FINAL REPORT

DEFORESTATION - VIEW FROM THE SPACE

Research based on the
Geographical Information Systems (GIS) and
Remote Sensing technologies

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Introduction

Forests are the lungs of the earth and an inalienable part of animal habitat. By destroying forests we destroy the world we live in. Socio-economic conditions force people to shift priorities and focus either on greed or self-preservation at the expense of the nature forgetting and neglecting the consequences of their short-sighted policy. Deforestation has started in Armenia since 1980 but the utter damage to the forest coverage was made in the period of difficult socio-economic conditions in 1990-1995 during energy crisis.

Deforestation is currently a serious problem inflicted upon themselves by people, who do not seem to be concerned with the future grave consequences of their long-term damaging activities. According to the National Programme against Desertification (quoted in "From need to Greed", Vem Media Acts, 2006) the earliest official estimation of the forests coverage was done in the early 19th century and recorded as of the country land.

The devastating effect of human activity started in 1992 during the years of energy crises, where the percentage of forests coverage dropped form 20% to 11.2%. Today's estimates of independent expert's show that only 8% of the tree coverage is left in the country. According to the World Bank, 80% of Armenia is at a risk of becoming a desert and with the current rate of deforestation, there will be no forests left by 2050.

According to the National Programme against Desertification (quoted in "From need to Greed", Vem Media Acts, 2006) it has been projected that if the current rate of deforestation do not slow down then in 10 years time the consequences will be catastrophic such as:

- decrease of humidity of soil by 10%-30%
- reduction of pastures by 20%
- reduction of cattle head by 30%
- reduction of production of fruits and vegetables by 10%

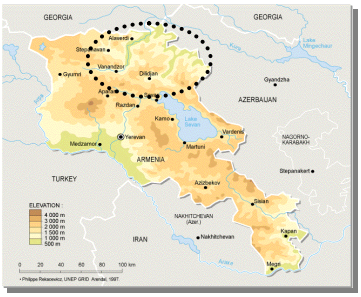
Recognition of seriousness of the problem and willingness to contribute into assessing the scale of the problem, finding solutions and increasing awareness of general public has supported development of the idea to make use of the remote sensing technology for environmental studies, which has been widely used overseas and proven to be an efficient method for identification of problem areas. Satellite imagery has been extensively used for forest inventory and assessments for national and sub-national level decision making, policy setting and monitoring purposes. Since the launch of Landsat programme by NASA, the imagery derived from Landsat sensors have been extensively used for identification of deforestation around the world.

The motivation for the project has originated due to understanding of the critical state of the Armenian forests coupled with the opportunity to apply the available expertise in remote sensing technologies.

Initial Objectives

The Project sought to identify the extent of deforestation in the north-eastern regions (Fig.1) due to the fact that forests are mostly located in the northern and southern parts of the country, therefore these areas have suffered damage made over the last twenty years. The research aim was also to serve the Armenian public agencies, non-governmental and international organisations as an unbiased visualisation of the problem for formation of policies and programmes. In addition, the findings of this research were planned to be used as environmental education and public awareness tools by the above mentioned stakeholders.

Fig. 1: Republic of Armenia



Source: UNEP, GRID Arendal, 2004

The objectives of the research include the acquisition, processing of satellite imagery and land cover classification for the period of 1980s-2000. The research makes use of modern remote sensing and image classification technologies to reveal and visualise the land cover changes between the specified periods of time.

Vegetation and, therefore, trees strongly reflect solar radiation in near- and mid-infrared bands of the electromagnetic spectrum. These two spectral bands, along with the visible spectrum (red-blue-green) bands are available in the Landsat imagery and allow accurate mapping of land cover. The project has had a substantial fieldwork element for identification of vegetation types and their spectral characteristics on the ground.

Project Results

The project started with the acquisition of the Landsat satellite imagery for the period of 1980s-2000 from the Global Land Cover Facility (GLCF), which is a free and publicly available repository of earth science data and products for understanding global environmental systems. The datasets (imagery) were downloaded form the GLCF FTP server and processed by using industry standard image processing software including IDRISI Kilimanjaro and MultiSpec.

A large number of field trips to the study area (from Yerevan, the capital city) were made for identification of the 'ground-truth' – the unique spectral characteristics of the selected known spots on the ground (different types of trees, logged areas, etc). These 'spectral signatures' have been processed by the specialised software to classify the image into the defined land cover types according to the earlier collected 'spectral signatures'.

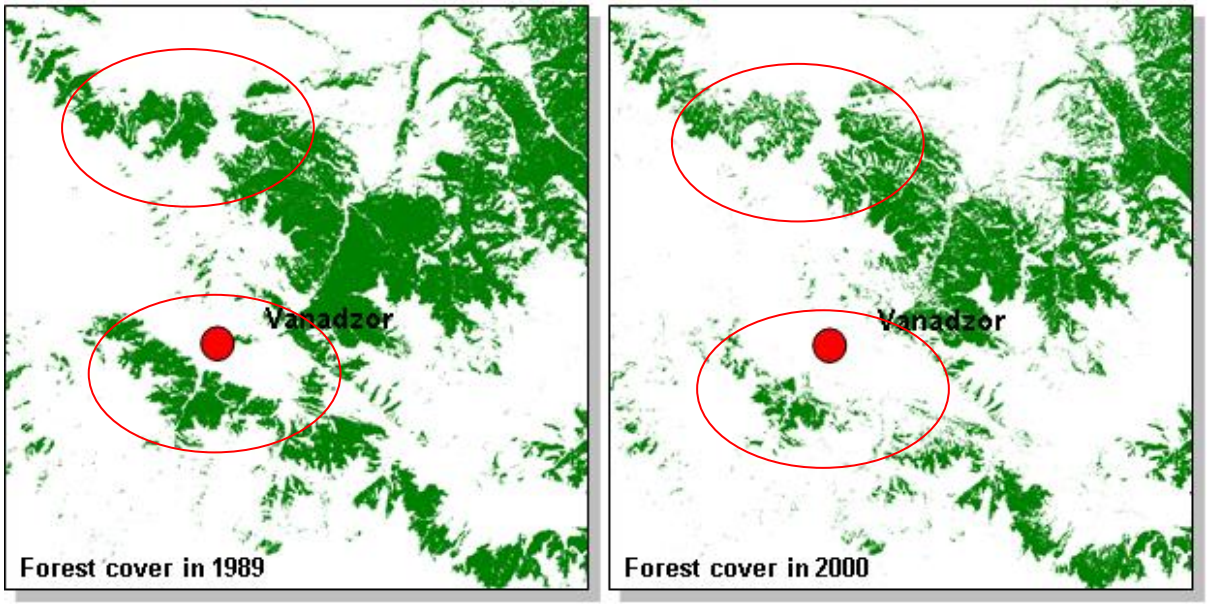
The data analysis for the purposes of forest cover change detection was run for the surrounding areas of Vanadzor city, a region representative site, which once was the industrial strong in Armenia with relatively large population.

Two satellite images (Landsat TM/1989 and Landsat ETM+/2000) were processed and analyzed. The results indicated that a significant change in land cover occurred between the 1989 and the 2000. In particular, the analysis revealed the reduction of vegetative cover in the study area. The data analysis was then followed by fieldwork to verify the results on the ground. Trips were organized to the study area for gathering observational data as well as taking photographs of the affected areas for subsequent verification with the forest cover classification of satellite imagery. The research produced a forest cover map of the study area for the years 1989 and 2000 (see illustrations below).

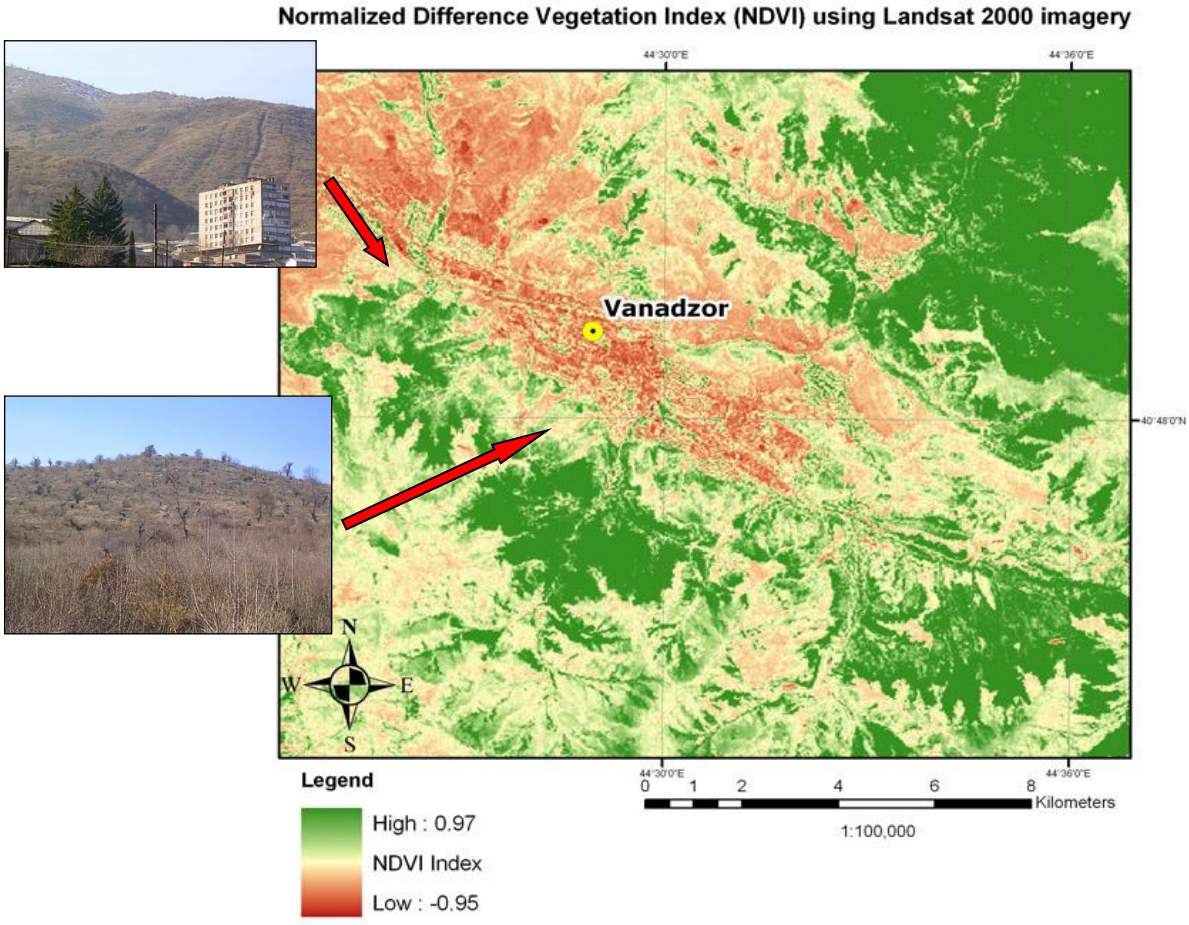
The surrounding area of Vanadzor city as seen on the Landsat satellite imagery taken from 1989 and 2000. The first two images (first row) show the original satellite imagery, with forest areas in dark green colour. The second row shows the forest cover classification results, where the green colour represents the forest areas.

Forests around Vanadzor city in 1989

Forests around Vanadzor city in 2000



The analysis of the data indicated a change in forest cover in the study area from ~25% in 1989 to ~19% in the year 2000.



The Normalized Difference Vegetative Index (NDVI) has been in use for many years to measure and monitor plant growth, vegetation cover from multispectral satellite data. The NDVI is calculated as a ratio between measured reflectivity in the red and near infrared portions of the electromagnetic spectrum. These two spectral bands are chosen because they are most affected by the absorption of chlorophyll in leafy green vegetation and by the density of green vegetation on the surface. Also, in red and near-infrared bands, the contrast between vegetation and soil is at a maximum.

Index values can range from -1.0 to 1.0. Higher index values are associated with higher levels of healthy vegetation cover, and vice versa, non-vegetation cover (for example soils, rocks) produces negative values.

The photographs (taken in October 2005) on the left of the NDVI map show the deforested hill slopes south to Vanadzor city. They confirm both the results of the land cover classification (page 2) and the calculation of NDVI index (above).

Collaboration with NGO's

The findings of the research have raised a keen interest of the leading NGO community at a National level, educational institutions and international organisations, such as:

- The Environmental Conservation Research Center of the American University of Armenia (ECRC/AUA)
- World Wild Fund (WWF) Armenia Office
- Armenian Forests NGO
- Armenian Tree Project (ATP)
- Individual researchers
- Young students involved in conservation

The above-mentioned organisations had set up a coalition, namely WWF, AUA and ATP, which has become very much interested in using GIS and other advanced technologies in identification of illegal logging of forest and establish an ongoing monitoring system to register any changes in forest coverage over the years.

The extensive discussions over the existing problems as well as the results of the research have set the grounds for drawing up a three-year campaign to be launch under the title SAVE OUR FORESTS.

The Armenian Tree Project participated in a number of field trips together with the representative of the World Wild Fund, which later on have sponsored a documentary film on the subject, where the actual results and findings of the

research about the Armenian Deforestation (1st time satellite imagery on forests went public in Armenia) have been included. The documentary, titled FROM NEED TO GREED has been has been widely distributed attracting attention of and giving food for thought to a general public, government officials and mass media.

The Environmental Conservation Research Center of the American University of Armenia has also expressed its interest in the Project Results and given their approval to incorporate the finding and methodology of research into the curricula for environmental education at ECRC/AUA as a case study. In fact, the results of the project became part of the GIS training courses delivered by the applicant/project leader for graduate level students.

Workshops, Seminars, Roundtables

Discussion of project results at the Public speaking/forum (June 2006) at ECRC/AUA (100+ people attended representing the Government, WWF, NGOs, Educational and Research institutions).

The Project results were also communicated to professional and public audience via numerous round table discussions with project partners and conservation specialists and organisation of public forums and seminars as discussed above. A number of journalists from mass media organisations have requested a guidance and advice to visit and make their own reports about the deforested areas covered in the mentioned documentary and forums.

Media Appearance

Perhaps, the most significant achievement of the project was the inclusion of project results in a documentary, titled FROM NEED TO GREED (Vem Media Arts (2006) *From Need to Greed*) that was widely circulated and draw an extensive public and professional interest.

A copy of the documentary may be provided to the Rufford Foundation on a DVD media, if requested.

Advanced Use of Modern Technology

GIS, Remote Sensing, GPS methods and tools have been incorporated into the activities of the leading environmental NGOs, presented above. This has enabled an understanding of the importance of using these technologies and readiness of the stakeholders to invest into acquisition of recent satellite imagery, GIS software and literature. In particular, the Armenia Tree Projects and Armenian

Forests NGOs are beginning to routinely use GPS equipment in their illegal logging fact-finding missions immediately after receiving specific results of the research. The ECRC/AUA has recently purchased 2006 satellite imagery for Armenia.

The use of technology facilitates visualising and understanding the size of the problem as well as provides an objective and unargued assessment of the real situation.

Modifications to the project

The major modifications to the project related to the medium of communication of the project results to the public i.e. via public forums, mass media and documentary rather than the print publication envisaged originally. This change resulted in a far better coverage and dissemination of results than was originally planned. The inclusion of project results in the university teaching materials and the documentary film were new elements not originally planned for.

Both the teaching materials and the documentary may be provided to the Rufford Foundation, if requested so.

Another major change was the increased emphasis on the fieldwork and on-site data collection that continued through 2007. This became possible through the saving of some funds from the budget lines planned for the publishing costs and software procurement (instead, a free evaluation copy was used).

This extended fieldwork and collection of significant amount of data for extending the project beyond its original scope has become a reason for the delay with the submission of the Final Report.

The remaining change relates to the non-inclusion of 2005 satellite imagery into the analysis since at later stages of the project, a more recent, 2006 imagery became available for use (being processed at the moment).

Further Areas of Research and plans

The project has been continued through 2007 and into 2008 and based on the results of the first phase, the applicant/project leader plans to:

- Implement an assessment of nation-wide forest coverage for 1977-2000-2006 (as opposed to the north-eastern region of the country)

- Assessment of Forests Vulnerability in terms of anthropogenic influences (a number of new studies have been commissioned during the last year that hold data and analysis on the economic livelihoods of population in the areas adjacent to forests. This information may be integrated within a GIS system for visualization of links and patterns leading to a better understanding of the linkages between the deforestation and human activities).