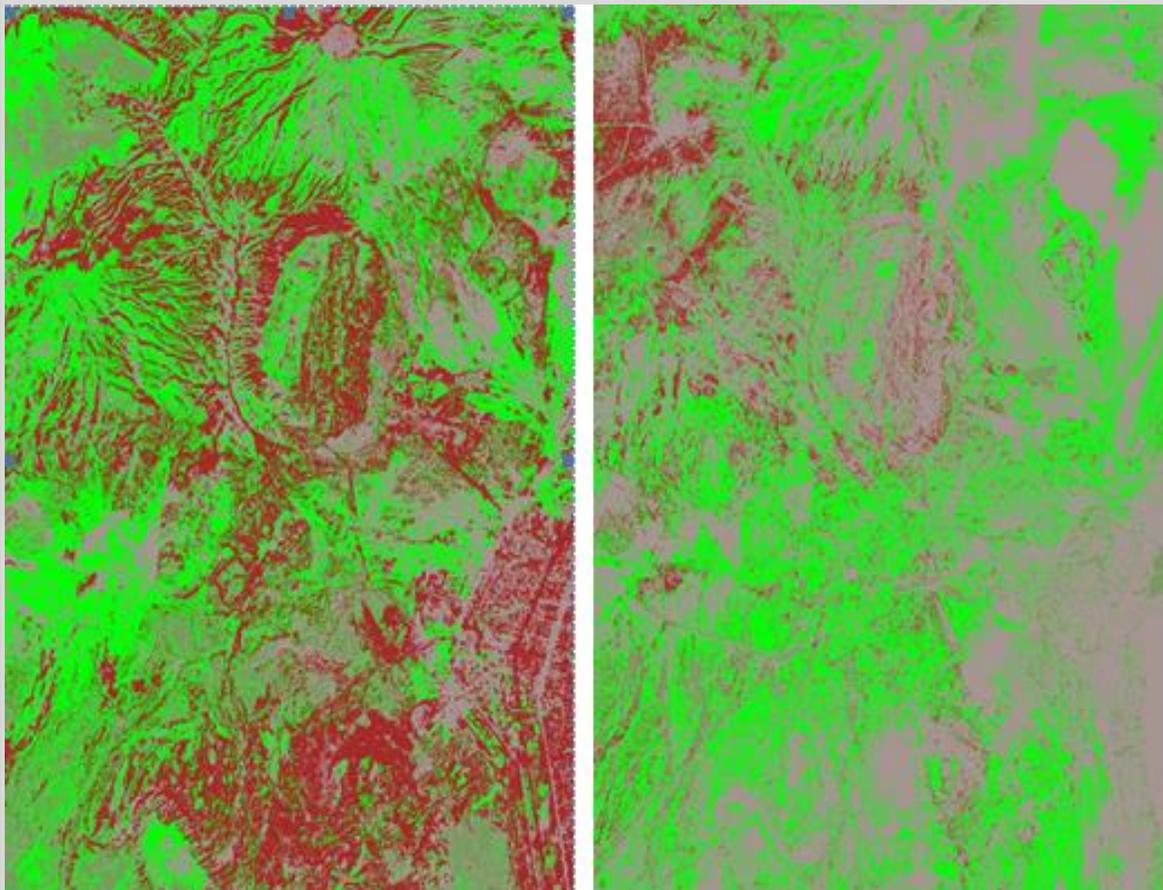# Rare vegetation monitoring within "buffer zones" around Industrial objects using Space technologies

Training Scripts
2016

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for the Project: "INCREASING CAPACITY FOR BIODIVERSITY CONSERVATION: Long-Term Integrated Research and Conservation Education Program, Azerbaijan"

Acknowledgements

Content

Introduction

The Training Test Scripts were compiled to describe the training process of using GIS and RS technologies on Monitoring rare vegetation within Buffer zones around Industrial objects in Gobustan National Park. The Training Test Scripts perform convenient tasks associated with the training program specially developed by Team leader (Yelena Gambarova) for Project "INCREASING CAPACITY FOR BIODIVERSITY CONSERVATION: Long-Term Integrated Research and Conservation Education Program, Azerbaijan" supported by Rufford Booster Grant for Nature Conservation.

Scope

This document describes the step-by-step instructions of each phase of the Training Test Scripts and their short description. The document includes Overview of the each Test Script phase, Prerequisites, any Steps required and tester identification. Each field in the Step Script definitions have been explained.

Definitions and Acronyms

a.s.l.   *Above Sea Level*

AOI   *Area of Interest*

ESA   *Environmentally Sensitive Area*

GDB   *Geographical Data Base*

GIS   *Geographic Information System*

GPS   *Global Positioning System*

IUCN   *International Union for Conservation of Nature and Natural Resources*

NDVI   *Normalized Difference Vegetation Index*

RS   *Remote Sensing*

RSGF   *Rufford Small Grant Foundation*

UNCCD   *United Nations Convention to Combat Desertification*

UTM   *Universal Transverse Mercator*

WGS 84   *World Geodetic System 1984*

Prerequisites

Knowledge of Windows-based software for basic file management and browsing is required.

Overview of Rare vegetation monitoring program

The goal of conservation education program "Monitoring rare vegetation within Buffer zones around Industrial objects using Space technologies" is taking as consideration rare vegetation distribution within "buffer zones" for recent years. This proposal addresses communities' recommendation through development of a conservation education program including the implementation of conservation training workshops. The workshops will provide training in rare vegetation surveys and the application of data to plant management in the "buffer zones" within the area of Gobustan.

The document describes the training program which is related to teaching of students and stakeholder groups to advanced capabilities of GIS and RS technologies on rare vegetation monitoring in the buffer zones" in the Gobustan State National Park, Azerbaijan.

The document describes training phases connected with hands-on experience for the collection of data, GIS analysis of the data, and map-making using the latest ESRI and ERDAS software. The script covers advanced aspects of GIS application program by phase and step by step. The participants will be provided with course materials and demo versions of image analysis software.

Scripts Organization

The Test Scripts consist of the following Test Scripts phases:

- ✓ Geographical Data Base design and creation of Specialized GIS Environment;
- ✓ Image Statistic Analysis;
- ✓ Rare vegetation classification of remotely sensed data;
- ✓ NDVI Calculation;
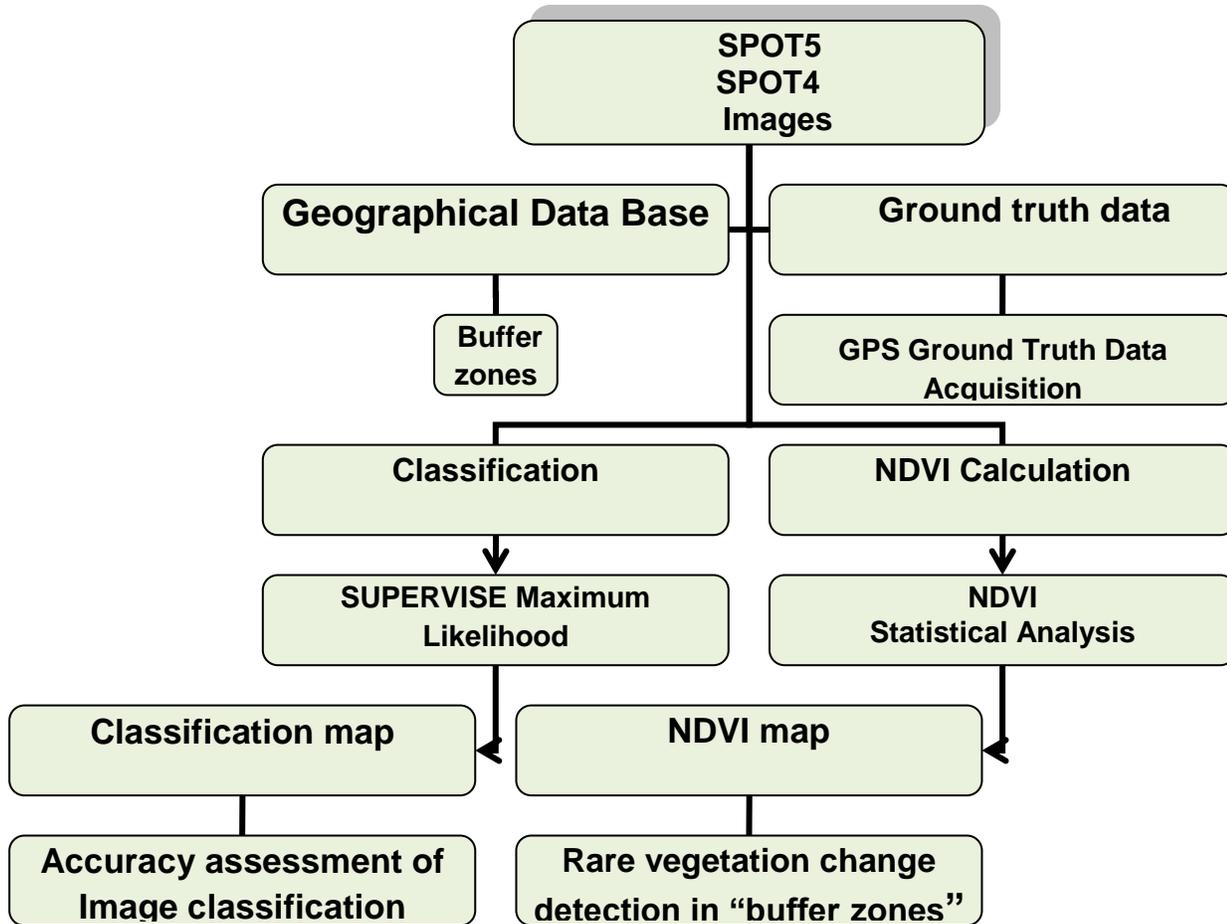- ✓ Change Detection method/

Prerequisites

ESRI ArsGIS 10.2 and Erdas Imagine software have been installed.

Step and Script step definitions

Training Test Script supporting *step-by-step* operational guide has been provided by the inspector and each field in the Step Script definitions have been explained.

1.   Structure of the rare vegetation monitoring

Overview. A flow chart showing the structure of the rare vegetation monitoring Program

```
                    ┌─────────────────┐
                    │     SPOT5       │
                    │     SPOT4       │
                    │     Images      │
                    └─────────────────┘

┌──────────────────────────┐    ┌──────────────────────────┐
│ Geographical Data Base   │    │    Ground truth data     │
└──────────────────────────┘    └──────────────────────────┘

        ┌──────────┐           ┌──────────────────────────┐
        │  Buffer  │           │ GPS Ground Truth Data     │
        │  zones   │           │      Acquisition          │
        └──────────┘           └──────────────────────────┘

   ┌──────────────────────┐    ┌──────────────────────────┐
   │    Classification    │    │     NDVI Calculation      │
   └──────────────────────┘    └──────────────────────────┘

   ┌──────────────────────┐    ┌──────────────────────────┐
   │ SUPERVISE Maximum    │    │          NDVI            │
   │    Likelihood        │    │  Statistical Analysis    │
   └──────────────────────┘    └──────────────────────────┘

┌──────────────────────┐    ┌──────────────────────────┐
│  Classification map  │    │        NDVI map          │
└──────────────────────┘    └──────────────────────────┘

┌──────────────────────┐    ┌──────────────────────────┐
│ Accuracy assessment  │    │ Rare vegetation change   │
│ of Image classification │ │ detection in "buffer zones" │
└──────────────────────┘    └──────────────────────────┘
```

Flowchart of methods applied in the study

2.   DATA Used

Overview. Four SPOT5 images in 2.5, 5 m resolutions and four SPOT4 images in 10 m resolution were used for the delineation and classification of rare vegetation communities.
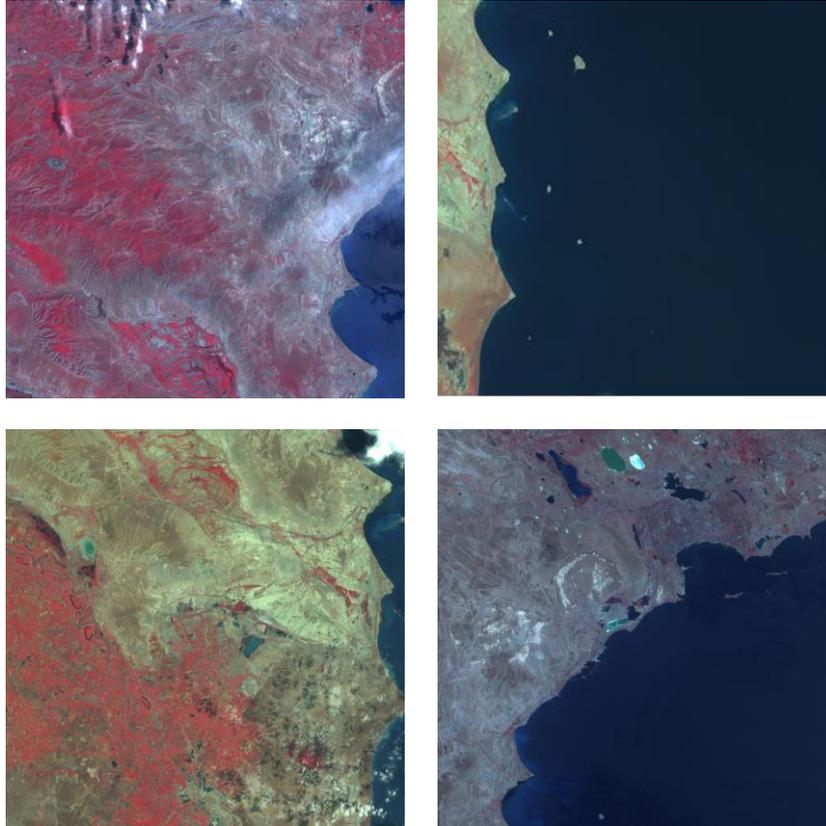
3. Geographical Data Base design and creation of Specialized GIS Environment

3.1 Raster Georeferencing

Overview. Georeference is the process of defining something existence in physical space or in other words establishing its location in terms coordinate systems representing earth defined through projection systems. It is used when establishing the relation between raster or vector images by determining the spatial location of the geographical features. This procedure is mandatory for data modeling in the field of geographic information systems (GIS). When data from different sources or time periods (like time series satellite images) need to be combined and then used in a GIS application, (e.g. for change detection, assess damages after a natural disaster etc.), it becomes essential to have a common referencing system.

The following overview gives step-by-step test script definitions of the phase "Georeferencing"

No	Steps	Materials
I	Establish control points	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 10.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software
II	Input the known geographic coordinates of these control points	
III	Choose the coordinate system and other projection parameters: Projected Coordinate System: WGS_1984_UTM_Zone_39N Projection: Transverse_Mercator	

3.2   Geographical Data Base

Overview. The phase is related to train trainees on how to create "*Geographical Data Base*" for performing workflow comprising of jobs connected with collecting of samples, hosting of classifier training and producing software as well as classification results analysis.

The following overview gives step-by-step test script definitions of the phase "Geographical Data Base design and creation of Specialized GIS Environment":

No	Steps	Materials
I	Raster Georeferencing	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 10.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software
II	Creation of Data Base consisting of relevant spatial data: Orthorectified satellite multi-spectral data, ancillary data: various spectral Indexes, DEM and its derivatives as well as vector Topographical data and Map template.	
III	Creation of the Generated Land Use Map with the following layers: • Settlement; • Industrial; • Transport Infrastructure; • Greenery;	
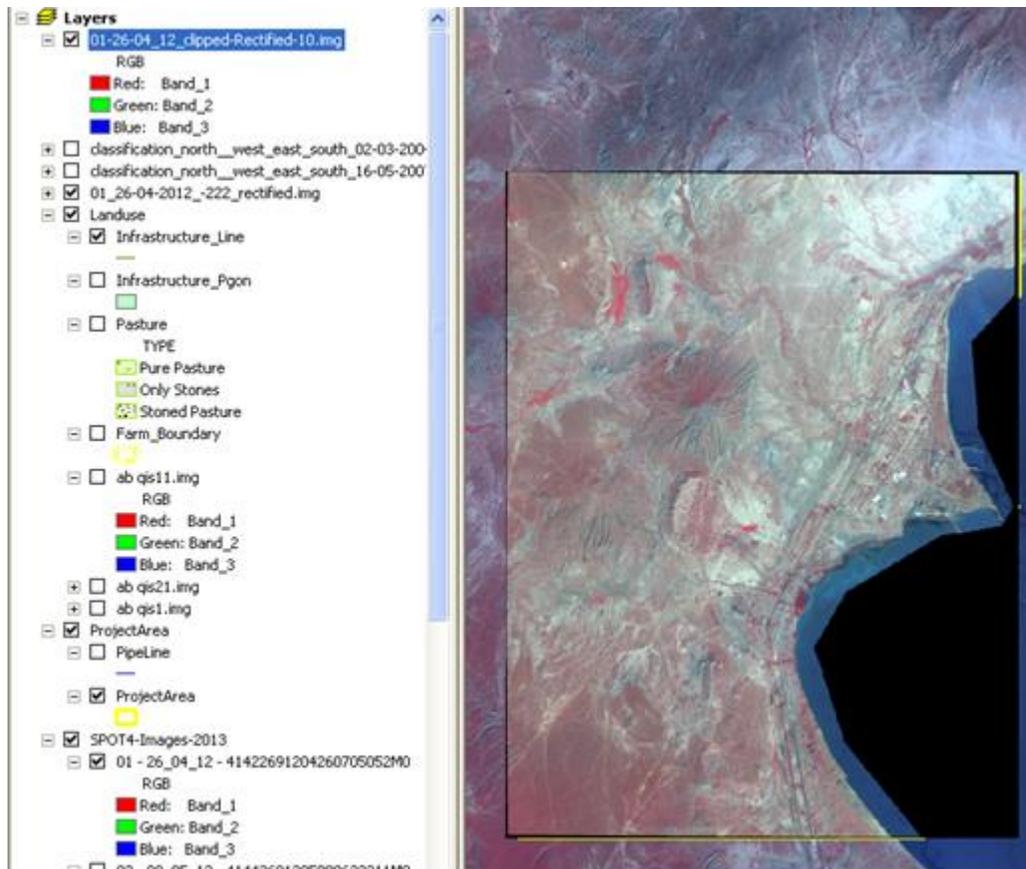
4. Field Study and Data Recording

Overview. Field data collection is important in remote sensing. The field data serve three purposes. Firstly, field data can be used to verify, to evaluate or to assess the results of remote sensing investigations. Secondly, field data can provide reliable data to guide the analytical process, such as creating training fields to support supervised classification. Thirdly, field data provide information to model the spectral behavior of specific landscape features.

GPS devices provided the coordinates for ground-reference data during fieldwork, the sample plots are accurately linked to SPOT imagery.

The sample plots are accurately linked to SPOT imagery.

Every plot is registered with GPS Garmin device to allow further integration with spatial data in GIS and image processing systems.

The coordinates for each reference point were recorded using hand-held GARMIN Global Positioning System (GPS). Information on land use and cover was recorded too.

Quadrates and plots assisted by satellite SPOT imagery have provided information on habitat types and status.

The following overview gives step-by-step test script definitions of the phase "Field Study and Data Recording":

No	Steps	Materials
I	Buttons & Pages in your GPS	
II	Getting to know the basic GPS terms	GPS devices
III	Set Up	
IV	Entering a grid reference	

Habitat Type	The name of vegetation communities	Sample plot GPS coordinates
DESERT/SEMI -DESERT		
	Salsola Nodulosa/ Artemisia Lerchiana	E49º22'36.87" N40º05'7.16"
	Salsola Nodulosa/ Salsola Dendroides	E49º23'14.52" N40º05'13.69"
	Tamarix	E49º21'48.12" N40º05'11.51"
	Alhagi pseudoalhagi	E49º21'40.32" N40º04'39.06"
	Suaeda dendroides	E49º22'44.96" N40º06'6.13"

5.   Image Statistical Analysis

Overview. The phase is related to train trainees on how to create "Image Statistical Analysis".

Once the training areas are selected, different methods are used for testing purposes such as histograms, separability, signature statistics and scatter plots.

The visualization technique in feature space allows estimating range of the correlation of training samples: thereto, for each of the class from the training data was estimated of Minimum and Maximum values on each band used and created three-dimensional parallelepiped in the Feature Space.

A series of specific processing operations for the images using ERDAS Imagine software

- **Statistic analyses** (*for the characterization of classes, selection of the instructing samples, conceiving classifications*);

- **Selecting Feature Space Objects**;

- **Data classification procedures**:

  > *Supervised classification: based on training areas using a priori knowledge of the number of classes, as well as knowledge concerning statistical aspects of the classes*

Image Statistical Analysis: Training samples

The following overview gives step-by-step test script definitions of the phase "Image Statistical Analysis Training samples":

No	Steps	Materials
I	Redefinition/Clarification of AOI (Area of Interest) and Training/test sites	Erdas Imagine software has been installed
II	Ground-truth Each training set corresponds to a certain vegetation type on the ground	

Ground-truth

➢ each training set corresponds to a certain vegetation type on ground

➢ Samples set of classes

6. Creation of Specialized GIS Environment

We have developed and built a toolset in Core GIS for managing/automating all processes during the project lifetime.

The Development process involves two steps with the following outputs:

1. Creation of the tools for collecting/gathering training and test sets of samples.
2. Creation of tools for designing, learning and testing of classifiers and performing classification on real data.

This software we called *Specialized GIS Environment* for solving applied tasks using RS data and classifiers.

No	Steps	Materials
I	Creating training and test signatures from imagery	
II	Performing statistical tests on separability and overlapping of signatures	ArcGIS 10.2 software has been installed
III	Graphical representation of results of statistical tests	
IV	Performing classification on real data	

Tools realizing these functionalities made mainly in the form of "Wizard" that consisted of finite number of steps with providing information in a dialog in window containing a control block panel. A dialog was the window in which each user step-by-step through an entire process, can select or determine values of set logically correlation parameters. As example below is the a main dialog of wizard which is activated by the tool "Create training and test signatures"
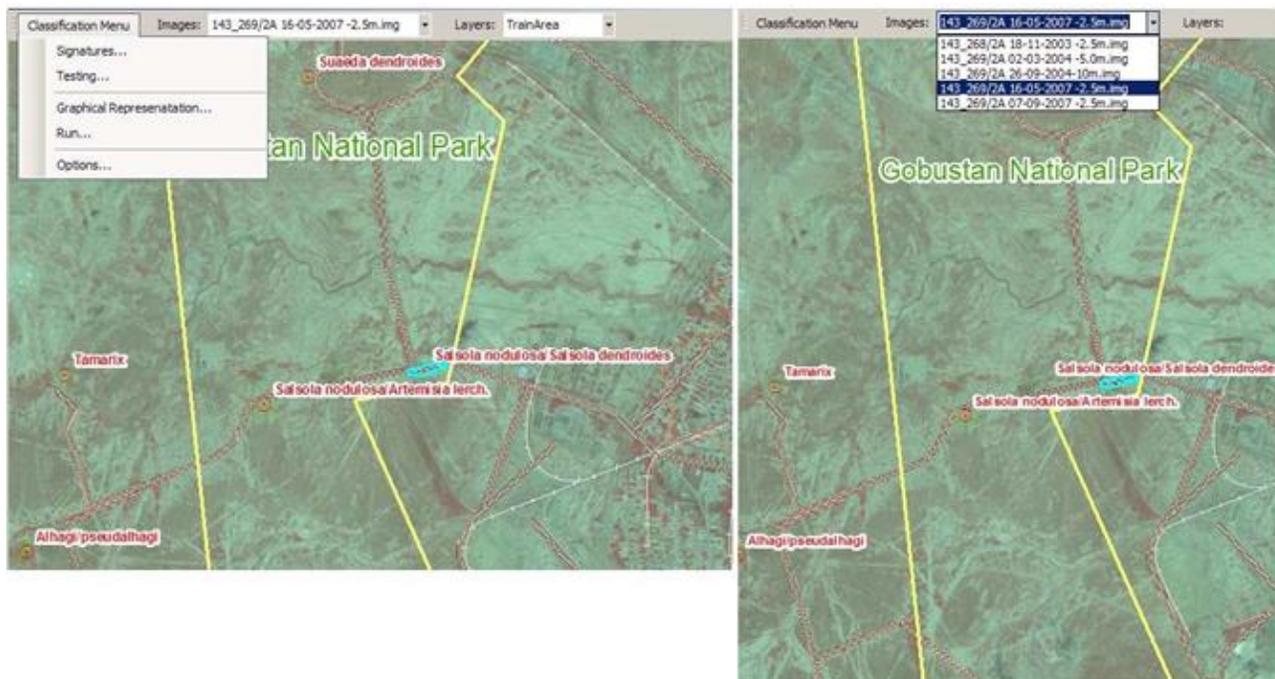
Note: *This Development of classifier's software   is specially developed by Project Team for Rufford Grant and it is Confidential Proprietary*

7.   Supervised Rare Vegetation Classification

Overview. The phase is related to train trainees on how to create "Rare vegetation classification".

Having acceptable levels for the Separability of the training areas, the next step is to conduct the classification process.

We will perform a supervised classification of SPOT scene of the Gobustan area using the Maximum Likelihood classifier and subsequently assess class Separability and classification accuracy.

The following overview gives step-by-step test script definitions of the phase "Rare vegetation classification":

No	Steps	Materials
I	Creating training and test signatures from imagery	Erdas Imagine software has been installed
II	Maximum likelihood classification	
III	Classification accuracy assessment	

Expected result

Contingency Matrix. Final classification scheme

Classified Data	Alhagi pseudoalhagi	Tamarix	Suaeda Dendroides	SalsolaNodulosa/Artemisia Lerchiana/SalsolaNodulosa/Salsola Dendroides
Alhagi pseudoalhagi	151	0	0	28
Tamarix	0	342	0	151
Suaeda Dendroides	1	11	65	128

SalsolaNodulosa/Artemisia Lerchiana/SalsolaNodulosa/ Salsola Dendroides	5	20	11	462
Column Total	157	373	76	769

8.   NDVI Calculation

Overview. A comparative method using Normalized Difference Vegetation Index (NDVI) has been developed for Rare Vegetation monitoring in Gobustan National Park, Azerbaijan. The NDVI was developed to display and quantify Rare Vegetation change using dates of SPOT5 satellite imagery. NDVI was computed for each date of imagery to define high and low vegetation biomass.

NDVI model was built in ERDAS Imagine's Model Maker (Figure 2). This was designed to subject images to the NDVI equation and produces a resulting image. After the NDVI model was built, each image was "ran-through" the model. The output from each image being ran-through the model, is the desired NDVI image.
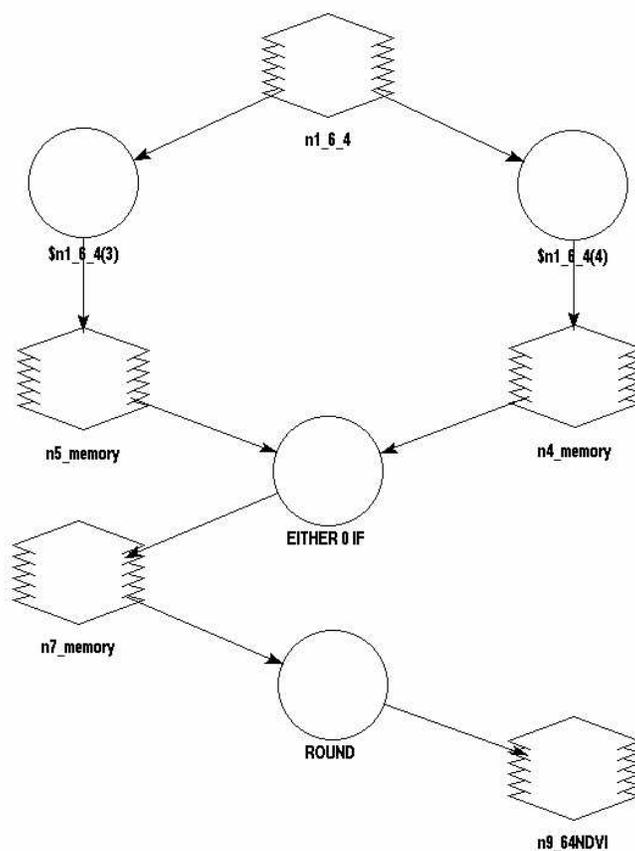
ERDAS Imagine's Model Maker

The following overview gives step-by-step test script definitions of the phase " NDVI Calculation":

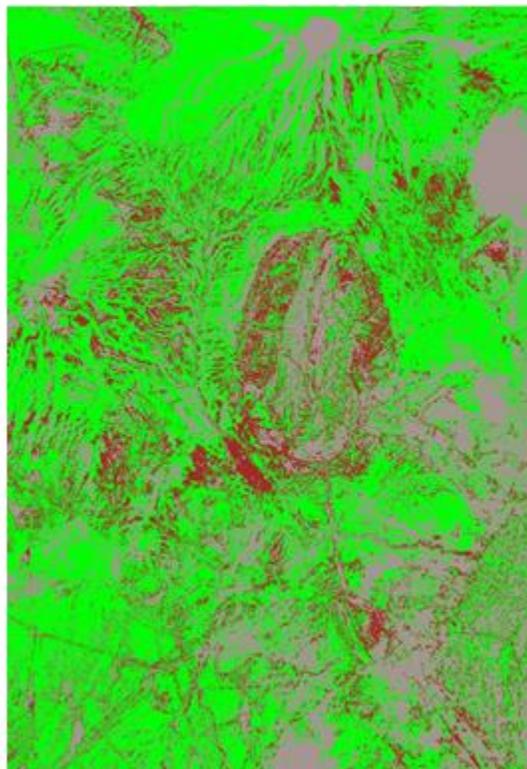| No	Steps	Materials
	Statistical analysis	Erdas Imagine has been installed
I	1. Comparison of NDVI values on North-West-East-South parts of Sensitive Area as a single whole	
II	2. Comparison of NDVI values on North, West, East and South as segments	

Expected result
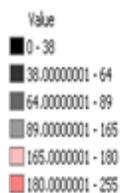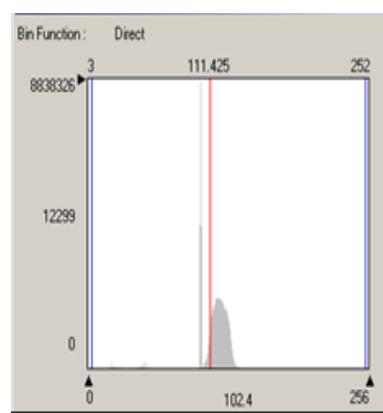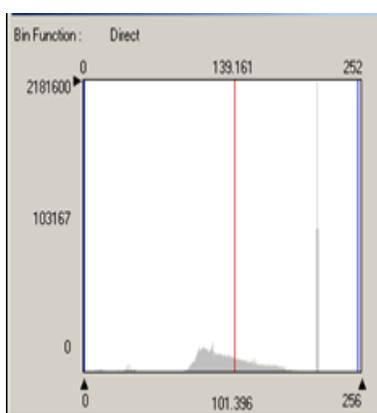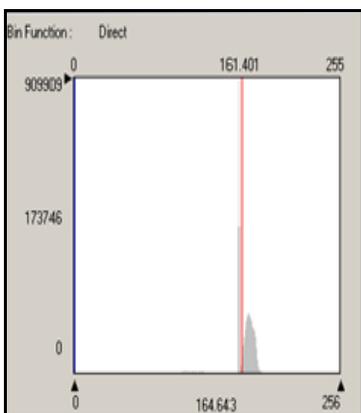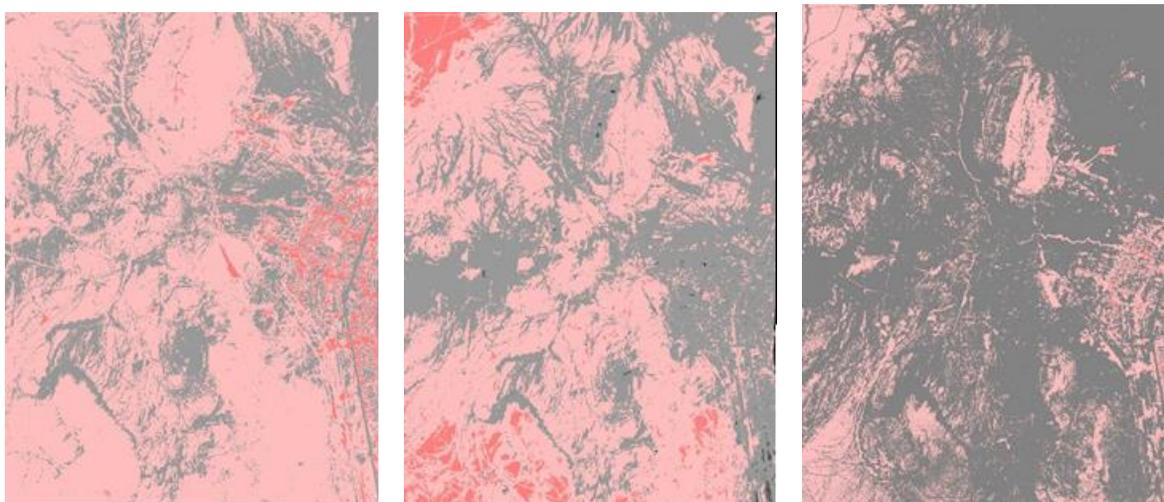
9.   Change detection

The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of vegetation. Change detection is temporal effects as Variation in spectral response involves situations where the spectral characteristics of the vegetation or other cover type in a given location change over time. Change detection and monitoring involve the use of multi-date images to evaluate differences in vegetation distribution due to environmental conditions and human actions between the acquisition dates of images.
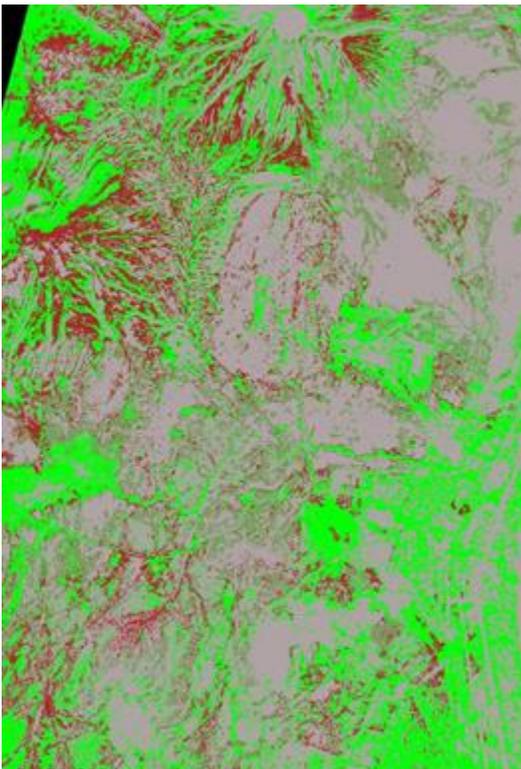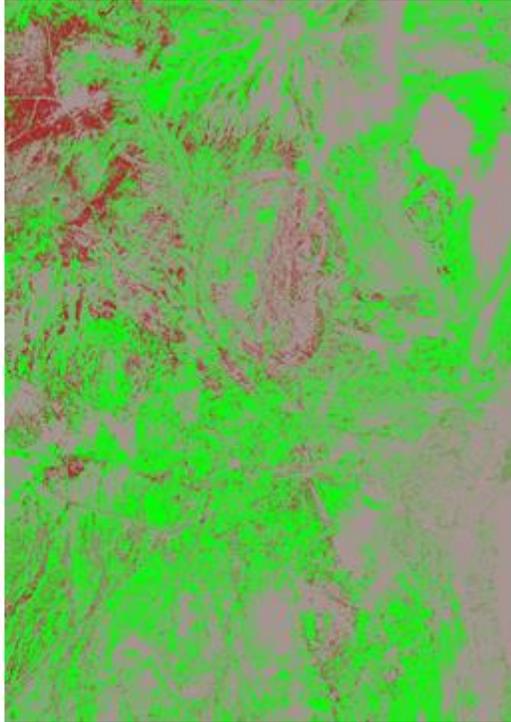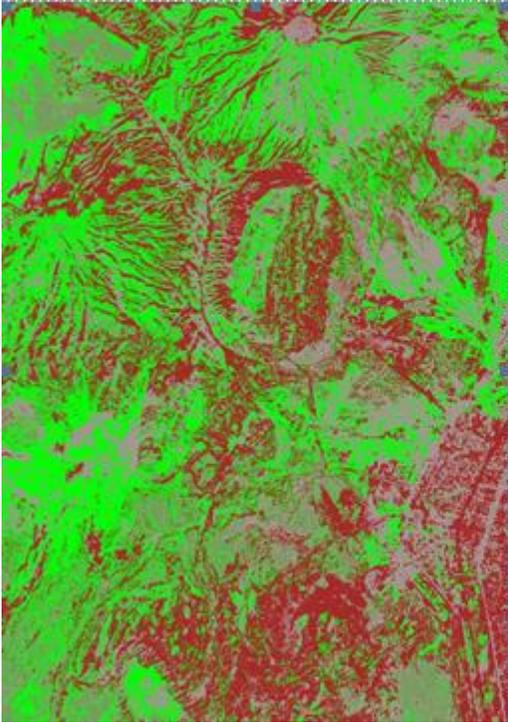
The following overview gives step-by-step test script definitions of the phase " Change detection":

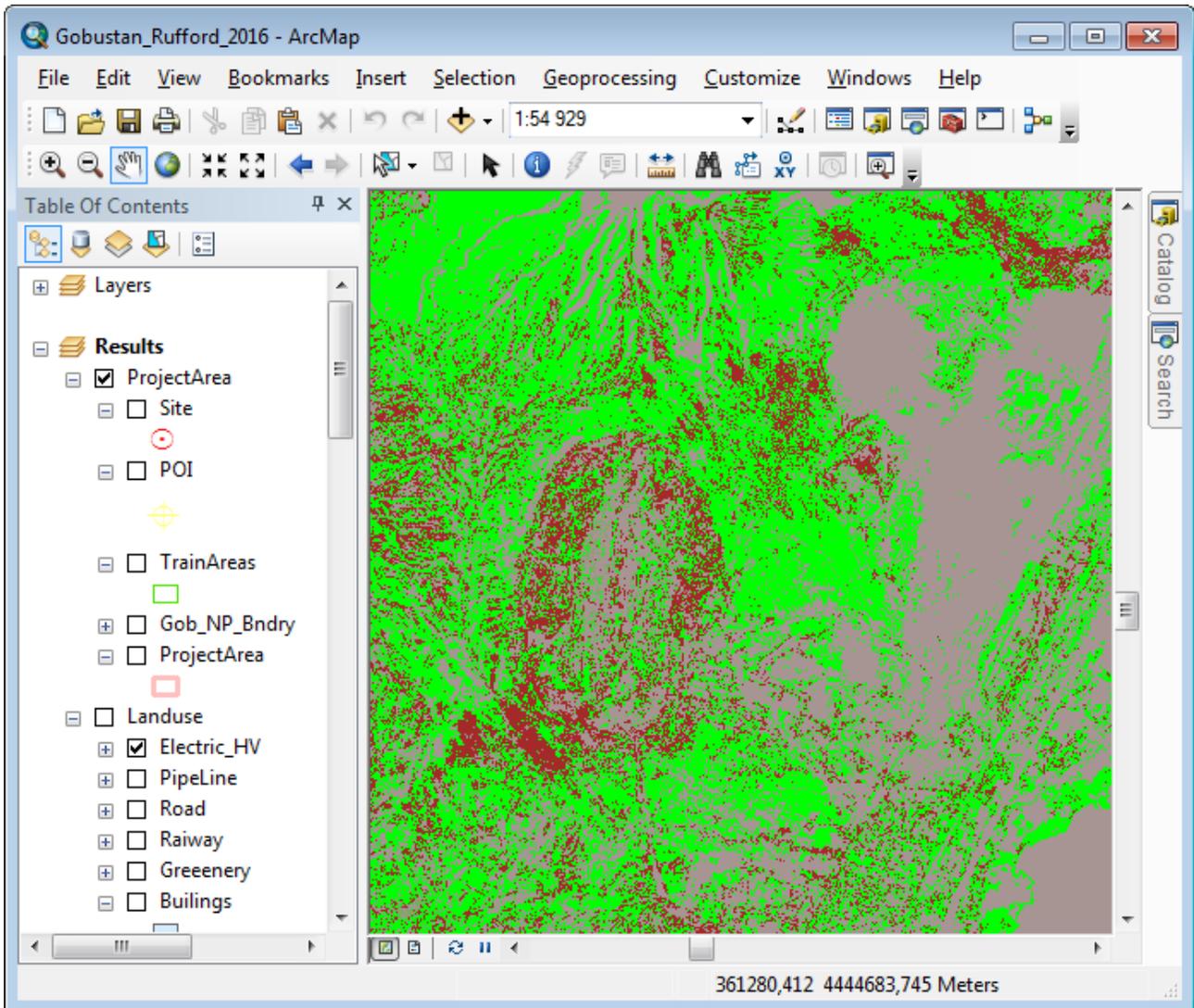| No	Steps	Materials
I	Comparison of NDVI values within "buffers zones"	Erdas Imagine has been installed
II	Comparison of NDVI values on North-West-East-South parts of Sensitive Area as a single whole	

Rare vegetation change detection within "buffers zones"
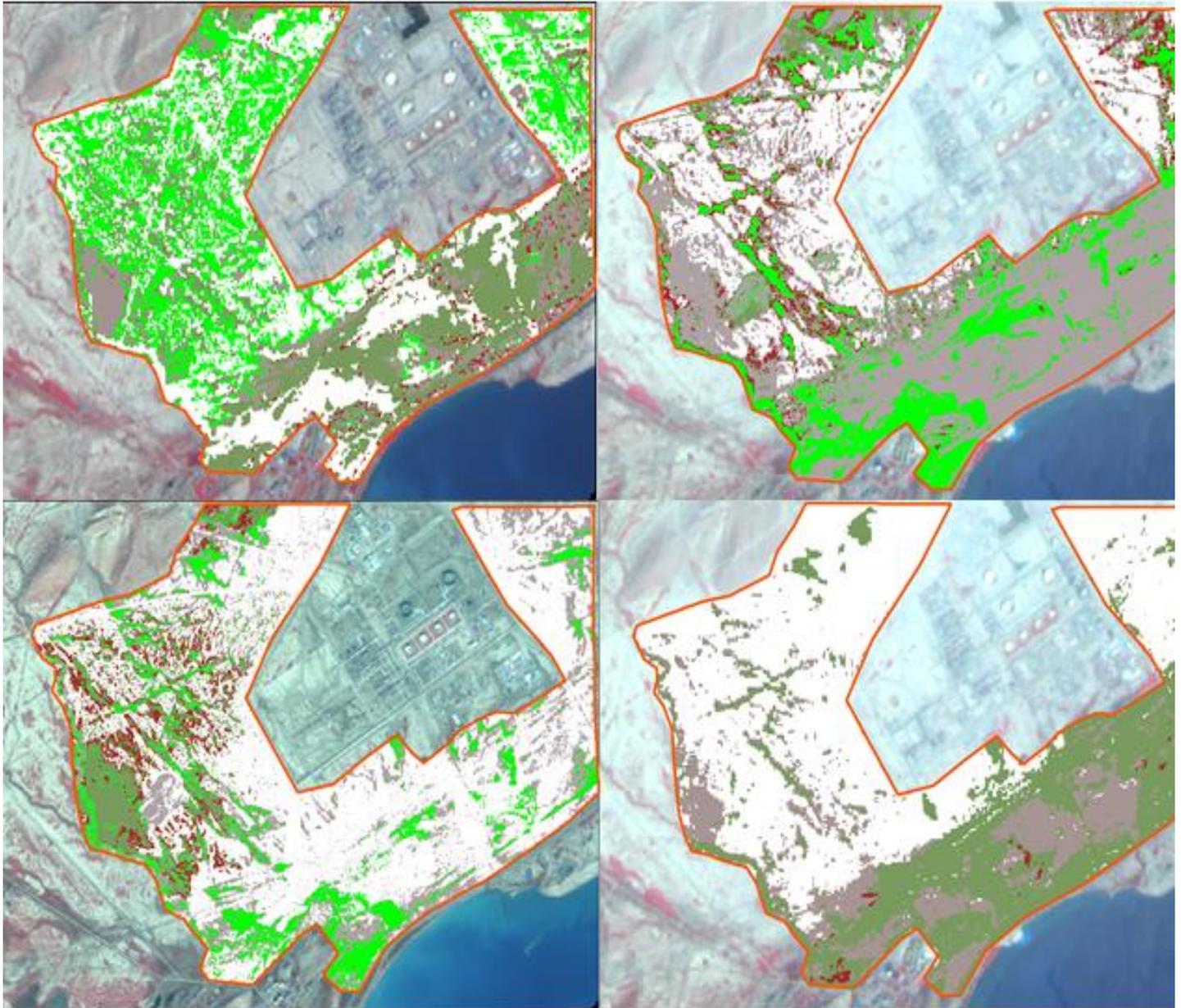
Alhagi-pseudoalhagi	
Tamarix	
Suaeda dendroides	
SalNod/ArtLerch/SalDend	
Bare ground	

Alhagi-pseudoalhagi	
Tamarix	
Suaeda dendroides	
SalNod/ArtLerch/SalDend	