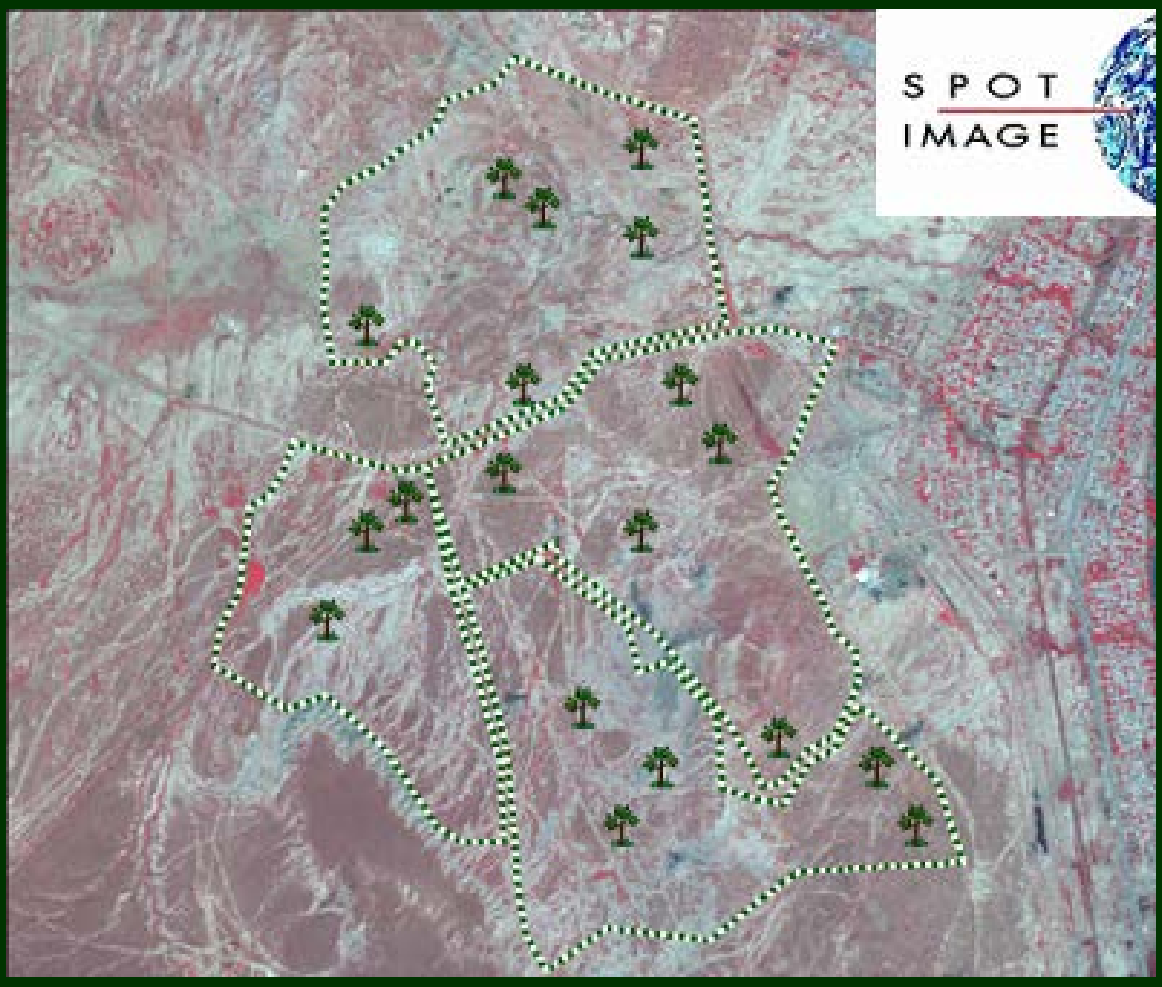
Rare Vegetation Monitoring Training Scripts 2013-2014



Provides

- **Step-by-step guide for setting up and managing "*Rare vegetation Monitoring using GIS and Remote Sensing Technologies*" program**
- **Additional practice scripts for review and skill refinement**

Developed by Yelena Gambarova for Project "Rare plant conservation in Azerbaijan: Monitoring threats and Education of Local Community" supported by Rufford Small Grants for Nature Conservation

Acknowledgements

This work was supported by the *Rufford Small Grants for Nature Conservation and Planet Action program* which provided recourses for the research that led to this training document.

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Appendix: Figures

1 Introduction

The Training Test Scripts were compiled to describe the training process of using GIS and RS technologies on rare vegetation monitoring in Azerbaijan. The Training Test Scripts perform convenient tasks associated with the training program specially developed by Team leader (Yelena Gambarova) for Project "Rare plant conservation in Azerbaijan: Monitoring threats and Education of Local Community" supported by Rufford Small Grants for Nature Conservation.

1.1 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.

1.2 Intended Audience

People who are actively working in plant conservation and managing conservation projects, perhaps within Government, non-governmental organisations (NGOs), Universities, botanic gardens, or as protected area managers. This training script is intended for scientists (professionals and students) who work with biodiversity data and are interested in developing skills to effectively use spatial analysis programmes with GIS applications.

1.3 Referenced Material

[R1] Planet Action : Final report
http://www.planet-action.org/web/85-project-detail.php?projectID=1027

[R2] Report for Rufford Grant Conservation
http://www.rufford.org/rsg/projects/yelena_gambarova

[R3] United Nations Convention to Combat Desertification (UNCCD) on website:
http://www.unccd.int/publicinfo/partners/stories.php?newch=gobustan

[R4] Protected Area (Gobustan State National Park) in the Azerbaijan Republic
www.cbd.int/iyb/doc/celebrations/iyb-Azerbaijan-success-en

1.4 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.

2 Overview of Rare vegetation monitoring program

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 Azerbaijan.

Decision-makers often rely on maps and spatial data created with Geographic Information Systems (GIS) for their analysis and decision making. While leaders don't have to be GIS specialists, they do need a good understanding of the strengths and limitations of the technology and what it can do for their respective agencies or organizations. They also need to understand what kinds of questions about natural resources can be addressed using these technologies. Our basic training teaches decision-makers how to harness these technologies effectively.

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 [R1]. The script covers advanced aspects of GIS application program by phase and step by step.

2.1 Straining Scripts Organization

The Test Scripts consist of the following Test Scripts phases:

1. Geographical Data Base design and creation of Specialized GIS Environment
2. Image Statistic Analysis
3. Rare vegetation classification of remotely sensed data
4. NDVI Calculation
5. Change Detection method

2.1.1 Prerequisites

ESRI ArsGIS and Erdas Imagine software have been installed.

2.1.2 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.

2.1.3 Appendices and References

This document is provided by Appendices and References for each Test Script phase.

1. Structure of the rare vegetation monitoring Program

Overview. The methodological approach of this Project will include training in the field of identification and census methods and the use of standardized monitoring methods.

A flow chart showing the structure of the rare vegetation monitoring Program [R2]

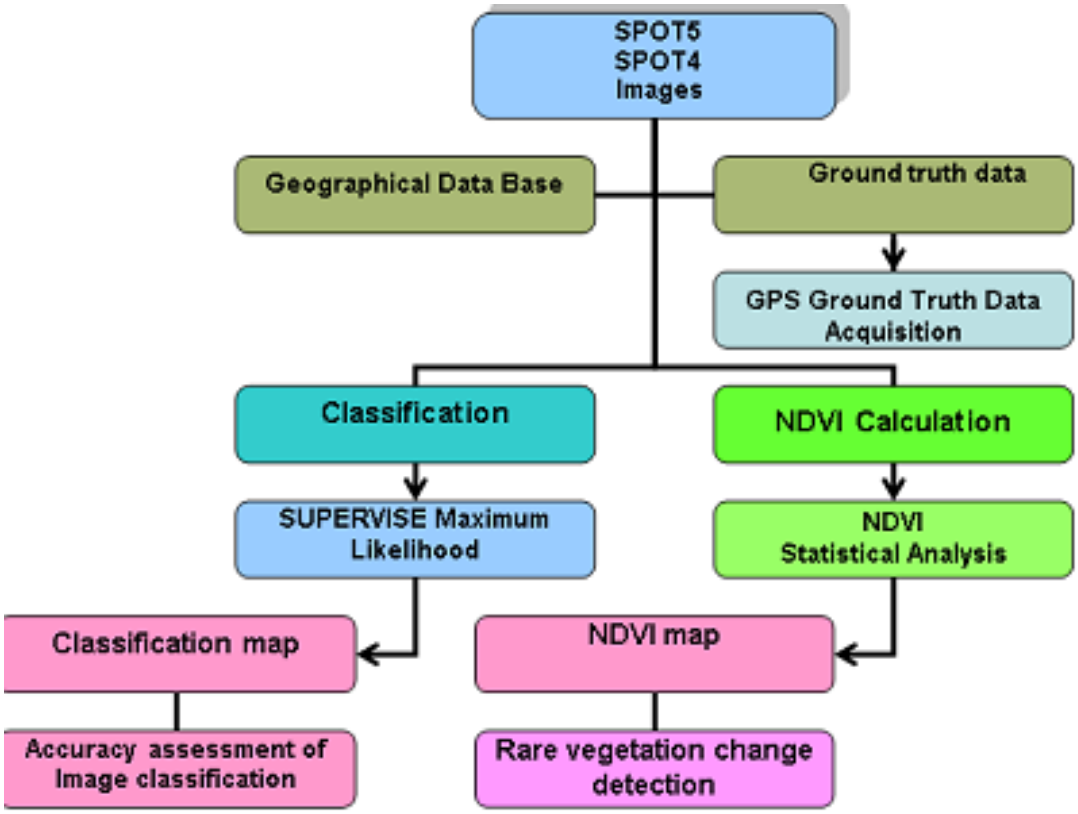


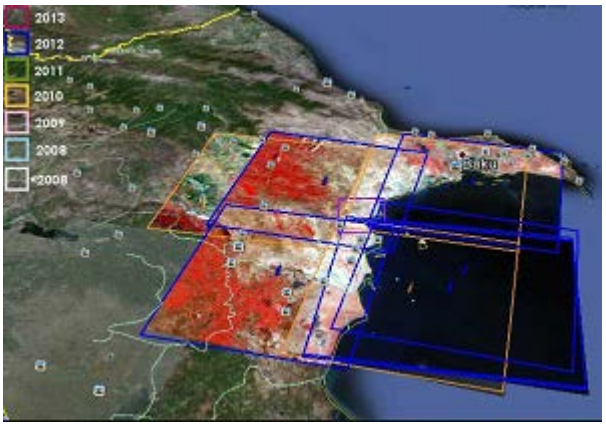
Figure 1. Flowchart of methods applied in the study

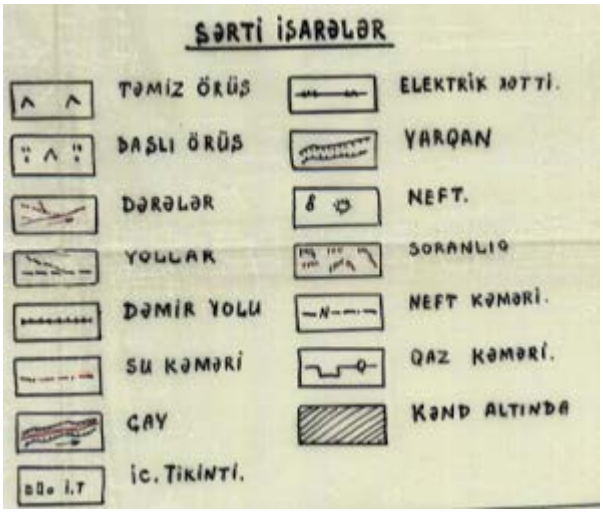
2. DATA Used

Overview. Four SPOT5 images in 2.5 m and 5 m resolutions, acquired between 2004 and 2007 and four SPOT4 images in 10 m resolution, acquired between 2010 and 2012 years were used for the delineation and classification of rare vegetation communities.

The following overview gives step-by-step test script definitions of the phase "DATA Used : SPOT Images and land cover maps":

Test Script phase 2:	**DATA Used : SPOT Images and Land Use Maps**
Prerequisites\ Preparation actions:	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 9.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document
Appendix:	Figure 2. Data used: SPOT Images & Land Use Maps

No	**Script step definitions**		**Note**
I	Selection of SPOT Images within the AOI 	ASTRIUM Scene ID : 41422691204260705052R Scene ID : 41442691205080633211R Scene ID : 41422691206070654282R Scene ID : 41432691008010727432R Scene ID : 41432701008010727522R	Provided by Planet Action Iniative

II	Topographical and Land Use Maps Creation of visual tools to guide and enhance conservation management initiatives in Gobustan 	These tools include a series of Land Use Maps that aid rare vegetation managers.	These maps are being utilized by State Land Committee of Azerbaijan Republic.
III		**Legend** Pure Pastures Stony Pastures Lowland Roads Railroad Water line River Ic.Tikinti Electric line Ravine Oil spills Salinity Oil pipeline Gas pipeline Settlement	

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, (eg. 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"

Test Script phase 3.1:	**Raster Georeferencing**
Prerequisites\ Preparation actions:	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 9.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document
Appendix:	Figure 3.1. Raster Georeferencing

No	**Script step definitions**	**Note**
I	Establish control points	
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	
IV	Minimize residuals	

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":

Test Script phase 3.2:	**Geographical Data Base design and creation of Specialized GIS Environment**
Prerequisites\ Preparation actions:	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 9.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document
Appendix:	Figure 3. Geographical Data Base (GDB)

No	Script step definitions	Note
I	Raster Georeferencing	
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;	
IV	Creation of Pasture Map with Pasture Types: • Pure Pastures • Stony Pastures	

3.3. Land use map Pasture Map

The following overview gives step-by-step test script definitions of the phase "Pasture Maps":

Test Script phase 3.2:	**Pasture Map**	
Prerequisites\ Preparation actions:	ESRI ArcGIS has been installed. It has been used ArcGIS Desktop 9.2 with its extensions (Spatial Analysis and 3D Analysis) as base (core) GIS software	
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document	
Appendix:	Figure 3.3. Pasture Map	
No	**Script step definitions**	**Note**
I	Personal Geodatabase Feature Class	
II	Editing environment	
II	Creating features	
III	Adding attribute data	
IV	Saving your edits	
V	Creation of Farm Boundary	

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.

The ground reference points were measured during the field visit to the study areas in the period from September 2009 to September 2013. They were selected based on pre-classified maps for the imagery. 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.

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

Test Script phase 4:	**Field Study and Data Recording**	
Prerequisites\ Preparation actions:	GPS devices	
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document	
Appendix:	Figure 4. Field Study and Data Recording	
No	**Script step definitions**	**Note**
I	Quadrates and plots assisted by satellite SPOT imagery have provided information on habitat types and status.	
II	GPS devices provided the coordinates for ground-reference data during fieldwork, the sample plots are accurately linked to SPOT imagery.	
III	The sample plots are accurately linked to SPOT imagery.	
IV	Every plot is registered with GPS Garmin device to allow further integration with spatial data in GIS and image processing systems.	

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":

Test Script phase 5:	**Image Statistical Analysis: Training samples**	
Prerequisites\ Preparation actions:	Erdas Imagine software has been installed	
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document	
Appendix:	Figure 5. Image Statistical Analysis: Training samples	
No	**Script step definitions**	**Note**
I	Redefinition/Clarification of AOI (Area of Interest) and Training/test sites	
II	Ground-truth Each training set corresponds to a certain vegetation type on the ground	

Habitat Type	Class	The name of vegetation communities
DESERT/SEMI-DESERT		
	1	Alhagi pseudoalhagi
	2	Salsola Nodulosa/Artemisia Lerchiana
	3	Salsola Nodulosa/Salsola Dendroides
	4	Tamarix
	5	Suaeda Dendroides

6. Image Statistical Analysis: Compare ellipsoids

Overview. Separability is a statistical measure of distance between two classes. Separability can be calculated for any combination of bands that is used in the classification, enabling you to rule out any bands that are not useful in the results of the classification.

The following overview gives step-by-step test script definitions of the phase " Image Statistical Analysis: Compare ellipsoids and Class Separability":

Test Script phase 6:	**Image Statistical Analysis: Compare ellipsoids Class Separability**
Prerequisites\ Preparation actions:	Erdas Imagine software has been installed
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document
Appendix:	Figure 6. Image Statistical Analysis: Compare ellipsoids

No	**Script step definitions**		**Note**
I	Compare Ellipses: View graphs of these statistics for compare classes	The graphs display as sets of ellipses in a Feature Space image. Each ellipse is based on the mean and standard deviation of one class. The color is used as the color for the class in the visualization functions, ellipses, *etc.*	*The ellipses are presented with the color regarding each class* *By comparing the ellipses for different classes for a one band pair, it is easy to see if the training set represents similar groups of pixels by seeing where the ellipses overlap on the Feature Space image (Figure 6).*
II	Class Separability We evaluated Class Separability on the following formulas: Euclidean spectral distances Divergence Transformed Divergence Jeffries-Matusita distance		*Separability is a statistical measure of distance between two classes. Separability can be calculated for any combination of bands that is used in the classification, enabling you to rule out any bands that are not useful in the results of the classification.*

7. Image Statistical Analysis: Histograms

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

Test Script phase 7:	**Image Statistical Analysis: Histograms**	
Prerequisites\ Preparation actions:	Erdas Imagine software has been installed	
Reference:	This subject is described in details in "Annual Report for Rufford Grant Conservation" document	
Appendix:	Figure 7. Image Statistical Analysis: Histograms	
No	**Script step definitions**	**Note**
I	Histograms associated to Vegetation Classes in the bands of the Spot data	
II	Classes discrimination test using the separability cell array	

8. 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”:

Test Script phase 8:	**Rare vegetation classification**
Prerequisites\ Preparation actions:	Erdas Imagine software has been installed
Reference:	This subject is described in details in “Annual Report for Rufford Grant Conservation” document
Appendix:	Figure 8. Rare vegetation classification

No	**Script step definitions**	**Note**
I	Maximum likelihood classification	
II	Classification accuracy assessment ERROR MATRIX ----------	

Classified Data	Reference Data: Alhagi-pse	Tamarix	Suaeda den	SalNod/Art
Alhagi-pse	86.67	5.41	0.00	0.00
Tamarix	13.33	94.59	0.00	8.57
Suaeda den	0.00	0.00	100.00	2.86
SalNod/Art	0.00	0.00	0.00	88.57

9. 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.

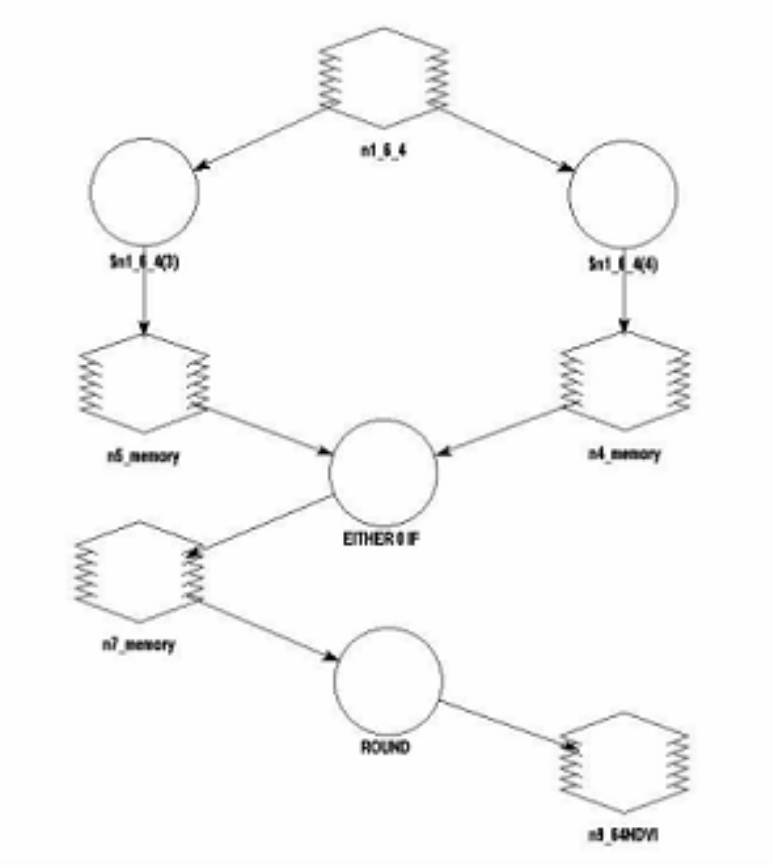


Figure 2. ERDAS Imagine's Model Maker

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

Test Script phase 9:	**NDVI Calculation**
Prerequisites\ Preparation actions:	Erdas Imagine has been installed
Reference:	This subject is described in details in “Annual Report for Rufford Grant Conservation” document
Appendix:	Figure 9. NDVI Calculation

No	**Script step definitions**	**Note**
	Statistical analysis	
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	

Appendix: Figures

Appendix: Figure 1

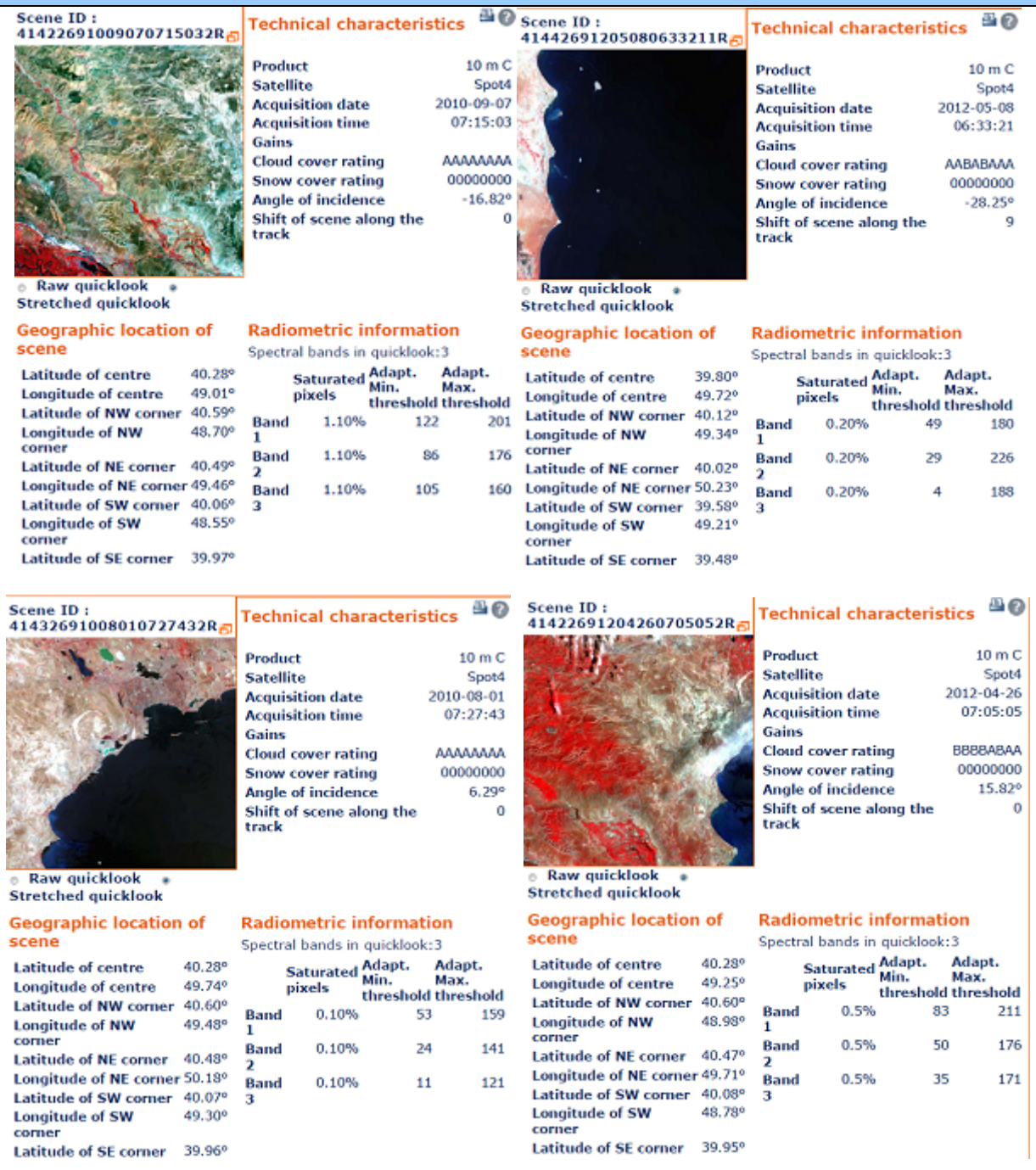
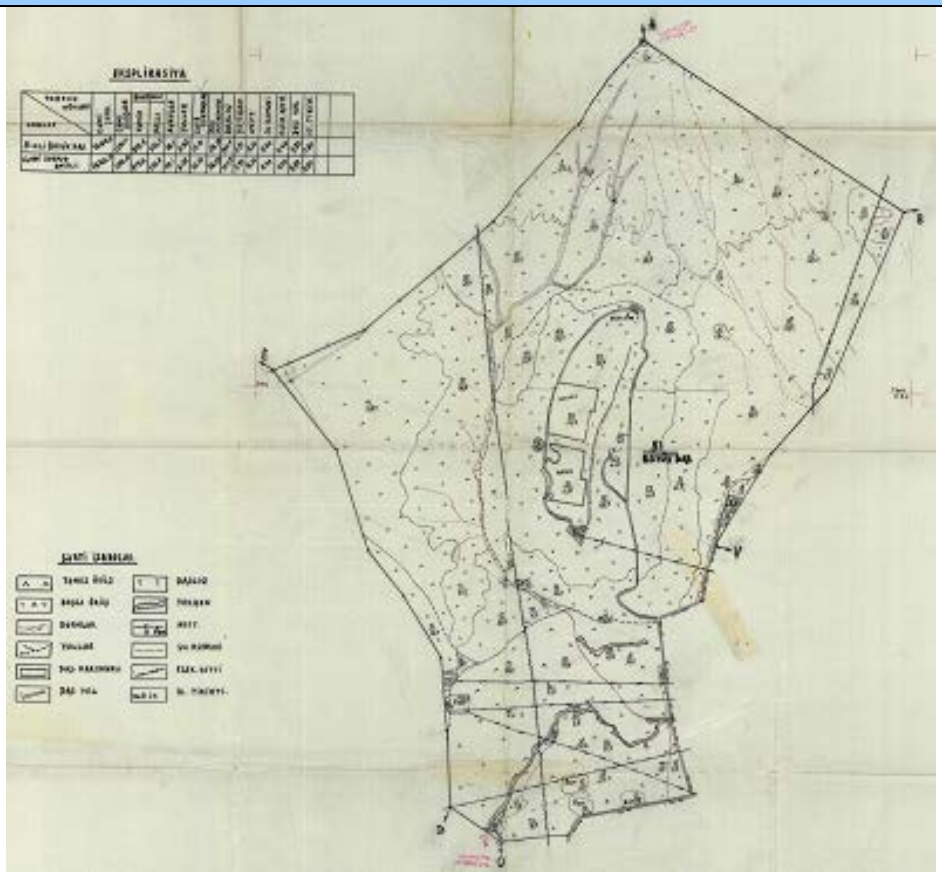


Figure 1*: SPOT Images*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script: *DATA Used : SPOT Images and Land Use Maps*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 2



Legend

- Pure Pastures
- Stony Pastures
- Lowland
- Roads
- Railroad
- Water line
- River
- Electric line
- Ravine
- Oil spills
- Salinity
- Oil pipeline
- Gas pipeline
- Settlement

Figure 2. *Topographical and Land Use Maps*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 2: DATA Used : *SPOT Images and Land Use Maps*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 3.2

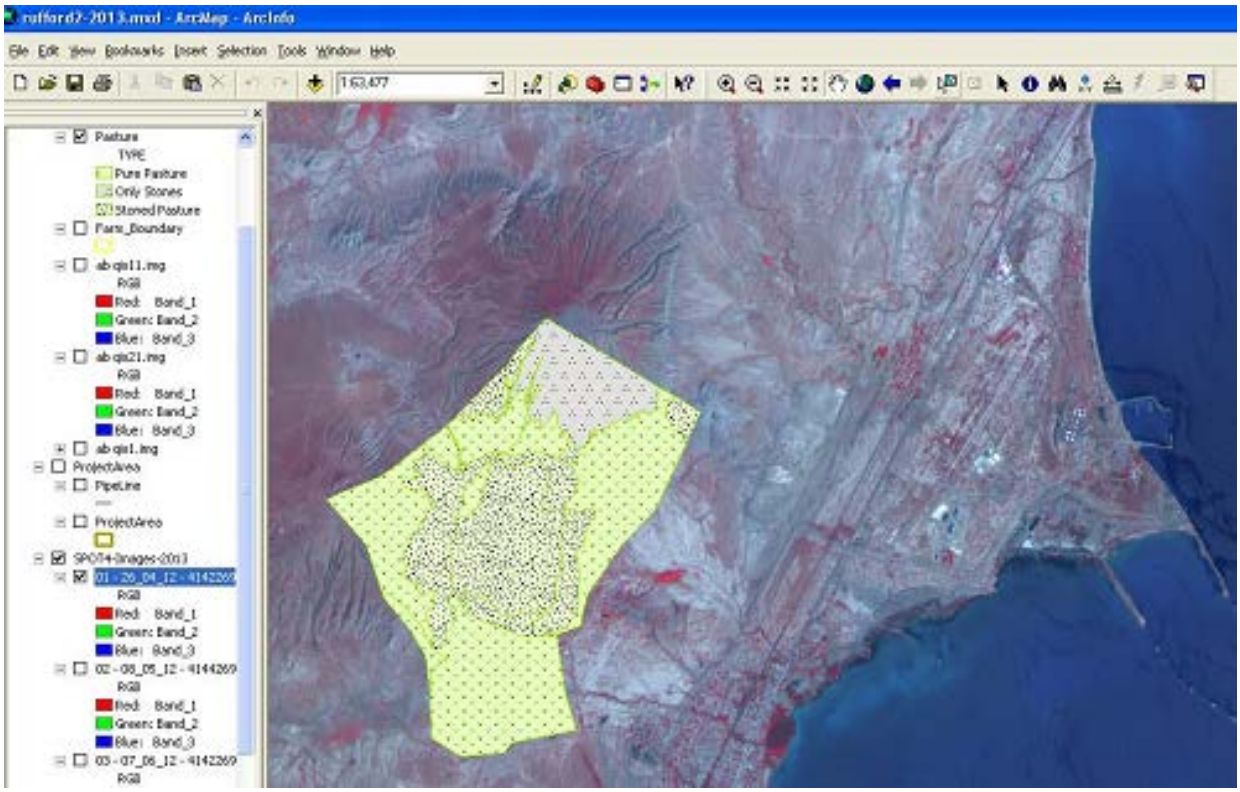
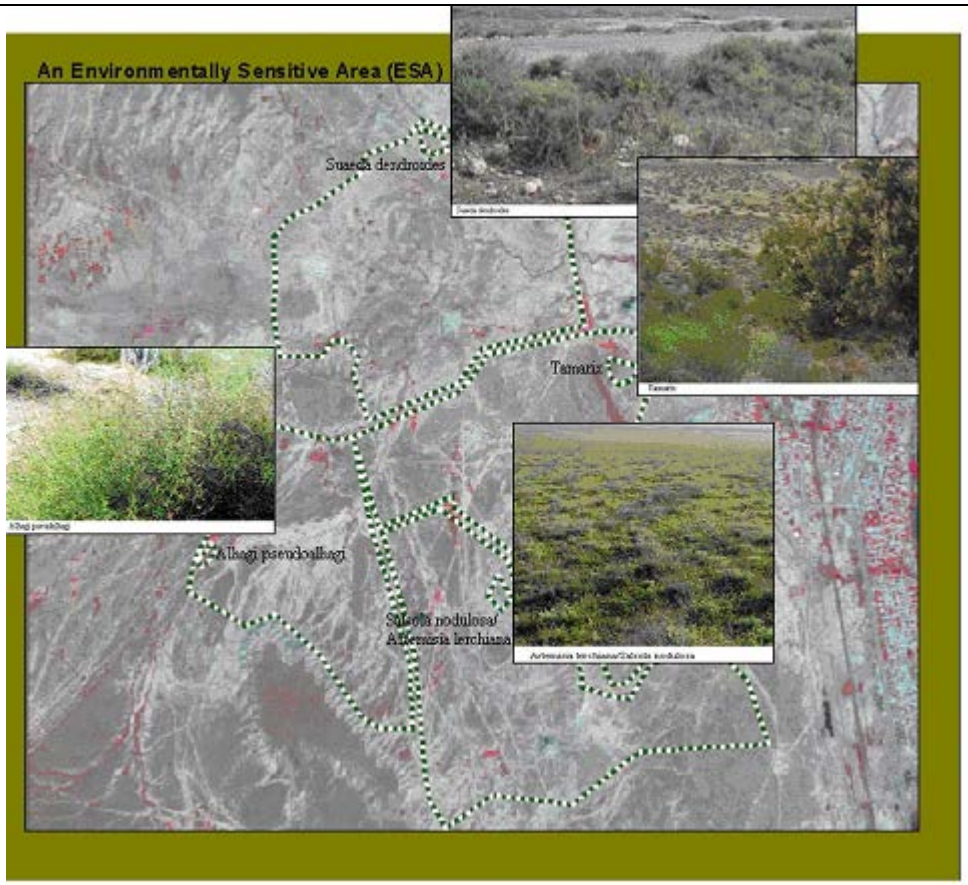


Figure 3.2. *Geographical Data Base*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 3.2: *Geographical Data Base design and creation of Specialized GIS Environment*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 3.3

Figure 3.3. *Pasture Map*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 3.3: *Pasture Map*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*



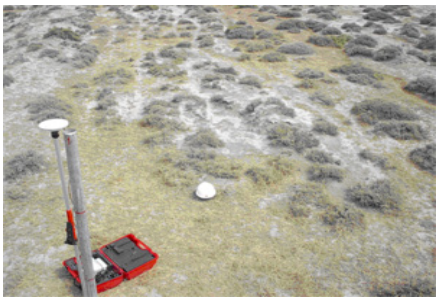


Figure 4. *Field Study and Data Recording*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 3: *Field Study and Data Recording*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 5

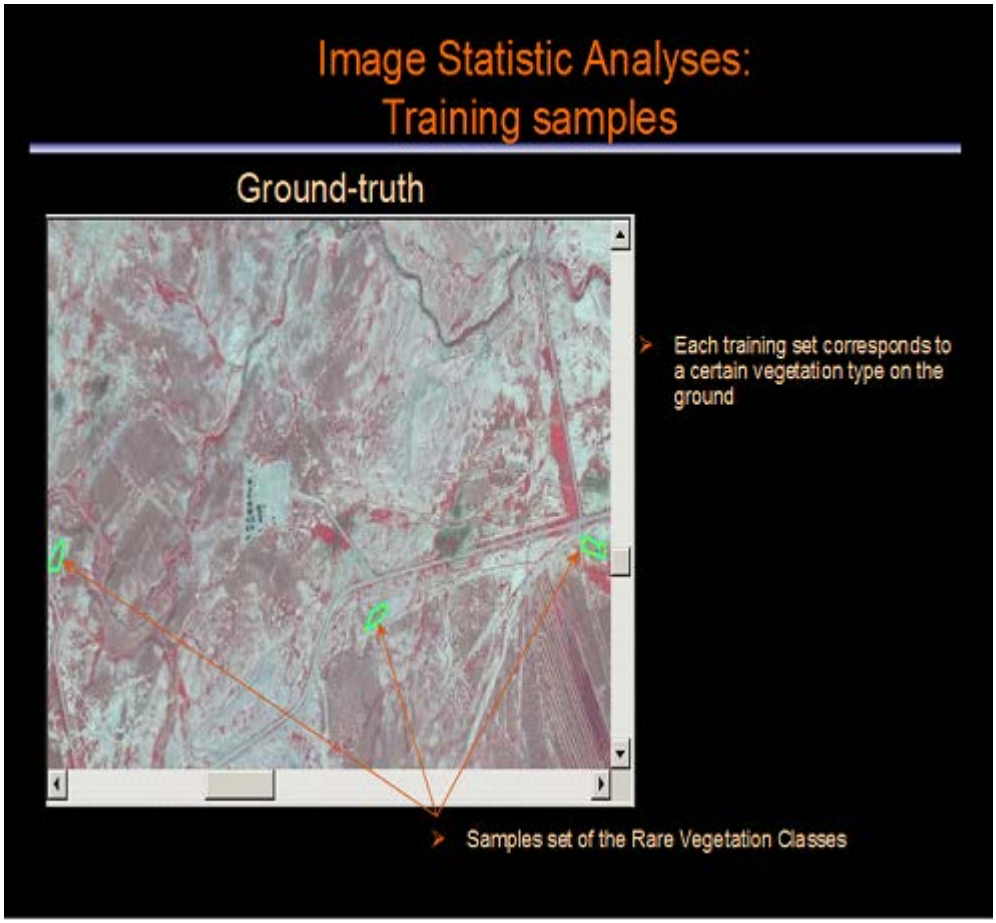


Figure 5. *Image Statistical Analysis: Training Sample*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 5: *Image Statistical Analysis: Training Samples*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 6

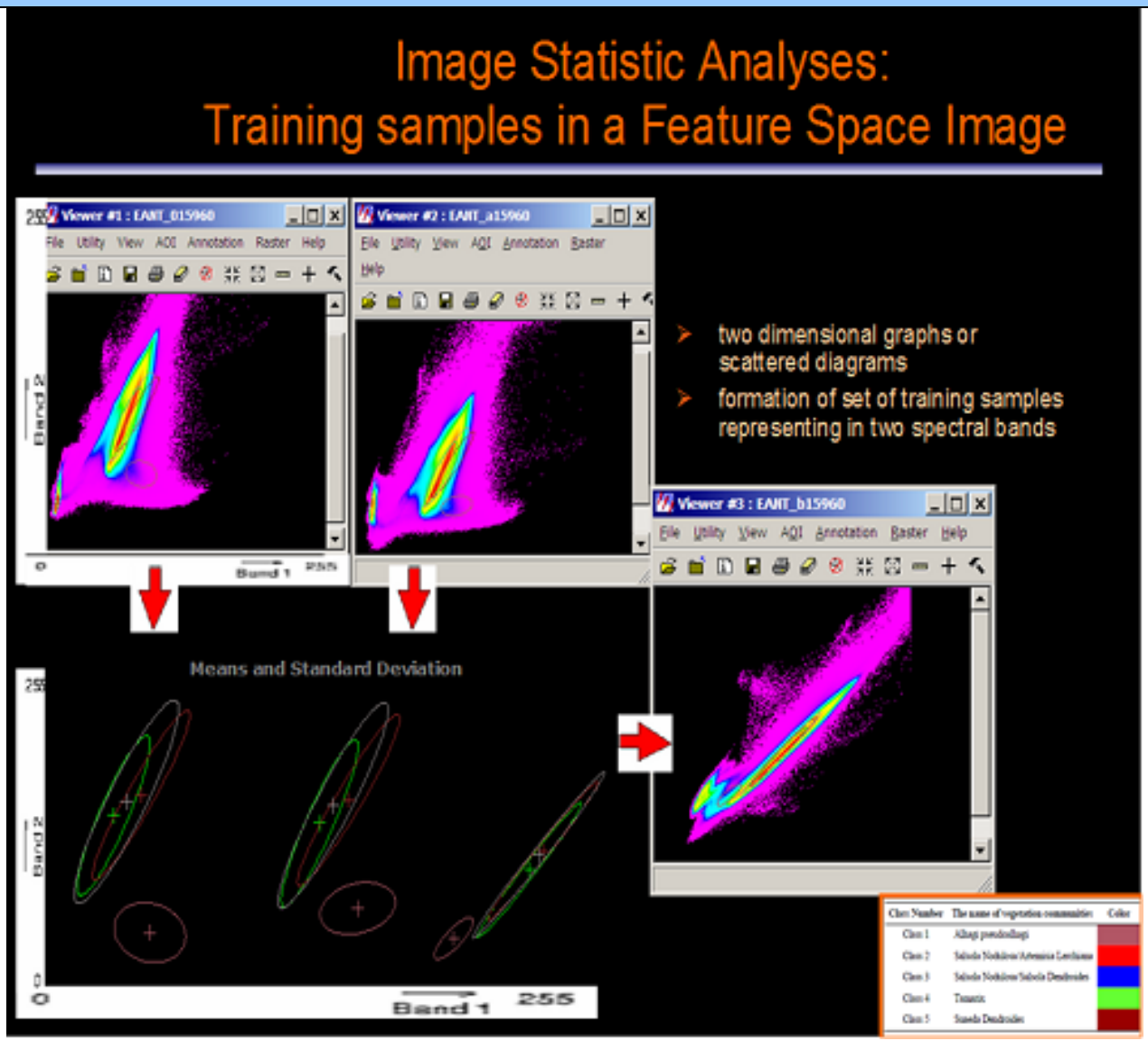


Figure 6. *Image Statistical Analysis: Compare ellipsoids*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 6: *Image Statistical Analysis:* Compare ellipsoids	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 7

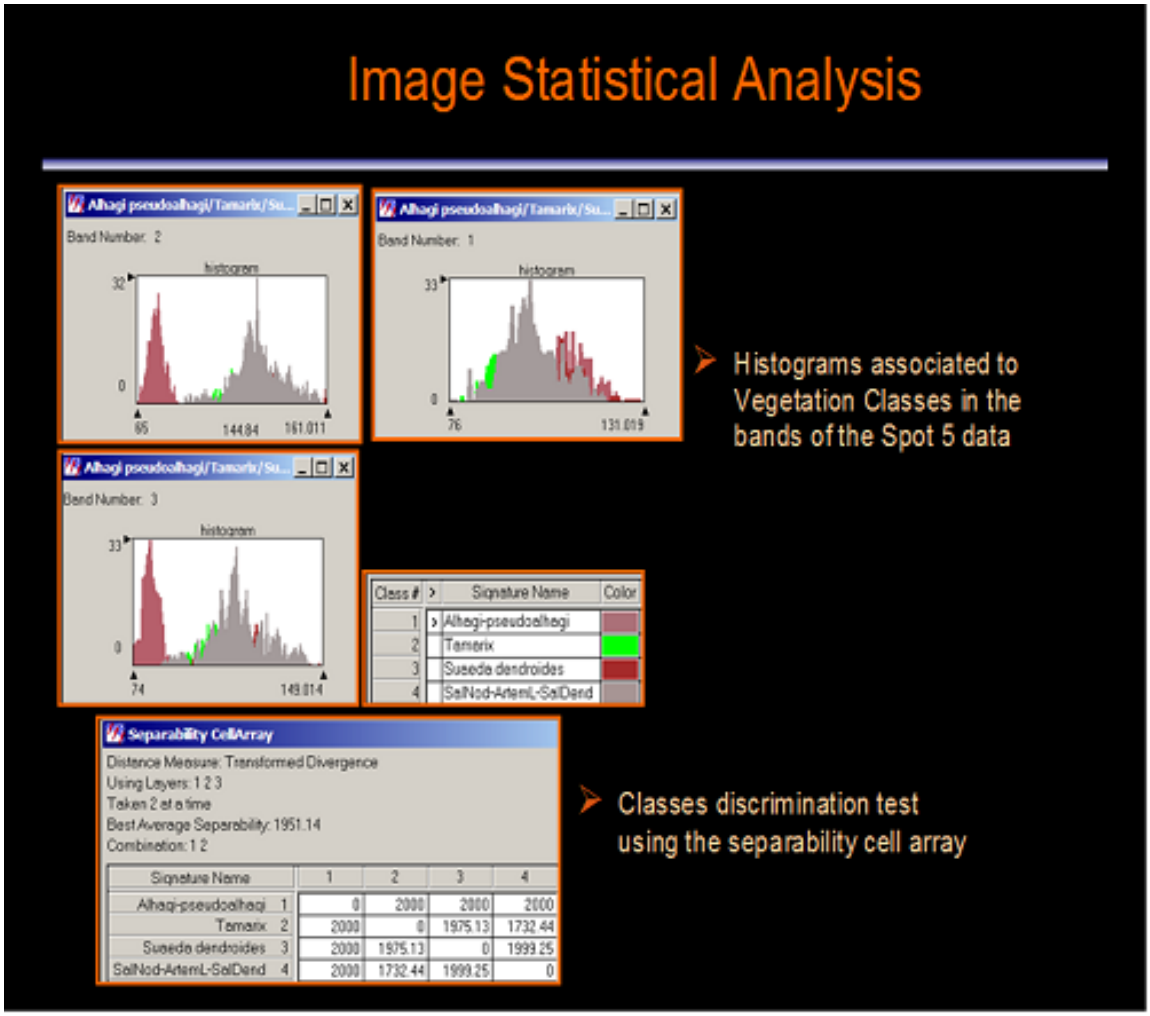


Figure 7. *Image Statistical Analysis: Histograms*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 7: *Image Statistical Analysis: Histograms*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*

Appendix: Figure 8

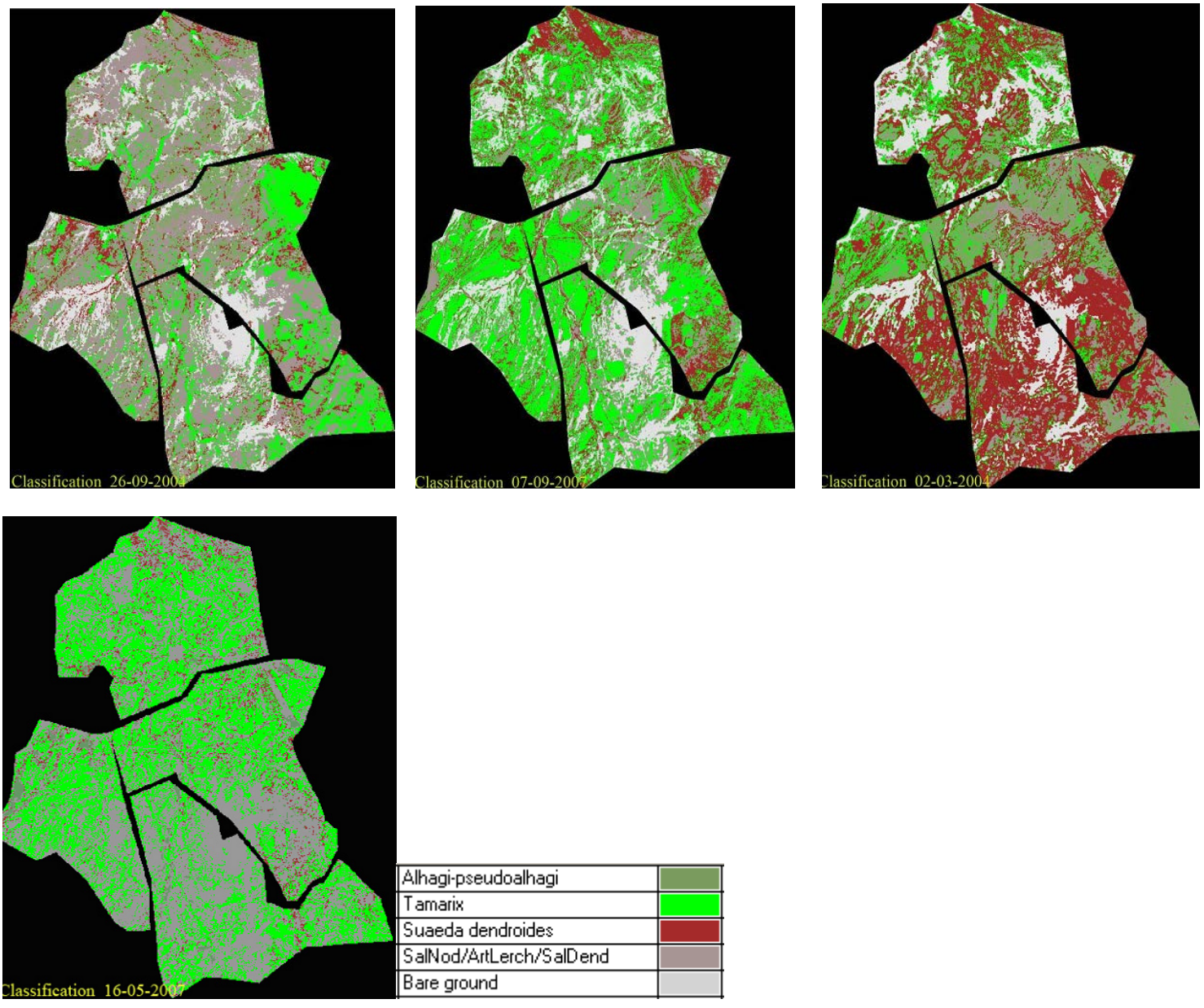


Figure 8. *Rare vegetation Classification*	Module Name: *Rare vegetation Monitoring Training Script*
Reference to Test Script phase 8: *Rare vegetation Classification*	Course Module: *Rare vegetation Monitoring using GIS and Remote Sensing Technologies*