RARE VEGETATION MONITORING IN THE GOBUSTAN NATIONAL PARK, AZERBAIJAN

FINAL REPORT

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ACRONYMS

a.s.l.	Above Sea Level
ESA	Environmentally Sensitive Area
GIS	Geographic Information System
GPS	Global Positioning System
GSNP	Gobustan State National Park
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

ACKNOWLEDGEMENTS

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PROJECT SUMMARY

The Gobustan State National Park is a nationally important desert/semi-desert located west and south-west of Baku, Azerbaijan. In 2007 Gobustan was declared a UNESCO World Heritage Site considered being of "outstanding universal value" for the quality and density of its rock art engravings. The Study Area at Gobustan contains a wealth of historical and archaeological sites and is also known for its rare vegetation. Climate change and various anthropogenic activities are causing large losses to natural habitats in this area. The importance of this habitat type is one of the reasons that the Gobustan desert has been proposed as the State National Park, so that some level of protection is offered to this desert. But ecology and conservation status of the vegetation in this area remain unknown: this vegetation is not listed as vulnerable or threatened.

This study is aimed at establishing and approving the methodology on the monitoring of spatial distribution of the vegetation communities using geo-spatial technologies; to assess evidence of negative trends in the disappearance of rare vegetation and draw recommendations on possible conservation options for the vegetation in Gobustan.

The first stage of the Project is pre-processing stage that includes: Field observation, Species information, Data collection and Data recording. At this stage the data on rare vegetation: description/diagnostic character/species distribution and soil types were collected, quality checked and analyzed as own source of information. Site-specific data were collected in the following formats: vegetation survey sample plots and field check sites.

The second stage of the Project includes as well the processing of remote sensing data to produce "measured" vegetation indicators.

The analysis of the spatial extent and temporal change of rare vegetation cover using remotely sensed data is of critical importance to rare vegetation monitoring. For this study, out of various change detection techniques, spectral change analysis method with special emphasis on vegetation indices was selected. The Normalized Difference Vegetation Index (NDVI) was used for rare vegetation change detection because of its acceptable accuracy and ability to detect the green vegetation. NDVI change was taken an account on the changes which happen on rare vegetation from 2004 to 2007.

The application of indices NDVI series of images supported by the results of the classification supervised generated in GIS indicates the vegetation degradation in the study area.

This study showed that rare vegetation distribution was significantly decreased in the areas which have been affected by anthropogenic and natural activities in this area.

The results indicates that major changes from 2004 to 2007 involved decrease in vegetation cover types including *Alhagi pseudoalhagi (*-10.89%), *Salsola Nodulosa/Artemisia Lerchiana/Salsola Dendroides* communities (-20.58%) and *Suaeda Dendroides* (-8.94%); and increase in *Tamarix* (+17.99%) and *Bare ground* (+4.35%).

The team members organized educational lessons and training for schoolchildren and students.

Our work has also been widely published in national agency AzerNews to make country people more aware of the conservation of the vegetation in Gobustan. As well, some information about the Project has been shared through Internet: some comments about the Project are available at the United Nations Convention to Combat Desertification (UNCCD) and Convention on Biological Diversity (CBD) Internet Web sites.

Three scientific papers have been published in international peer reviewed journals and few others are under preparation.

1. INTRODUCTION

1.1 Background Information

Overview of Flora and Fauna in Azerbaijan

The Republic of Azerbaijan is included within one of Conservation International's 25 'biodiversity hotspots'. There are biologically rich areas that are under the greatest threat of destruction and represent a variety of global ecosystems, identified based on the three criteria: the number of species present, the number of endemic species in an ecosystem and the degree of threat faced. Azerbaijan is included within the 'Caucasus' hotspot.

More than 10% of plants in Azerbaijan are considered to be under danger of extinction, 450 species of them were presented as exotic and extinct species in order to be included in second edition of the Red Book of Azerbaijan Republic (although only 140 of them are mentioned in the current Red Book of Azerbaijan[1]). In 1992 the government recognised that 2,124 plant species in Azerbaijan are rare, endemic, threatened, or of economic importance (Government Order number 167). (Country Study on Biodiversity of Azerbaijan Republic, Fourth National Report to Convention of Biological Diversity, Baku, 2010).

1.2 Location and Conservation Value

The Gobustan is located between the southern outcrops of the Caucasus Mountain range and the Caspian Sea, some 60 km south of the capital Baku as in presented in the Figure 1.

Figure 1. Gobustan, Azerbaijan

The study area at Gobustan contains a wealth of historical and archaeological sites and is also known for its rare vegetation. In 2007 Gobustan was declared a UNESCO World Heritage Site considered to be of "outstanding universal value" for the quality and density of its rock art engravings, for the substantial evidence the collection of rock art images presents for hunting, fauna, flora and

[1] Red Book of Azerbaijan SSR, Published: Ishig, (1989). This classifies species by threat (0-4): extinct, endangered, rare, and vulnerable or data deficient.

lifestyles in pre-historic times and for the cultural continuity between prehistoric and mediaeval times that the site reflects.

The Gobustan semi-desert extends on 1780 km² (178 700 hectares) and is characterized by a semi-arid climate with continental influence and humid, cool winters and dry hot summers. The mean July temperature reaches 26.4°C and the mean January temperature 2°C in this area. Average rainfall is 200-400mm per year in Azerbaijan but can be as little as 150-200mm in semi-desert areas such as Gobustan (*National hydro-meteorological service 2004*).

The climate of this region, characterized by extreme temperatures and low rainfall, makes the land increasingly fragile with respect to anthropogenic impacts (from agricultural and industrial uses), and water management (including irrigation) has had particular impacts on the territory.

1.3 Species Information

The desert vegetation of this region has primary been determined by the extreme climate, with its low rainfall and high summer temperatures, which creates a pronounced seasonal rhythm of growth and seed production typical of interior continental deserts.

The desert communities in the Gobustan State National Park represent the most ecologically important habitat, from a botanic point of view. The great age of many of the desert communities and their slow growth rate further enhance their botanic significance. The importance of this habitat type is one of the reasons that the Gobustan desert has been proposed as a State National Park, so that some level of protection is offered to this desert. Plant communities such as these, which develop very slowly are particularly susceptible to this disturbance and are easily lost, taking many years to recover (at least 10-12 years).

Desert and semi-desert vegetation in this region has two main components, perennial plants and, annual or ephemeral plants. Perennial plants include bushes such as mugwort species (*Artemisia species*) and several species of saltwort (*Salsola species*) which are visible all year, beginning growth in early spring with the rains, slowing in mid-summer and then growing again with the autumn rains until colder temperatures stimulate leaf fall. It is an ephemeroid a long-lived perennial species, which flowers and sets seed early each spring within a 40-50 day period, and then withers until autumn rain stimulate new growth from underground root stocks.
Due to ephemeral nature of the herbaceous species in desert plant communities the different seasonal rhythms of the different vegetation groups, it is the varying dominances of perennial bush species that are used as a basis for vegetation classification. Generally one or two species will form the basis for a vegetation type. Combinations of three or four dominant species are rare.

Table 1 below lists the three prevailing semi-desert botanic communities and their normal restoration time listed in percent ground cover reclaimed over time. Table 2 presents a recovery time in years for each species.

Table 1. Habitat natural recovery rates

COMMUNITY	SOIL TYPE	PERCENTAGE RECOVERY AFTER 1-12 YEARS											
		1	2	3	4	5	6	7	8	9	10	11	12
Salsoletum nodulosae + Suaeda dendroides association	*Argillaceous saline*	*0*	*0*	*5-10*	*10-20*	*20-30*	*30-40*	*40-50*	*50-60*	*60-70*	*80-90*	*90-100*	*90-100*
Artemisietum fragrans + Salsoletum nodulosae association	*Argillaceous saline*	*0*	*0*	*5-10*	*10-20*	*20-30*	*30-40*	*40-50*	*50-60*	*60-70*	*80-90*	*90-100*	*90-100*

Table 2. Recovery time in years for each species

Species	Recovery time in Years
Salsola nodulosa	10-12
Salsola dendroides	10-12
Alhagi pseudoalhagi	1-2
Suaeda dendroides	8-10

Source: Dr. V. Hajiyev, Azerbaijan Academy of Sciences.

Name and floristic description/diagnostic character/species distribution

Salsola nodulosa

Low, 10-30cm, shrub of heavily protruding branches of grayish scales. Buds almost globular, grayish. Leaves periodical, short, and gibbous at the bottom. Flowers singular, in bushy spiciform inflorescence.

Distribution in Azerbaijan: Caspian lowland, Apsheron, Gobustan, Steppe plato, Kura-Araz lowland, Nakhichevan valley

Salsola dendroides

Subshrub, 40-70 cm high, with dense lowered stems of branches in the upper part. Light green plant. Leaves periodical, fleshy, short, adjoining stem. Flowers on spiciform branches in wide paniculate pyramidal inflorescence

Distribution in Azerbaijan: Absheron, Gobustan, Caspian coast, Kura-Araz lowland, Kura zone, Nakhichevan valley

Artemisia fragrans

30-40 cm high perennial. Vertical root, lower leaves have stalk, oblong, seated, globular. Inflorescence narrow, pyramidal paniculate. Flowers yellow.

Distribution in Azerbaijan: Gobustan, Samur-Devechi lowland, Caspian lowl., Apsheron, Kura valley, Lencoran, Mugan.

Alhagi pseudoalhagi

Perennial, reaches 60 cm. Deep rooted. Light green naked plant. Straight stem, oblong obtuse leaves, flowers on leave fistula.

Distribution in Azerbaijan: Major Caucasus (Guba zone), Gobustan, Samur-Devechi lowland, Caspian coast, Apsheron, Kura zone.

Tamarix
Naked, bluish grey shrub of brown greyish bark. Spear-shaped coming down leaves. Clusters lateral cylindrical, 3-9mm wide. Bracts blunt, 1- 2mm long. Corona bell-like. Petals pink, egg-like, straight. *Distribution in Azerbaijan*: Major Caucasus (Guba zone), Steppe Plato, Kura-Araz lowl. Nakhichevan valley, alluvial soil.

Gobustan, the easternmost part of the Greater Caucasus, ranges from the Caspian shore up to its highest point, Mount Gijäkiat 1047 m a.s.l. The vegetation changes with rising elevation from semi deserts with salt shrubs to semi-deserts and steppes with wormwood to grass steppes at higher altitudes. In the rain shadow of hill ridges, it is generally more desert-like than in the surrounding area. Furthermore, a distinction can be made between northern and southern slopes of the tall mud volcano cones, rising up to 400 m above the surrounding.
The height above the Caspian Sea level as well as the soil texture is main factors on the development of certain vegetation communities. The vegetation types described below (Figure 2).

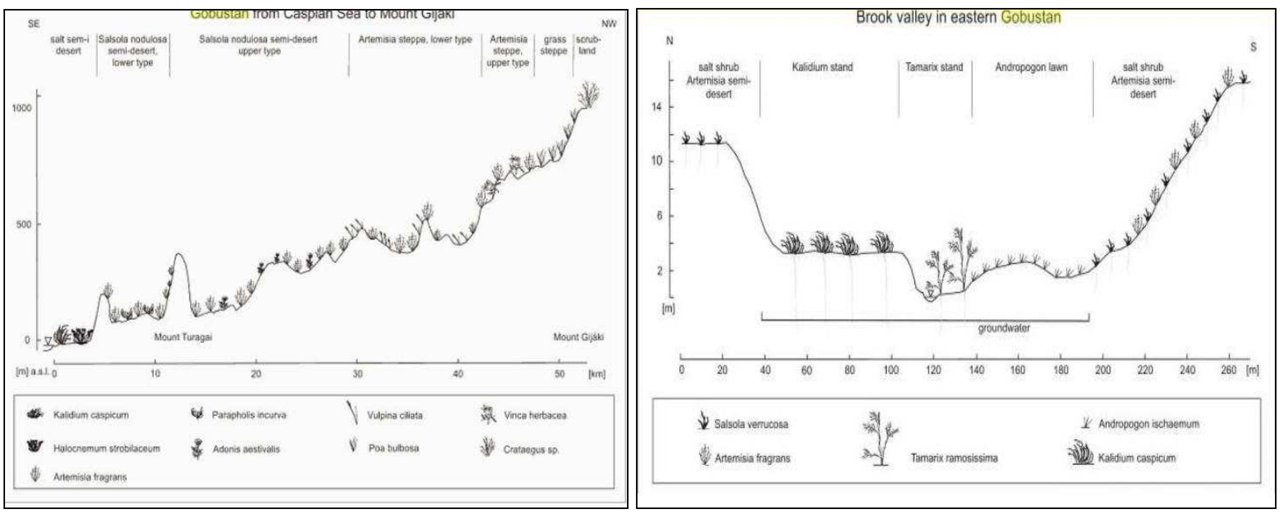


Figure 2. Gobustan: Cross section from the Caspian Sea to Mount Gijäki
Source: Sebastian Schmidt, Martin Uppenbrink, Michael Succow Foundation. Potential Analysis for Further Nature Conservation in Azerbaijan, 2009

2. OBJECTIVES

General Objective
To assess evidence of negative trends in the disappearance of rare vegetation in GSNP and amend the current situation. The project also seeks to build the capacity of relevant organizations and institutions for quantitative evaluation of rare vegetation spatial distribution.

Specific objectives
- To establish and approve methodology on the monitoring of spatial distribution of the communities using geo-spatial technologies and geo-spatial data;
- To identify some of the threats facing rare vegetation in GSNP;
- To draw recommendations on possible conservation options for rare vegetation in GSNP.

3. METHODOLOGY

One of the most important areas of ecological study is the quantitative assessment of biomass production. These measurements have a direct correlation to the level of primary, or photosynthetic, productivity in a biological system. Investigation of biomass production typically involves taking leaf or plant level measurements on representative tracts and scaling the data to larger areas. Data acquisition becomes more difficult with larger study areas, and projections of regional biomass flux become inaccurate. Geographic Information Systems (GIS) and Remote Sensing provide new and powerful tools for large-scale biomass measurements. The processing of satellite imagery and its analysis in a GIS provide a useful method for assessing large-scale photosynthetic biomass flux over time.

The methodological approach of this project includes training in the field of identification and census methods and the use of standardized monitoring methods. Remote Sensing (RS) and Geographic Information Systems (GIS) together form a powerful information acquisition and analysis tool for monitoring environmental changes.

Flow-chart in Figure 3 shows the analysis methods applied in the study to attain the research objectives.

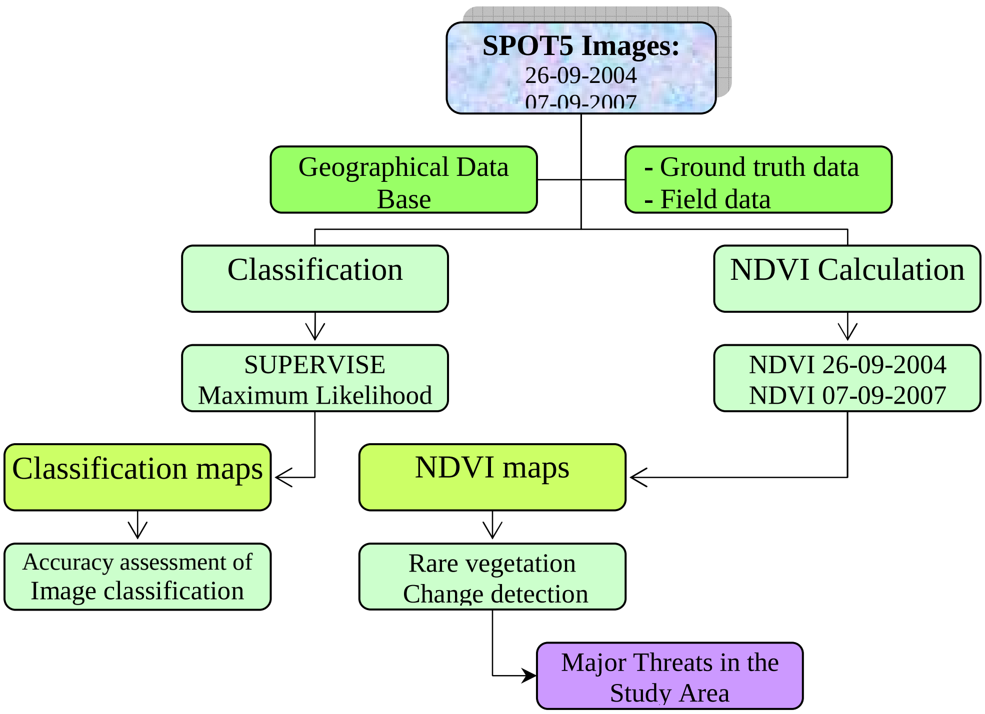


Figure 3. Flowchart of methods applied in the study

SPOT 5 images in 2.5m and 5m resolutions, acquired between 2004 and 2007 were used for analysis of rare vegetation distribution. Analysis of the distribution of rare species was focused on an **Environmentally Sensitive Area** (ESA) which is a type of designation for an area which needs special protection because of its landscape, wildlife or historical value. The Sensitive Area within GSNP was divided into four parts conditionally definable as: North, West, East and South (Figure 4).

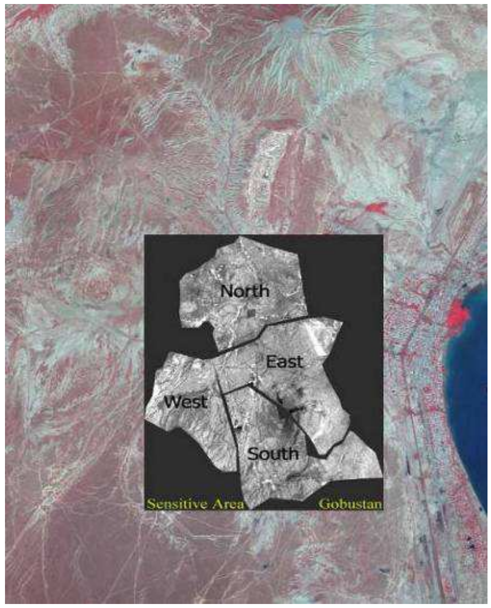


Figure 4. Environmentally Sensitive Area in GSNP

4. DATA COLLECTION

4.1 Field observation

The field surveys were carried out beginning in mid – August 2010 and ending at the end of April, 2011. A total of four different field reconnaissance trips were made. Before each field reconnaissance trip was made, mission preplanning was conducted to ensure successful data collection. Specific factors where considered for data collection:

1. Geographic distribution - an attempt to obtain point data evenly throughout the study area
2. Proximity routes - for travel purposes
3. Comprehensive classification - to ensure point data was collected for all rare vegetation classes employed in this study.

Field Survey 1

The preliminary vegetation survey was undertaken by our team in August 2010. Because of scattered distribution of vegetation these fieldwork activities were done in different locations. Route planning is usually carried out to achieve a single objective such as to minimize transport cost, distance traveled or travel time. In order to find an optimal route we needed topography maps and maintenance facilities. Printed map sheets with patch boundaries overlaid on the image, as well ancillary information such as determination of optimal diversion route to object of interest, were taken into the field.

4.2 Data Recording

During this survey we compared satellite images with what really existed on the ground, establishing the so-called "ground truth".

Every plot was registered with Global Positioning System (GPS) device to allow further integration with spatial data in GIS and image processing systems (*Appendix 1*).

The Global Positioning System has developed into an efficient GIS data collection technology which allows for users to compile their own data sets directly from the field as part of 'ground truthing'

(*Cunningham, 1998*). Ground-truth surveys are essential components for the determination of accuracy assessment for classified satellite imagery (*Congalton, 1996*).
The Field Survey was conducted in order to collect qualitative and quantitative data and information on actual rare vegetation classes to be use for supervised classification analyses.
The measurements were done on two different dates of the growing seasons. GPS measurements were done at selected points of geographical coordinates in system WGS84.

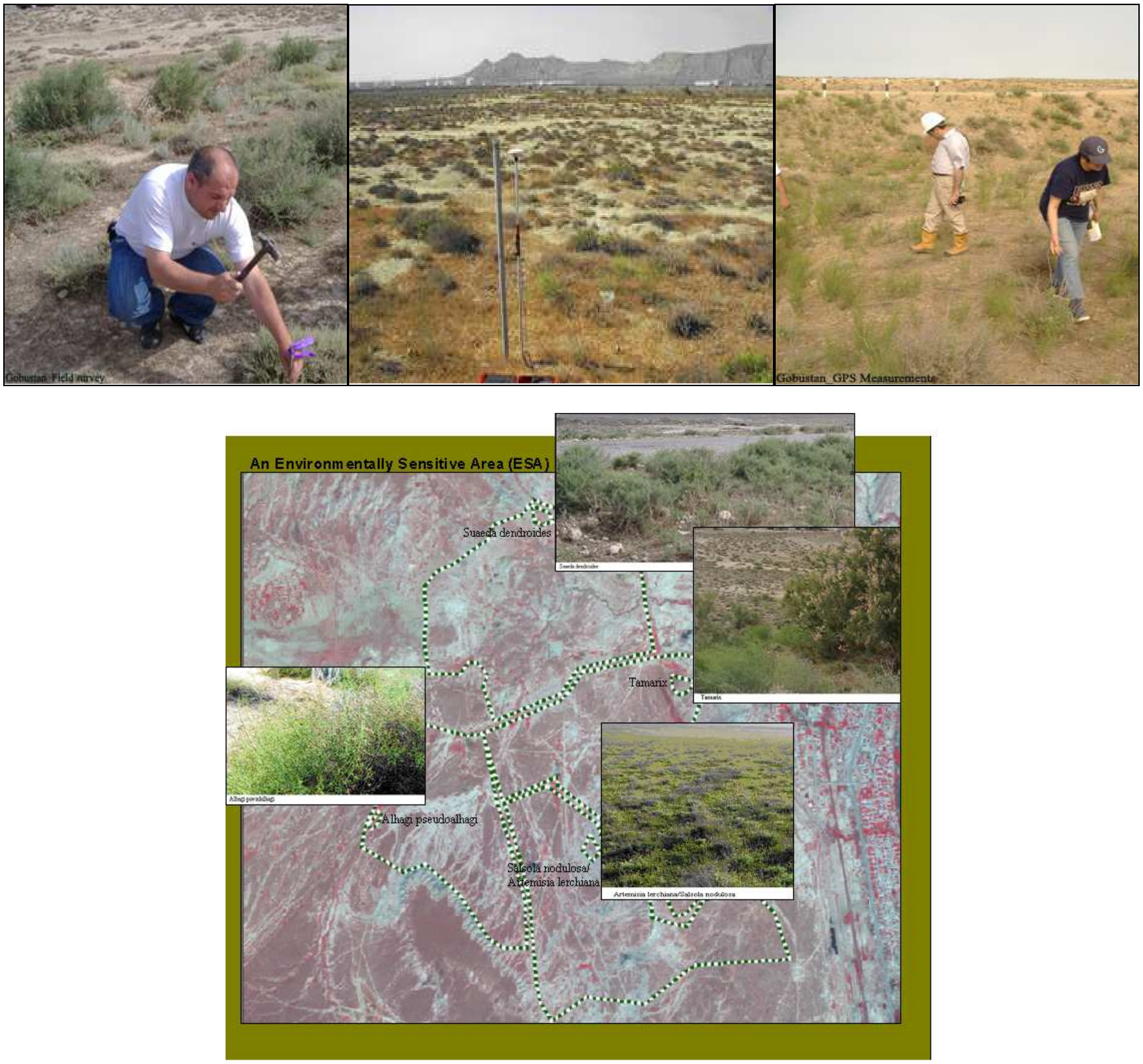


Figure 5. Field surveys, growing season.

As the result of these Field Surveys, we sufficiently enlarged our data and information on the rare vegetation distribution in Gobustan. Sampling was conducted in the Sensitive Area of Gobustan National Park, where we registered new localities of the vegetation (Figure 5). The latitude and longitudes were recorded for each plot (*Appendix 1 and Appendix 2*).

Field Survey 2

Field Survey 2 was conducted to:

- Identification of the floristic and structure of the vegetation type in GSNP
- Provide confirmation of rare plants recorded in vegetation samples (releves)
- Soil types identification in GSNP
- Better understand the current distribution and abundance of plants in GSNP

The identification of collected plants is verified using plant keys and by consulting with other botanists (Figure 6).

Tamarix, Gobustan, November 2010
Termination of vegetation period

Salsola nodulosa/Suaeda dendroides communities
Gobustan, 2011

Field Survey in Gobustan, November 2010
Identification of the floristics and structure of the vegetation type

Field Survey, Gobustan 2010
Vegetation samples

Figure 6. Field surveys, November 2010.

Soil and soil types

The expanses of semi-desert communities that occur in the eastern plains and at the foot of the west hills and in the north hills vary in species composition and abundance where there are differences in soil type and salinity levels. The topsoil in the Gobustan desert region is very thin and has an elevated salinity, supporting sparse, saline tolerant vegetation (Table 3).

***Salsola nodulosa* and *Suaeda dendroides* association**

The *Salsola nodulosa* and *Suaeda dendroides* association is common for this region and is characteristic of *Solonchak* (i.e. soils containing relatively high levels of neutral salts) and *Salsola dendroides* with slightly saline, clay and pale loam soils. Homogonous groupings of *Salsola nodulosa* and *Suaeda dendroides* would occur where these soils types occurred discretely, with the former species showing a preference for *Solochak* and the latter species preferring the slightly saline clay.

Table 3. Main indicative desert and semi-desert shrubs and their soil and salinity affinities

SPECIES	SOIL AFFINITY
Mugwort sp (*Artemisia fragrans*)	Low salinity, typically clay
Saltwort sp (*Salsola dendroides*)	Slight salinity, clay and pale loam
Saltwort sp (*Salsola nodulosa*)	Salty pale soils (Solonchak)
Sea blight sp (*Suaeda dendroides*)	Salty pale soils (Solonchak)


Solonchak associated with Salsola nodulosa,
Gobustan, September-October 2010

Solonchak associated with Salsola nodulosa,
Gobustan, November 2010

Salt accumulations on the soil surface and polygonal cuts below Salsoletum nodulosae,
Gobustan_2010

Salsola nodulosa
Gobustan, November 2010

Figure 7. Soil types in Gobustan

5. DATA PROCESSING AND ANALYSIS

5.1 Statistical analysis. Results and interpretation

In this study, the NDVI techniques of change of rare vegetation distribution were applied (*Galvгo et al., 2000, Sader et al., 1992 and Lillesand et al., 2007*).
NDVI values which extracted for SPOT5 26/09/2004 and SPOT5 07/09/2007 images were compared statistically. NDVI change was taken an account on the changes which happen on rare vegetation distribution from 2004 to 2007.

Comparison of NDVI values on the Sensitive Area as a whole
An attempt was made to show whether any differences in NDVI values will come up when using methods of statistical analysis. The Median, Mean, Standard Deviation values are shown in Figure 8 and in Table 4. As Table 4 shows the NDVI values in 2007 generally lower than in 2004 year.

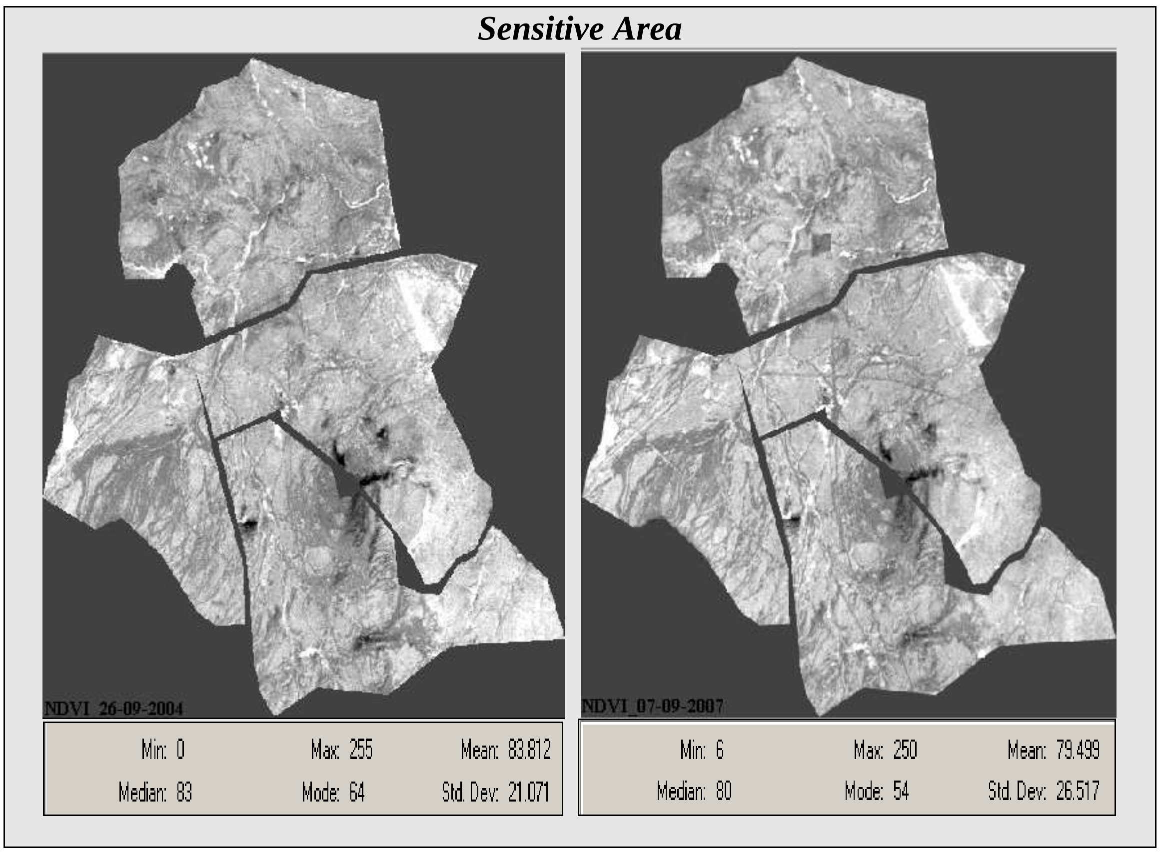


Figure 8. Results of Statistical analysis on the NDVI: 26/09/2004 and 07/09/2007

Figure 8 shows both periods of NDVI images. It shows that high reflectance of vegetation was seen in 2004 image of the study area, with increase in NDVI values. Conversely, vegetation reflectance is low in 2007 image, likewise in NDVI value.

Comparison of NDVI values on the North, West, East and South as segments
Comparison of NDVI values on *North, West, East and South* as segments was also done for NDVI images for 2004 and 2007 years (*Appendix 3)*.

The statistical analysis carried out on NDVI values for the North, West, East and South parts of Sensitive Area have shown that the reduction of NDVI values in 2007 was significant (Table 4)

Table 4. Results of Statistical analysis on the North, West, East and South parts of the Sensitive Area

North-West-East-South	Mean	Std. Deviation
NDVI_ North _26-09-2004	37.876	23.352
NDVI_ North _07-09-2007	41.796	30.732
NDVI_ West _26-09-2004	60.130	35.085
NDVI_ West _07-09-2007	41.796	30.732
NDVI_ East _26-09-2004	89.925	24.466
NDVI_ East _07-09-2007	82.513	28.855
NDVI_ South _26-09-2004	97.071	74.395
NDVI_ South _07-09-2007	38.165	30.637

5.2 Rare vegetation classification in the Sensitive Area of GSNP

Figure 9 shows the spatial extent of rare vegetation after classification according to supervised classification.

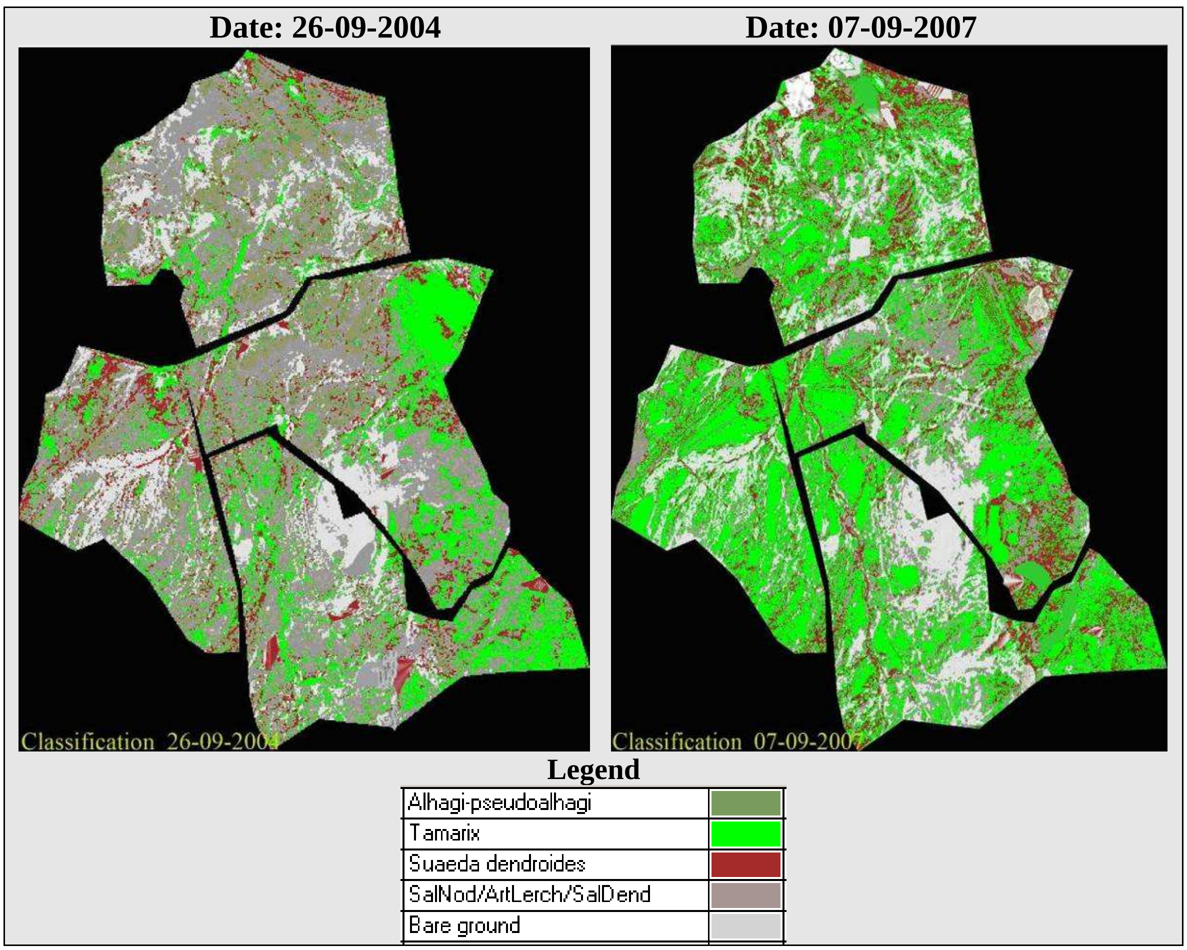


Figure 9. Rare vegetation classification

The application of indices NDVI series of images 2004 and 2007 supported by the results of the classification supervised generated in a geographic information system has permitted to determinate vegetation degeneration in the study area.

5.3 Change detection using Normalized Difference Vegetation Index

The use of remote sensing data in recent times has been of immense help in monitoring the changing pattern of vegetation. Change detection as defined by *Hoffer (1988)* 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. *Singh (1989)* described change detection as a process that observes the differences of an object or phenomenon at different times.

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. Figure 10 shows the changing pattern of vegetation for both periods been crossed.

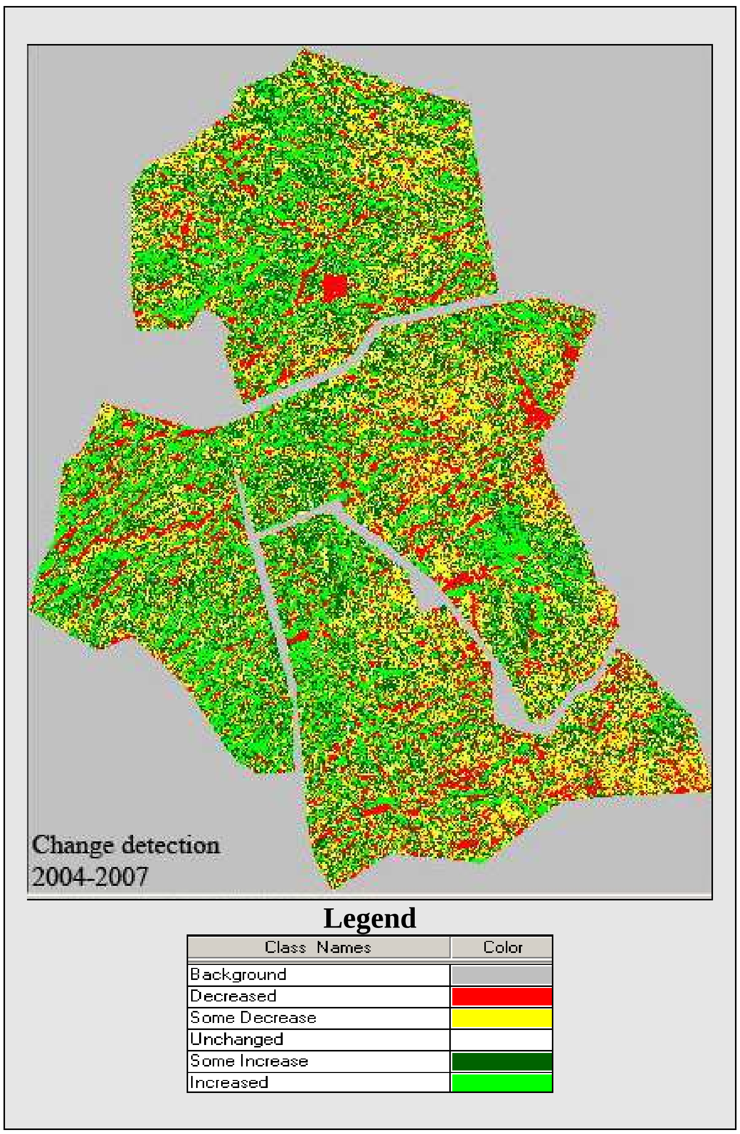


Figure 10: Sliced map of difference of NDVI values in 2004 and 2007. Red - highly

decreased NDVI values in 2007, yellow – some decreased NDVI values in 2007, white - no change NDVI values, green - increased NDVI value in 2007.

Change detection was taken an account on the changes which happen on 2004 to 2007. The Change Image is a five-class thematic image, typically divided into the five categories of Background, Decreased, Some Decreased, Unchanged, Some Increase, and Increased (Figure 10).

5.4 Rare vegetation degradation in the Sensitive Area of GSNP

Premised on the objective of this study, vegetation cover over the study area has changed. The above mentioned methods for analysis have proved this change. Table 5 shows the spatial extent of vegetation after classification according to supervised classification for both images.

Table 5. Spatial extents of rare vegetation in GSNP

Rare vegetation communities	**Area in hectares, September 2004**	**% of the area**	**Area in hectares, September 2007**	**% of the Area**	**% change between both periods**
Alhagi pseudoalhagi	229.26	15.85	70.7	4.96	10.89 decrease
Tamarix	251.07	17.36	503.07	35.35	17.99 increase
Suaeda Dendroides	240.36	16.9	113.15	7.96	8.94 decrease
Salsola Nodulosa/ Artemisia Lerchiana/ Salsola Dendroides	622.13	43.08	320.64	22.5	20.58 decrease
Bare ground	230.64	15.95	288.75	20.3	4.35 increase

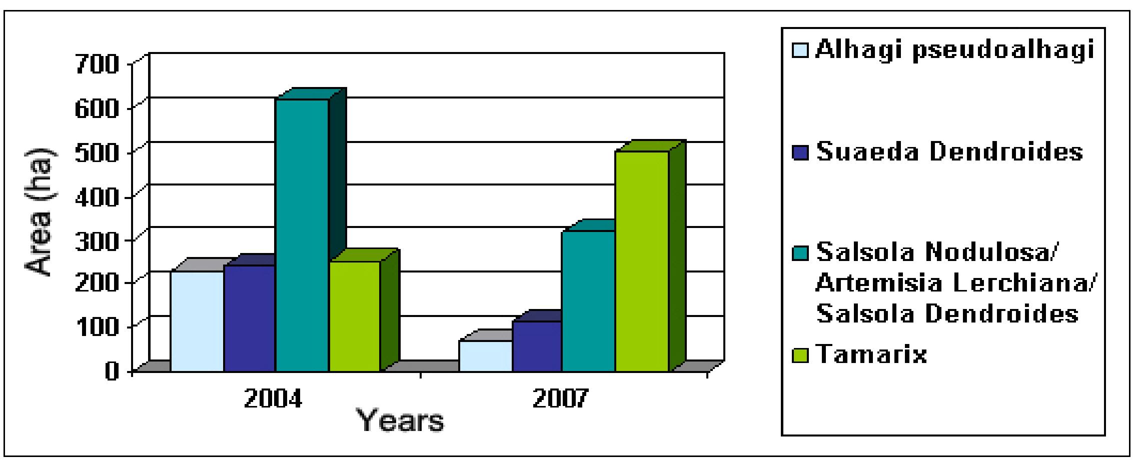


Figure 11. Rare vegetation distribution from 2004 to 2007 years in the study area (Area in hectares)

The results indicates that major changes in the study area from 2004 to 2007 involved decrease in vegetation cover types including *Alhagi pseudoalhagi* (-10.89%), *Salsola Nodulosa/Artemisia Lerchiana/Salsola Dendroides* communities (-20.58%) and *Suaeda Dendroides* (-8.94%); and increase in *Tamarix* (+ 17.99%) and *Bare ground* (+4.35%) - Figure 11.

The rapid development of infrastructure in the region during the last decade contributed to the rapid spread of *Tamarix*, which began to capture more space near humidified sites.*Tamarix* has a deep, extensive root system that extends to the water table, and is also capable of extracting water from unsaturated soil layers (a facultative phreatophyte). Initially, the primary root grows steadily downward with little branching until it reaches the water table, which can be at the depth of 3 m or deeper (Figure 12). Once the water table is reached, secondary root branching becomes profuse. An extensive root system is largely responsible for its competitiveness and survival under stress.
Analysis of biological and ecological characteristic of *Tamarix* and its effect on the ecological environment demands special optional research efforts, more surveys and ground measurements.

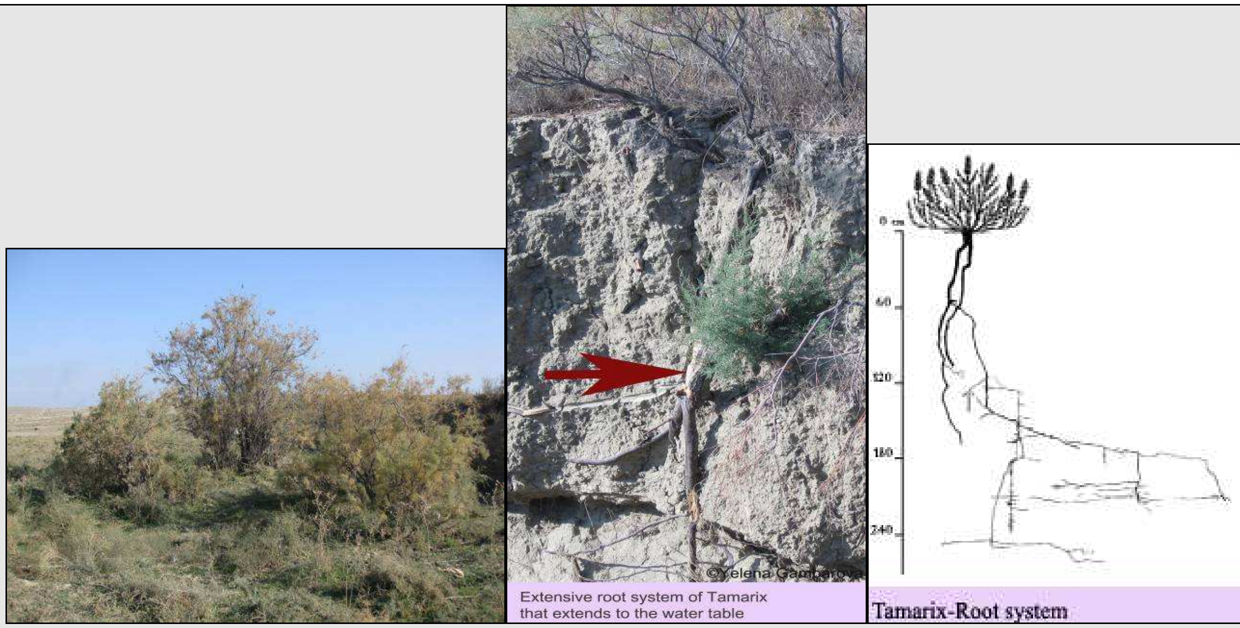


Figure 12. Root system of *Tamarix*

6. IMPACTS OF RARE VEGETATION DEGRADATION

Threats facing to rare vegetation in the Gobustan National Park

In this study we outline the main threats facing to rare vegetation and their habitats. In order to learn more about these threats, our team has organized field surveys in the study area. During the surveys we highlighted some potential threats facing to rare vegetation in the Gobustan National Park.

Accompanying the images are insights from Gobustan, details on how we made information on the threats facing each species. We examined the types of threats facing species.

Direct Threat 1: Overgrazing
Overgrazing of winter and summer pastures by domestic sheep, goats and cattle is a major threat to terrestrial biodiversity. In many cases overgrazing threatens rare and endemic plants. Traditionally, the main land use system of Azerbaijan used to be extensive livestock breeding with summer pastures in the mountains and winter pastures in the lowland steppes. And still today they provide very important fodder grounds for livestock production. Apart from the oil business, agriculture including livestock

breeding plays the most important role in the country. Number of sheep and goats increased by 60% from 4.6 to 7.5 million heads from 1995, when privatization reform began, until 2005 (FAO 2006).

Some vegetation is strictly protected by law, while others extensively for livestock grazing, particularly in the winter when mugwort species (*Artemisia species*) are palatable to animals due to low concentrations of alkaloids. In the spring and summer alkaloid concentrations are high making the plants unpalatable. Saltwort species (*Salsola nodulosa*) is a plant of very high nutritional value and provides much more energy per gram than mugwort species (*ESIA Ecological Baseline Report, 2002*). The semi-deserts of Gobustan are mainly used as winter pastures (November-April/May) for various livestock (Figure13).

Goat herds, Gobustan, 2010

Project team with cattleman
Gobustan, November 2010

Cowherds in Gobustan, November 2010

Drinking place for sheet, Gobustan

Figure13. Direct Threat 1: Overgrazing. *(Photos by Yelena Gambarova, 2010-2011)*

In addition, herdsmen have built artificial ponds to catch the surface runoff as drinking water for livestock (Figure13).

Direct Threat 2: Infrastructure Development

Oil and gas exploration and all of the equipment, platforms, wells, processing plants, reservoirs and pipelines dominate much of coastal Azerbaijan and oil spills along the coast are a common problem The well at the Duvanniy field have been gas well with project depth 3,000 meters. The daily debit of the gas from the Southern-Eastern Gobustan comprises 400,000 cub m fuel or 12 million cub m a month. Gobustan in particular is crossed by a growing number of oil, water and gas pipelines. Pipeline construction and petroleum exploration damage long strips of soil and vegetation that are slow to recover.

To identify this threat, our team has made field surveys in April 2011 (Figure 14). The task of the survey team has been to inspect this potential threat for rare vegetation.

Gobustan Operating Company Duvanniy Base, 2011

Infrastructure Development, Gobustan 2011

Dark brown indicating negative effect of infrastructure development on local vegetation Gobustan 2011

Figure 14. Direct Threat 2: Infrastructure Development. *Photos by Yelena Gambarova*

It shows a typical pattern of single halophytic shrubs, like *Salsola nodulosa*, on bare soil. Almost all plots are affected by erosion.

Other Threats:

Climate change threat to natural resources:

Based on global models of Climate Change, experts estimate that average temperatures in Azerbaijan could increase more then 2°C. Associated with this it is expected that the incidence of temperature extremes will increase, as will extreme weather events. This process will strongly affect the Gobustan area, where the climatic and anthropogenic factors of climate change would coincide with each other. Global Climate Change is increasingly affecting local vegetation due to increasing the annual temperatures, which modify the vegetation community's distributions. Change in climate and atmosphere features effects upon function of ecosystem and subsequently, causes to decreasing of biodiversity.

Natural contamination

In the Gobustan area natural seepages of crude oil occur in small quantities from mud volcanoes. As a result, an elevated concentration of hydrocarbons, metals and phenols from natural sources (mudflow and seepage) presents threat to local vegetation. Over 300 mud volcanoes are present in Azerbaijan, the majority of which are found in the Gobustan. Mudflows form as the mud travels down slope away from its source. The total volume of gas emitted by all mud volcanoes in Azerbaijan is estimated to be about 20 million cubic meters each year *(Gallagher et al, 2001)*. Gas emitted by mud volcanoes of Gobustan is composed mainly of CH_4 (90–99.8 vol%) and CO_2 (0.2– 8.6 vol%) *(Etiope et al, 2004)*.

Mud flow creates deep cuts on the slopes, Gobustan

Figure 15. Gobustan, *Photo by Yelena Gambarova, 2011*

7. RECOMMENDATIONS

Consultations were carried out with local communities and discussions were conducted to generate ideas regarding measures for reducing threats to rare vegetation in the study area.

All participants foresaw a big need to have clear and forward-looking environmental management policies to ensure that these resources are conserved to sustain both the present and future generations.

Arising from the threats mentioned above, from the ecological information of the vegetation, and from the outcomes of this project on rare vegetation distribution are the following recommendations, which aims to reduce these threats and protect each species:

How rare vegetation in GSNP can be conserved and protected against further threats:

- More surveys and monitoring are needed to identify all the available rare species, and generate data for the GSNP authority use in the management of this area.
- Establish the biodiversity status of the vegetation in GSNP to convince the policy maker to change the conservation status of the vegetation populations presented in this research.
- Encourage local communities' participation in the conservation activities, for example, by offering the local communities with alternative sustainable livelihoods like eco-tourism so that they can reduce the number of sheep and goats that are regularly herded through this area.
- Set educational and awareness programs, ecological teaching programmes and ecological clubs should been developed for schools.

8. CONCLUSION

The three most important outcomes of the project

- The most important outcome is that rare vegetation monitoring using Remote Sensing approach gave significant results. During the project, detailed and updated information about rare vegetation communities were collected and presented; a database on the status of these species and their habitats in selected sites combined; and the acquired data skillfully processed. The statistical analysis carried out on the NDVI values in different years show disappearance of rare vegetation.

- The data we are producing is crucial to design conservation and management strategies for rare vegetation, and also to identify sensitive areas for the spatial zoning scheme, particularly in the Gobustan National Park to be created in the short term.

- The recommendations which aim to reduce threats to rare vegetation and protect each species were determined.

A key observation based on the field reconnaissance and analysis is as follows:

The study area has been undergoing direct and indirect activities for these years. In areas undergoing direct activities (natural and anthropogenic), the effect of these activities has left the study area with degraded land, bare surfaces today. The data we are producing is crucial to design conservation and management strategies for rare vegetation, and also to identify sensitive areas for the spatial zoning scheme, particularly in the Gobustan National Park to be created in the short term.

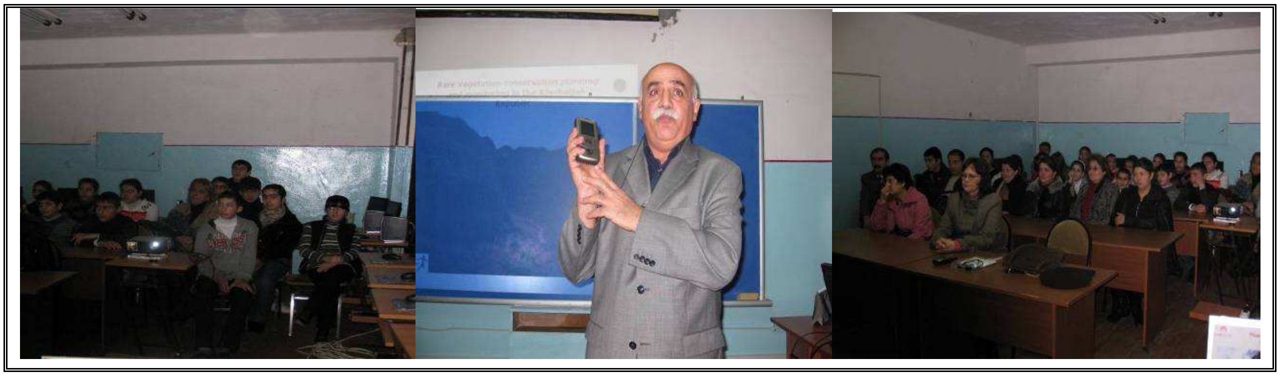
9. RESULTS DISSEMINATION

9.1 Education and Public awareness activities

Increasing outreach of awareness campaigns of conservation education in schools

Enlightenment work in school of Baku was conduct. Team members organized educational lesson on the “Rare and endangered species and their protection against disappearance” for schoolchildren in Baku school. Supporting materials banners and leaflets were used during the lesson. 30 participants attended the training: schoolchildren, teachers and director of the school. Pictures, maps, GPS equipment and slides were used to have a better illustration of the field work.

By using interactive methods during the training, participants were informed about the threat of disappearance of rare and endangered species and importance of their conservation. Moreover, participants shared with their knowledge and experiences and one of them, the director of the school, said that it is also necessary to conduct such trainings for schoolchildren to bring up on them love and a serious attitude towards environment as a whole.



Photos: Educational lesson in Baku school

Involvement of students in environmental activities

Two training sessions were conducted on the "Using new space technologies for rare vegetation monitoring" in Training Centre, Baku. Within the framework of this training, importance of vegetation's role in ecosystems and necessity of their conservation as well as Remote Sensing and GIS as an advance space technology for rare vegetation monitoring, were undertaken.

Photos: Training centre, Baku, Azerbaijan

9.2 Media Appearance

During implementation of the Project few articles, describing the main point of work done by our team, were published in the international peer-reviewed journals.

Scientific articles based on the results of the monitoring and the data base analysis in the Gobustan National Park was published in:

1. Yelena M. Gambarova, et al., Remote Sensing and GIS as an Advance Space Technologies for Rare Vegetation Monitoring in Gobustan State National Park, Azerbaijan, *International Research Journal of Geographic Information System*, Volume 2, 2010, 93-99.
www.scirp.org/Journal/Home.aspx?IssueID=261

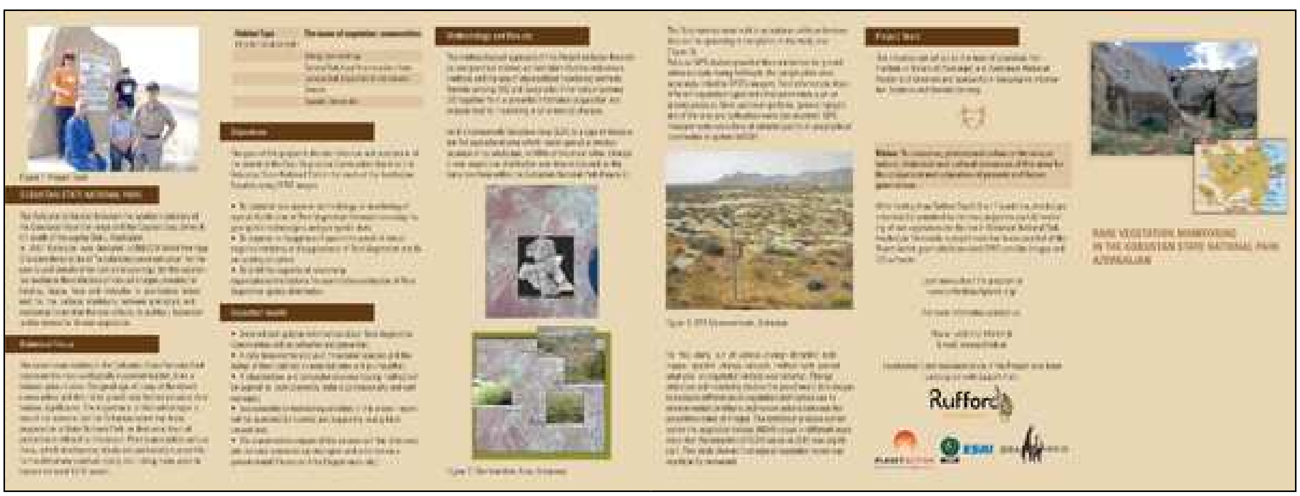
2. Yelena M. Gambarova et al., Rare vegetation classification of remotely sensed images, Gobustan National Park, Azerbaijan, *International Geoinformatics Research and Development Journal,* Vol. 1, Issue 2, June 2010.
www.igrdg.com/Home.htm

3. Yelena M. Gambarova et al., Using Remote Sensing Technique for Monitoring Rare Vegetation Degradation in Azerbaijan, *3rd International Conference on Geoinformation Technology for Natural Disaster Management*, 19-20 October, 2010, Thailand.

3rd International Conference on Geoinformation Technology for Natural Disaster Management & Rehabilitation was held in Chiang Mai, Thailand, 19-20 October 2010. The symposium will focus on the use of geoinformatics for natural disaster preparedness such as earthquake, flood, typhoon and tsunami etc., and for rehabilitation and risk management by exploring the various causative factors. There will also be deliberations on how to use GIS for better planning of risk areas.
For more information about the conference please visit the conference website
www.e-geoinfo.net/git4ndm2010/conf.htm

Success Stories
As well, some information about the Project has been shared through Internet: for example, some Comments about this Project were post by Yukie HORI - Coordinator of United Nations Convention to Combat Desertification (UNCCD) on website:
http://www.unccd.int/publicinfo/partners/stories.php?newch=gobustan

Information brochure "Rare vegetation of the Gobustan State National Park under close attention"
We contributed in the design of a leaflet, aiming at highlighting this Protected Area, natural area resources value, mainly rare vegetation. 100 leaflets were printed and distributed during public campaigns: at training sections, meetings and conference. They were also sent to primary schools.



Information brochure published under the Project

PLANS FOR THE FUTURE: The Way Forward

Our objective is to continue this project to a greater extend. We aim to complete planned activities which will include obtaining more information about *Tamarix* distribution in recent years.
The results of this study have shown the rapid growth of *Tamarix* between 2004 and 2007 years.

Tamarix have occupied 503 hectares in 2007 (35% of the Study Area) as compared with 2004 (17% of the Study Area) (Table 5). Comparatively, the area occupied by *Tamarix* in 2007 is slightly larger than twice the size of the territory in 2004.

To our knowledge, this distribution map is the first approximation towards modeling the potential range in GSNP. The result produced in this study show that there is a very high risk of *Tamarix* distribution over large areas in Azerbaijan. Comprehensive *Tamarix* field surveys are thus required to confirm the preliminary results of this study. Analysis of biological and ecological characteristic of *Tamarix* and its effect on the ecological environment (including rare vegetation) demands special optional research efforts, more surveys and ground measurements. Analyzing the effect of *Tamarix* on the ecological environment, we should to take into account its positive and negative role *(Egan, 1996), (Zeng et al, 2002).*

The Future project will include the response of rare vegetation to the rapid growth of *Tamarix* in the study area. Future work will also have to include the analysis of higher resolution remotely sensed time series (from 2007 to 2010 years).

We have intention to continue what we were able to start last year very successfully, with the aim to improve scientific investigations, increase the public's awareness and achieve political decisions in order to safeguard rare vegetation in the regions of Azerbaijan.

The Future project will facilitate further in-depth training, interaction, and coordination of Azerbaijani teachers, students, and other groups interested in preserving their ecosystem. Details of planned future activities will be included in the application for a second RSGF.

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Appendix 1

Field Survey 1

Sample Plot Proformas

Habitat Type	The name of vegetation communities	Sample plot GPS coordinates
DESERT/SEMI-DESERT	Salsola Nodulosa/ Artemisia lerchiana	49º21'59.43"E 40º05'52.10"N 49º22'23.72"E 40º04'48.75"N 49º22'39.36"E 40º03'29.91"N
	Salsola Nodulosa/ Salsola dendroides	49º22'11.23"E 40º04'28.90"N 49º22'18.64"E 40º05'12.97"N
	Suaeda dendroides	49º22'30.23"E 40º06'11.59"N 49º23'19.01"E 40º04'36.56"N 49º21'44.05"E 40º04'32.81"N
	Alhagi pseudoalhagi	49º22'53.63"E 40º05'19.66"N 49º22'34.05"E 40º05'03.07"N
	Tamarix	49º23'18.72"E 40º05'2.51"N 49º23'57.4"E 40º03'30.91"N 49º22'27.54"E 40º03'30.99"N

Appendix 2

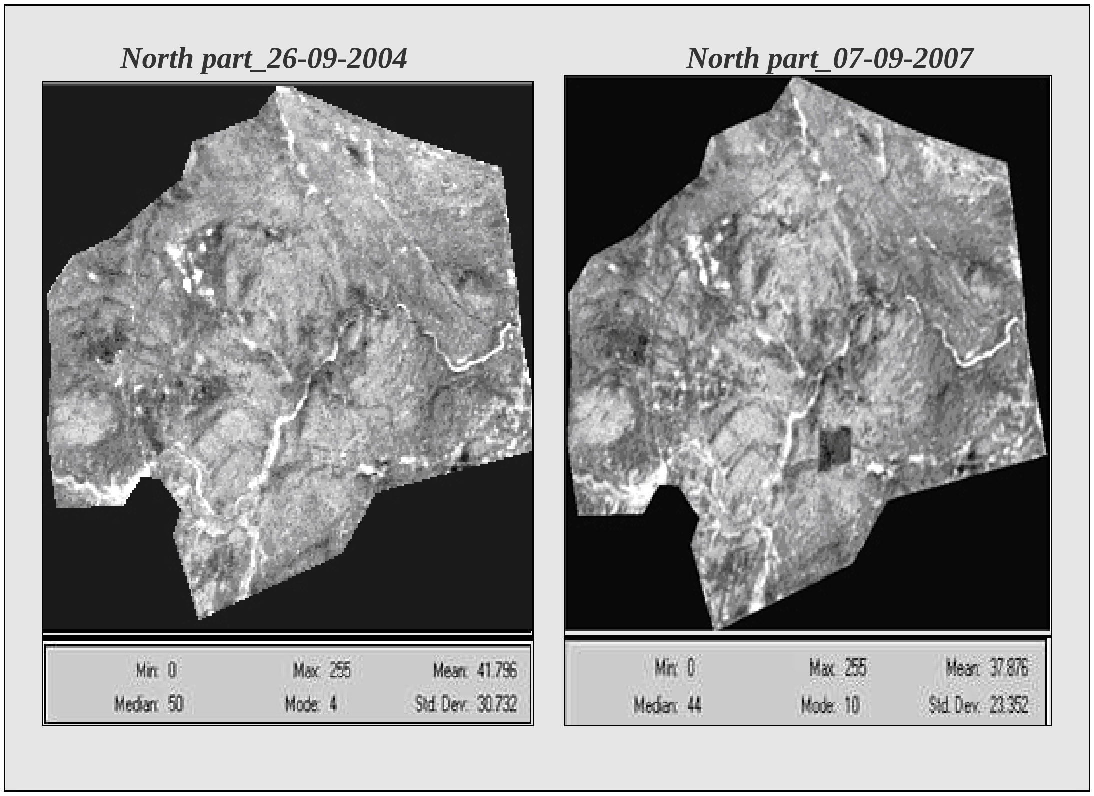
Field Survey 2

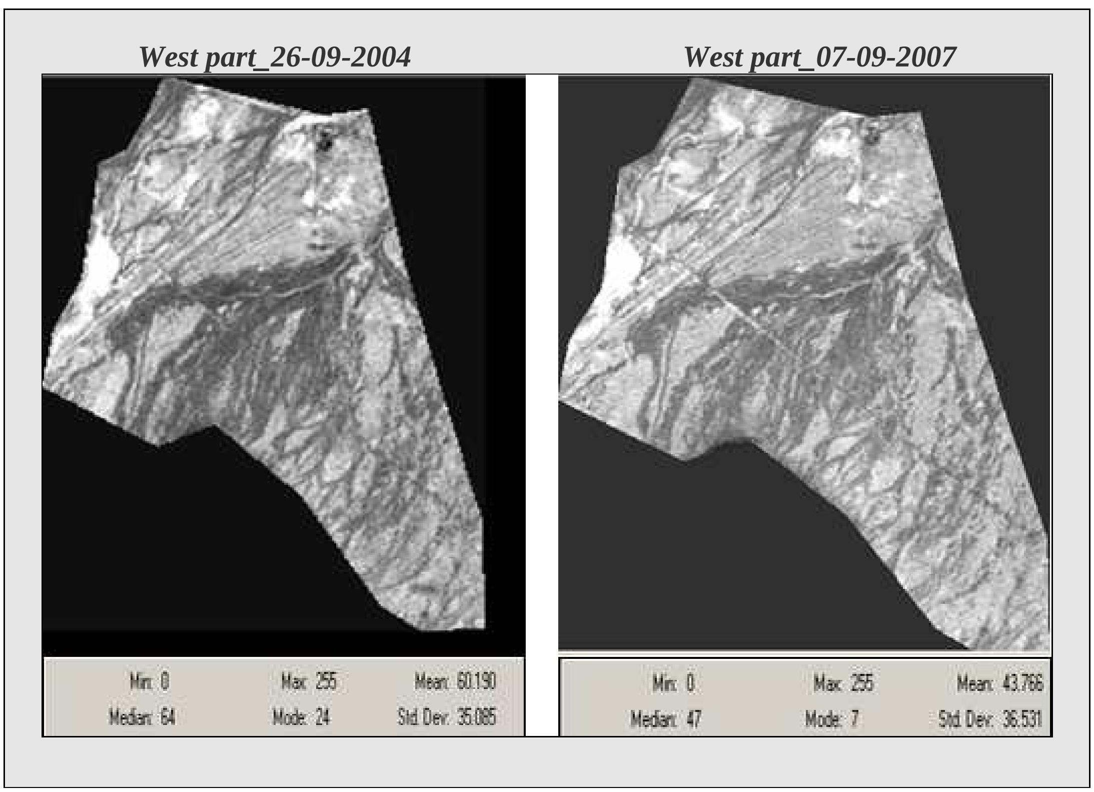
Sample Plot Proformas

Habitat Type	The name of vegetation communities	Sample plot GPS coordinates
DESERT/SEMI-DESERT	Salsola nodulosa/ Artemisia lerchiana	49º23'57.09"E 40º03'47.29"N 49º21'53.63"E 40º03'35.90"N
	Salsola Nodulosa/ Salsola dendroides	49º21'11.23"E 40º03'28.90"N
	Suaeda dendroides	49º22'26.85"E 40º04'16.21"N 49º23'04.96"E 40º05'22.23"N
	Alhagi pseudoalhagi	49º22'21.65"E 40º03'22.74"N 49º20'59.18"E 40º04'13.54"N
	Tamarix	49º21'20.22"E 40º04'42.43"N 49º22'17.74"E 40º05'45.74"N

Appendix 3

NDVI output from the image taken in 2004 and 2007





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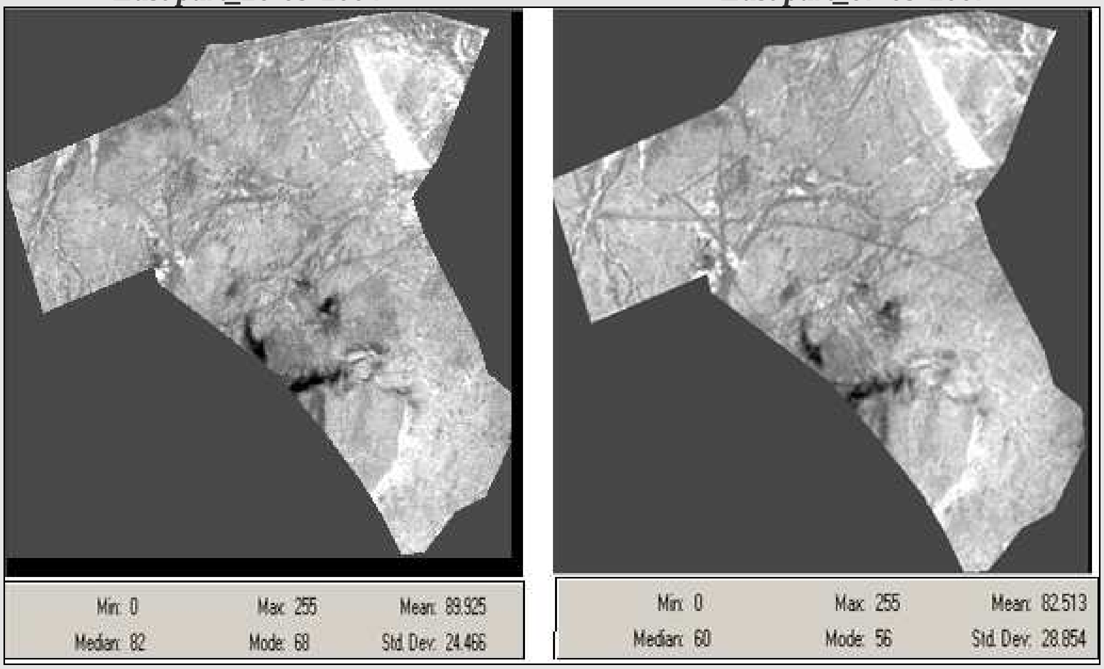
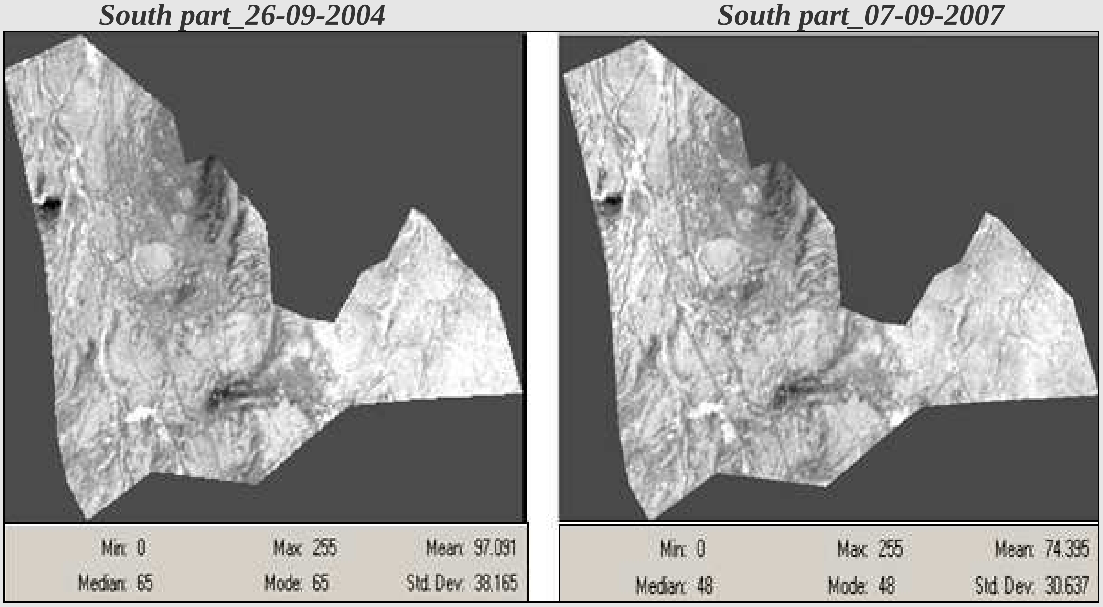


South part_26-09-2004 ***South part_07-09-2007***



Appendix 4

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Rare vegetation monitoring in Azeri national park

BAKU – A team of scientists from the Institute of Botany of Azerbaijan and Azerbaijan National Academy of Sciences and specialists in Geographic Information Systems and Remote Sensing are undertaking an initiative on monitoring rare vegetation in the Gobustan National Park in southern Azerbaijan.

With funding from Rufford Small Grant Foundation, the Azerbaijani scientists will continue the project on spatial monitoring of rare vegetation spread in the Gobustan National Park.

Previously, the project team was awarded the Planet Action grant which provided SPOT satellite images and GIS software.

The goal of the project is to identify and evaluate the extent of the Rare Vegetation Communities found within the Gobustan National Park using SPOT images.

The scholars aim to establish and approve methodology on the monitoring of spatial distribution of the communities using geo-spatial technologies and geo-spatial data; to assess evidence of negative trends in the disappearance of rare vegetation and amend the current situation. The project also seeks to build the capacity of relevant organizations and institutions for quantitative evaluation of Rare Vegetation spatial distribution.

During the project, detailed and updated information about Rare Vegetation Communities will be collected and presented; a database on the status of threatened species and their habitats in selected sites combined; and the acquired data skillfully processed. Consistent monitoring in the target region will be promoted by training and supporting young local researchers. The outputs of the surveys can find their way into national conservation strategies.

The methodological approach of this project includes training in the field of identification and census methods and the use of standardized monitoring methods. Remote Sensing (RS) and Geographic Information Systems (GIS) together form a powerful information acquisition and analysis tool for monitoring environmental changes.

An Environmentally Sensitive Area (ESA) is a type of designation for agricultural area which needs special protection because of its landscape, wildlife or historical value. Change in rare vegetation distribution over time is focused on the Sensitive Area within the Gobustan National Park.

The field surveys were conducted in accordance with preliminary data on the spread of rare plants in the area researched. Since GPS devices provided the locations for ground-reference, data during fieldwork and the sample plots were accurately linked to SPOT5 imagery. Information about different vegetation types and other indicators such as grazing pressure, land-use/cover patterns, general topography of the area and cultivation were also recorded.

The surveys were conducted by scholars headed by Team Leader Yelena Gambarova, Project Mentor Adil Gambarov, and Local Project Experts Rustam Rustamov and Maral Zeynalova.

TAGS: Azerbaijan, Baku, team of scientists from the Institute of Botany of Azerbaijan, Azerbaijan National Academy of Sciences, Geographic Information Systems and Remote Sensing, Gobustan National Park in southern Azerbaijan, Rufford Small Grant Foundation, Rare Vegetation Communities, Remote Sensing (RS), Geographic Information Systems (GIS), Local Project Experts Rustam Rustamov, Maral Zeynalova

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Appendix 5

http://www.unccd.int/publicinfo/partners/stories.php?newch=gobustan

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TUE 19 Oct 2010

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Rare vegetation monitoring in the Azerbaijan Republic *(follow-up)*

With funding from **Rufford Small Grant Foundation** (RSGF), Azerbaijani scientists be permitted to continue a Project on spatial monitoring of rare vegetation distribution in Gobustan National Park, Azerbaijan. Previously the project team has been awarded of the **Planet Action** grant which provided SPOT satellite images and GIS software.

Date and location of event:

Country: Azerbaijan

Project Period (years): 2010-2011

The Gobustan is located between the southern outcrops of the Caucasus Mountain range and the Caspian Sea, some 60 km south of the capital Baku.

The desert communities in the Gobustan State National Park represent the most ecologically important habitat, from a botanic point of view. The great age of many of the desert communities and their slow growth rate further enhance their botanic significance. The importance of this habitat type is one of the reasons that the Gobustan desert has been proposed as a State National Park, so that some level of protection is offered to this desert.

Primary organizer(s):

This project is being carried out by scientists from Institute of Botany of Azerbaijan, Azerbaijan National Academy of Sciences and specialists in Geographic Information Systems and Remote Sensing.

1) Yelena M. Gambarova – Project Leader (Aeronavigation Applications Development Department, R.I.S.K. Company, Baku, Azerbaijan)

2) Adil Y. Gambarov – Project Mentor (SAHIL IT Company, Baku, Azerbaijan)

3) Rustam B. Rustamov - Senior scientist (Institute of Physics of the National Academy of Sciences, Azerbaijan)

4) Maral H. Zeynalova – Senior scientist (Institute of Biology of the National Academy of Sciences, Azerbaijan)