise 5 for independent check of the accuracy and subsequent area estimation.

Exercise 4: Image Classification Using Random Forests

By Mr. Atif Shahzad and Mrs. Aqeela Mobeen

Random Forests (RF) is a classification and regression algorithm used in machine learning and is increasingly being used to satellite image classification for creation of continuous field data such as percent tree cover, biomass, land cover etc. Random Forests is a non-parametric regression model capable of using continuous and categorical data and is easy to parametrize, is non-sensitive to over fitting, can handle outliers in training data and also calculates ancillary information such as classification error and variable importance.

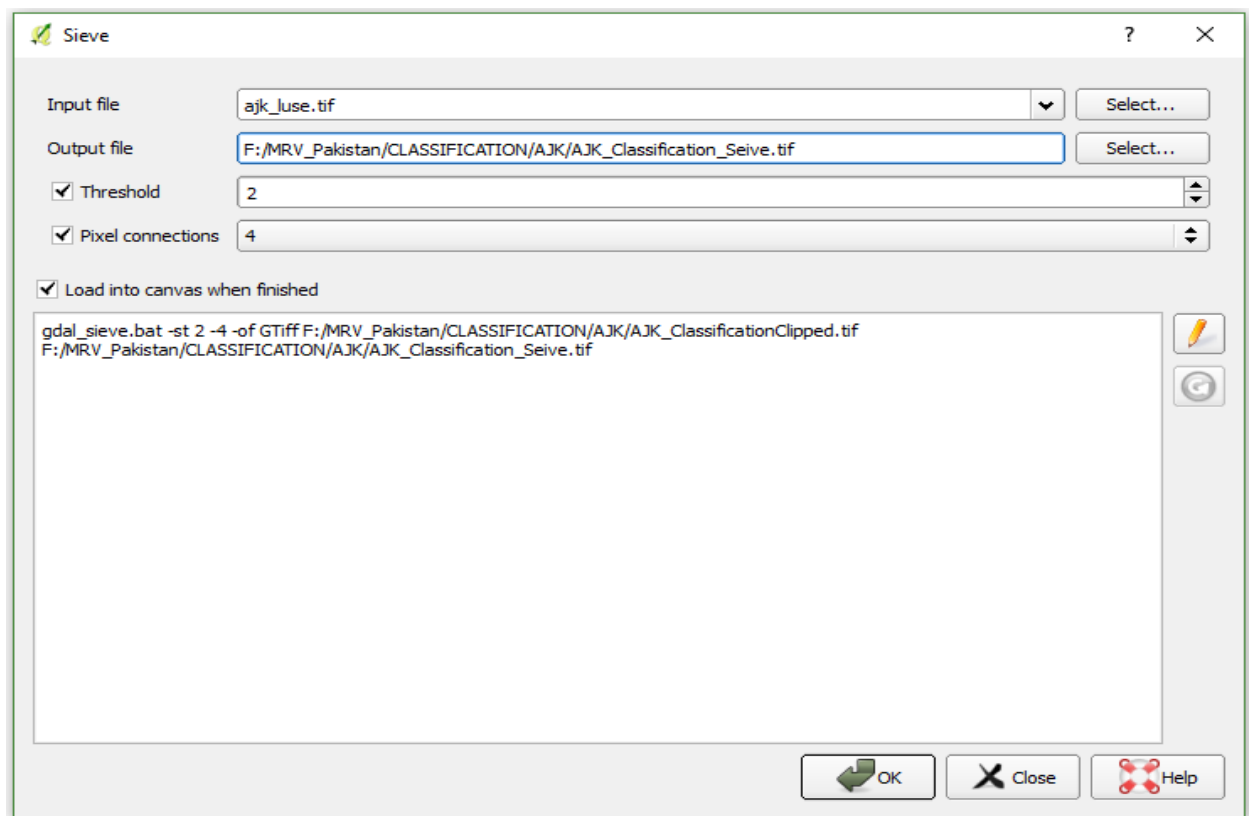
Random forest classification was applied for land cover mapping of AJ&K using training data from exercise 3. Participants were introduced the Orfeo Toolbox which is an open source GIS software for remote sensing analysis. Orfeo Tool Box can also be used within QGIS Interface from Processing Toolbox geo-algorithm.



Exercise 5: Post Classification Processing

By Mrs. Aqeela Mobeen

A short exercise was conducted the resource person to demonstrate how post classification processing is done. Post classification processing is used to remove noises such as salt and pepper” effects of individual classified pixels. These classified pixels need to be removed if you are confident that these happen to be due to classification errors. This was done by “sieving” isolated pixels and replacing them with the classification of surrounding majority class pixels.



Exercise 6: Accuracy Assessment and Area Estimation

By Mr. Afrasiyab

Accuracy assessment of LULC map classes and areas estimation of LULC classes was done using the sample of reference observations of the study area. The basic idea here is the assumption that the mapped areas of land cover (or change in land cover) are biased because of image classification errors, which are identified by comparing the map to a sample of reference observations. Area estimates and accuracy are then inferred by analyzing the sample. This can be done following the process prescribed by FAO which includes three main steps:

1. design and selection of sample (as described in Exercise 2A)
2. response design: interpretation of sample and decision of agreement of reference and map observations; (as described in Exercise 2B)
3. analysis of sample

Results of the accuracy assessment by generating an error matrix was discussed among the participants.

LULC	Forest	Cropland	Grassland	Wetland	Settlement	Other Land	n_i	$A_{m,i}$ (ha)	W_i
Forest	20		4			2	26	138,164.79	0.12570
Cropland	6	36	35	1	11	15	104	354,675.22	0.32267
Grassland	4	7	20		2	16	49	205,151.17	0.18664
Wetland				9		1	10	25,249.39	0.02297
Settlement	26	5	11	1	2	2	47	177,478.28	0.16146
Other Land	6		1		1	35	43	198,468.14	0.18056
Total	62	48	71	11	16	71	279	1,099,186.99	

Closing Remarks:

Dr. Ghulam Akbar appreciated participants for attending this training and showed his immense gratitude to the trainers with his remarks that it was a big achievement that the advanced course of the training were delivered by Local Resource persons. He also wished that these training may also be repeated at the provincial level for building further capacities.

Various participants from Provincial Forest Departments and students also expressed their satisfaction on the content with a view that after the training they can now work on their respective tasks with all the necessary resources available online. They

Syed Mahmood Nasir / Inspector General of Forests awarded certificates to the participants and trainers. He also appreciated the participants from Provincial Forest Departments, CSO and Academia for attending the training.

Pictures of Event



Pictures of Event



ANNEX-A Profile of Trainers and Agenda

Training on Satellite Land Monitoring System March 13-15th, 2018– Islamabad Training Program

Day 1 – Tuesday- 13 th March, 2018		Resources / Trainers
8:30 – 9:00	Registration	National REDD+ Office
09:00- 09:05	Recitation	
9:05 - 9:15	Welcome Remarks & introduction of participants	National REDD+ Office
9:16 – 9:30	Speech by Chief Guest (TBD)	National Project Director/ National REDD+ Coordinator
9:30 – 10:00	Introduction to the Training Modules and Objectives (lecture)	Mr. Afrasiyab, GIS/MRV Expert National REDD+ Office
10:00-10:15	Tea/ Coffee Break	
10:15 – 10:45	Satellite Imagery Acquisition and Processing (Lecture)	Mr. Atif Shehzad,
10:45-11:30	Exercise 1A- Image Exploration and downloading	Atif Shahzad+ resource persons
11:30-13:00	Preparation of data / installation of software's	All resource persons
13:00 – 14:00	Lunch/ Prayers	
14:00 - 15:15	Exercise 1B- Atmospheric and Topographic (BRDF) Corrections	Ms. Aqeela+ resource persons
15:16– 15:30	Tea/ Coffee Break	
15:30 – 17:00	Exercise 1B- Atmospheric and Topographic (BRDF) Corrections (continued)	Mr. Kiramat Hussain+ resource persons
<i>End of Day 1</i>		
Day 2 – Wednesday- 14 th March, 2018		Resources / Trainers
9:00 – 09:30	Systematic sampling and LULC interpretation (Lecture)	Afrasiyab
09:30 –11:00	Exercise 2-A-Sample design for visual interpretation of Systematic Grids	Afrasiyab + Resource persons
11:00-11:15	<i>Tea/ Coffee Break</i>	
11:15 –13:00	Exercise 2-B Interpretation of LULC Classes using Open Foris Collect Earth	Aqeela Mobeen + Resource persons
13:00–14: 00	<i>Lunch/ Prayers</i>	
14:00-15:30	Image Classification (Lecture)	Kiramat Hussain
14:00 –15:15	Exercise 3A: Creating training and validation set	Kiramat Hussain + resource persons
15:16 –15:30	<i>Tea/ Coffee break</i>	
15:30– 17:00	Exercise 4 Image Classification using Random Forest Image Classifier	Mr. Atif Shehzad + resource persons
<i>End of Day 2</i>		

Day 3 – Thursday-15th March, 2018		Resources / Trainers
9:00 – 11:00	Exercise 4 Image Classification using Random Forest Image Classifier (continued)	Mr. Atif Shehzad + resource persons
11:01–11:15	Tea/ Coffee Break	
11:15 – 11:30	Post Classification Processing (lecture)	Ms. Aqeela Mobeen
11:30 –13:00	Exercise 5: Post Classification Processing	Mr. Kiramat hussain+ resource persons
13:01 –14:00	Lunch and Prayers	
14:01 –14:30	Accuracy Assessment and Area Estimation (lecture)	Afrasiyab
14:30 – 15:45	Exercise 6 Accuracy Assessment and Area Estimation	Afrasiyab + resource persons
15:45 –16:00	<i>Closing Ceremony and Certificate Distribution + Tea / Coffee</i>	National REDD+ Office
End of Training		

*National Resource Persons: Muhammad Afrasiyab (National REDD+ Office/MoCC), Mr. Kiramat Hussain (G-B) Ms. Aqeela Mobeen (Punjab), Mr. Atif Shehzad (SUPARCO)

ANNEX-B List of Participants



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TOT

Training on Satellite Land Monitoring System
March 13-15th, 2018
Venue: Grand-Regency Hotel, Islamabad
Attendance Sheet

S.No	Name & Designation	Organization	Contact No./Email Address	Signature		
				Day 1 13.03.2018	Day 2 14.03.2018	Day 3 15.03.2018
1	Sami Ullah Khan GIS Manager	The Urban Unit	0331-5218303 samullahkhan990@gmail.com			
2	Sumayyah Aleem Research Associate	National REDD+ Office	Sumayyah.khan@redd-pakistan.org			
3	Muhammad Afraziyab GIS/MRV Expert	National Redd+ office MOCC	mafraziyab@redd-pakistan			
4	Farhat Jabeen Research Associate	National REDD+ office				
5	Farid Ullah GIS Specialist	KP Wildlife Department Peshawar.	gisspecialist.wildlife@gmail.com			



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S.No	Name & Designation	Organization	Contact No./Email Address	Signature		
				Day 1 13.03.2018	Day 2 14.03.2018	Day 3 15.03.2018
6	Faryal Safdar GIS Programmer	GIS Lab, Punjab Forest Department LHC	0322-5083241 faryal.khan@gmail.com			
7	Atif Shahzad Manager	SUPARCO	0323-2428828 atif.sb@gmail.com			
8	Aqsa Mubeen	Punjab Forest GIS Lab, Lahore.	amubeen@hotmail.com			
9	Dr. Ghulam Akbar	National REDD+ office	g.akbar@redd-pakistan.org			
10	Sayed Mofazzal Hasan Gillani	Forest Dept AJK	0355-6750523 0333-9376203			
11	Iftikhar Ahmad Arain	Swat Forest Department	03002785975 iftikhar.arain2003@yahoo.com			



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S.No	Name & Designation	Organization	Contact No./Email Address	Signature		
				Day 1 13.03.2018	Day 2 14.03.2018	Day 3 15.03.2018
✓ 12	Zahidullah RPO GBPD	Gilgit Baltistan Forest Dept.	Zahidkhan51@yahoo.com 03339440363	[Signature]	[Signature]	[Signature]
✓ 13	Ufiab Ahmad Khan	CLISC	uabalam2005@yahoo.com 08165770577	[Signature]	[Signature]	[Signature]
✓ 14	Esbrat Fatima	Institute of Space Technology, ISB	esbratfatima@yahoo.com 03418827462	[Signature]	[Signature]	[Signature]
✓ 15	NAVEED MUSTAFA	PAKISTAN AGRICULTURAL RESEARCH COUNCIL (PARC) Islamabad	naveedmustafa@yahoo.com 0329-5413238	[Signature]	[Signature]	[Signature]
✓ 16	SALAR SAIED	HI-AWARE, PARC ISLAMABAD	0333-4327567	[Signature]	[Signature]	[Signature]
✓ 17	Sohail Babar	Mo CC	03224666677	[Signature]		
✓ 18	Hina Choudhary	PMAS (AAUR)	03315844114	[Signature]	[Signature]	[Signature]
	Najeebullah	Redd+	0331-5529050	[Signature]	[Signature]	[Signature]



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S.No	Name & Designation	Organization	Contact No./Email Address	Signature		
				Day 1 13.03.2018	Day 2 14.03.2018	Day 3 15.03.2018
✓ 21	Aof Ali Khan PhD Scholar	PMAS-AAUR	0332-5030530 aridean251@gmail.com	[Signature]	[Signature]	[Signature]
✓ 22	Hamad Khalid Satti Internee REDD+	NUST	0344-5050097 hamadkhalid12@gmail.com	[Signature]	[Signature]	[Signature]
✓ 23	Hasnain Bashir M.S C.R.S & GIS	PMAS-AAUR	03344563440 hasnain1109@gmail.com	[Signature]		[Signature]
✓ 24	NOORUDDIN MS (RS & GIS)	PMAS-AAUR	03150511285 noorsmk321@gmail.com	[Signature]	[Signature]	[Signature]
✓ 25	M. Nadeem Dav MS (RS & GIS)	PMAS-AAUR	nadeemmasee@gmail.com	[Signature]	[Signature]	[Signature]
✓ 26	Muhammad Arshad Lab Engr. (ED, UET Taxila)	CIVIL ENG. DEPT. UET TAXILA	arshadshahzad71@gmail.com 03218911377		[Signature]	[Signature]
27	Mohammad Qasim	National Redd+ MoCC Office	mqasim@redd-pakistan.org		[Signature]	[Signature]



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S.No	Name & Designation	Organization	Contact no & email	Signature Day 1	Day 2	Day 3
10/11/28	Rukhsana Bano	red +	rukhsanabano2115@gmail.com			
10/11/29	Kinza Farooq		kinzafarooq08@gmail.com			
30	Aqsha Malik		malikaysha123@gmail.com		aysha. aysh-	
31	S. Ubaydullah Ali Shah	REDD+	sayisayed72@gmail.com			s.k
32	Ishrat Fatima	REDD+ intern	syedafatimah44@gmail.com			