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Use of Satellite Images and GIS Technologies for the Effective Management of the Territory of Bulgaria

Vassil Vassilev, Pavel Milenov

Remote Sensing Application Center (ReSAC) of the Agency for Sustainable Development and Eurointegration (ASDE)
4, Sveto Preobrazhenie Blvd
BG, 1712 Sofia, Mladost, Bulgaria
Tel/Fax:/+359 2/ 74-50-21; 981-82-16
e-mail: resac@techno-link.com
www.resac-bg.org

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Abstract: The Environment, Agricultural and Urban management is of valuable importance for Bulgaria, because of the following:

- *Bulgaria is at transition period now with rapid changes in all fields related to environment, agriculture and urban;*
- *The adoption of the Common Agricultural Policy of the EU by Bulgaria will require precise planning of the agriculture which include knowledge about the soil types and structure, relief characteristics, crop and field statistics, yield forecasting, pests management and other all of which require use of spatial data;*
- *The fast degradation of the obsolete industrial installations, rapid development of the new facilities, the enlargement of new building districts and tourist resorts creates, if not well managed, considerable risk for the environment;*
- *As a rule, the administrative control mechanisms react with considerable delay to the present environment problems and changes;*
- *The decision makers could be facilitated by the use of modern technologies such as remote sensing and GIS for better management of territories.*

The present paper present some practical examples from the ReSAC projects on the use of earth observation data integrated together with vector data into the GIS databases for management of territories in Bulgaria.

Remote sensing (RS) and geographic information systems (GIS) are technologies, which allow for the continuous monitoring of the land surface, its characteristics, and development and allow performance of analyses for the future scenarious. Earth observation data are independent source of information, which represents the real state of the earth and is not influenced by the human intervention. That is why combining the satellite images or aerophotos with different types of vector datasets and auxiliary information within the GIS environment makes them a powerful source for decision-making, analyses and forecasts. All of the aspects of the management of territories (environmental, agricultural and urban) are of valuable importance for Bulgaria, because of the following reasons:

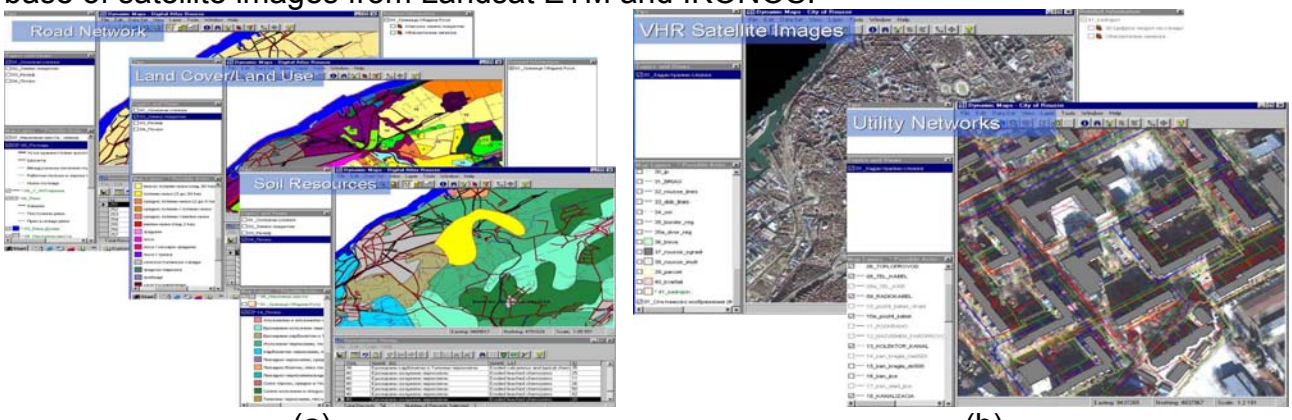
- The period of transition in which is Bulgaria now is connected with rapid changes in all fields related to environment, agriculture and urban which should be monitored and documented in order to be more precisely analysed and planned;

- The adoption of the Common Agricultural Policy of the EU by Bulgaria will require precise planning of the agriculture which include knowledge about the soil types and structure, relief characteristics, crop and field statistics, yield forecasting, pests management and other all of which require use of spatial data;
- The fast degradation of the obsolete industrial installations, rapid development of the new facilities, the enlargement of new building districts and tourist resorts creates, if not well managed, considerable risk for the environment;
- As a rule, the administrative control mechanisms react with considerable delay to the present environment problems and changes most often because of the lack of updated information which to be organised in such a manner which to allow meaningful and succesful analyses;

The decision makers could be facilitated by the use of modern technologies such as RS and GIS for better management of territories.

RS/GIS in the Urban Management

The changes of land use and land cover over a time period control the pressure on land. Urban development now is so complex and dynamic that new techniques should be used for planning of cities and towns. The rapid changes in the urban areas in Bulgaria which occur could be analysed very quickly using the RS and GIS and to provide the decision makers with a tool which to be used in management of urban areas.
Good examples of the use of RS and GIS by the local authorities responsible for urban management are the Digital Atlasses for Rousse (Municipality and City) and Vratsa.
The Digital Atlass of the Rousse Municipality (Fig. 1(a)) contains thematic maps with the corresponding additional information for land cover/land use, soil resources, relief and hydrography of the territory of the Rousse Municipality.The Atlas is created using Dynamic Maps software of GTOS/FAO.
The Atlas also contains the main layers of infrastructure, hydrology and the administrative borders of the municipality as well as the analysis of the condition of the road network (incl. "agricultural" roads). The creation and analyses of the GIS layers was made on the base of satellite images from Landsat ETM and IKONOS.



(a) (b)

Fig. 1. (a) Dynamic Atlas of the Rousse Municipality – different GIS layers. (b) Dynamic Atlas of the City of Rousse – Ikonos image with the overlayd cadaster of the utility networks and buildings.
The Digital Atlasses of the cities of Vratsa and Rousse (Fig. 1(b)) contains orthorectified satellite image from IKONOS (1m) from 2003, as well as the cadaster layers - parcels, buildings, utility networks and others. The Atlas of Rousse also contains 3D-views of the city prepared with DEM in scale 1:5,000 and the height of the buildings (Fig 2).

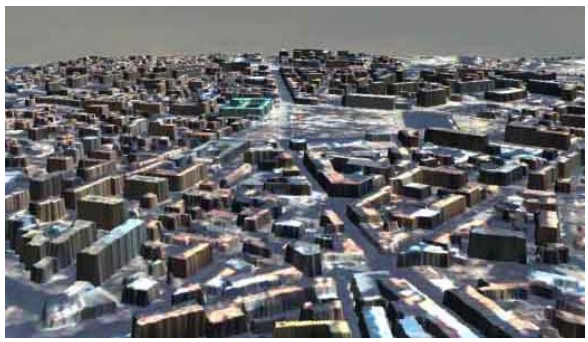
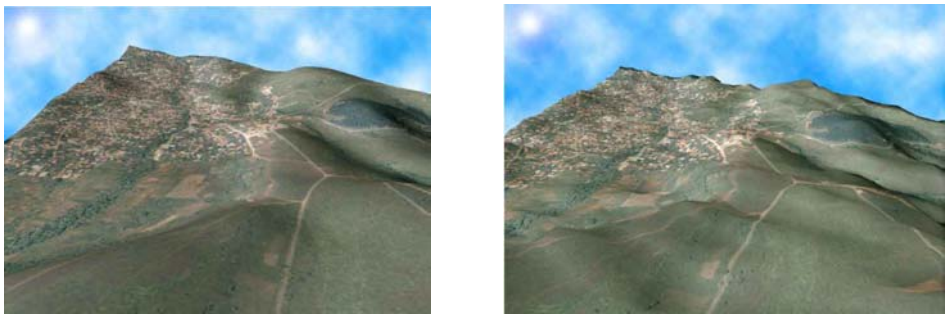


Fig. 3D view of the City of Rousse – Ikonos image draped over the DEM in scale 1:5,000.

The information from the Digital Atlases could be used from the municipalities to: support the efforts for the development of the Overall Building Management Plan of the urban areas; to be the base for the future integrated information system of the municipality, integrating together data from cadaster, property register, buidings and regulation, agricultural land management, infrastructure, public utilities, satellite images, aerophotos etc.; to serve as a prototype of a regular monitoring of the territory based on a satellite images.

In order the very high-resolution data to be used for urban planning they have to orthorectified with enough precision. The available sources of DEM in Bulgaria are quite few. One good solution is to use the SRTM data. In September 1998 German Aerospace Center issued an Announcement of Opportunity for the use of data originated by the payload of the Shuttle Radar Topography Mission. The evaluation was completed in March 1999. From Bulgarian side ReSAC and ASDE participated with the project "Model for Sustainable Development and Eurointegration for "Sofia-East" Ecological Zone".

The SRTM data were used in the continuation of the project one result of which is the creation of the Digital Atlas of Ecozone “Sofia-East”. SRTM data were integrated and merged with other sources of satellite information, thematic maps, topomaps and reference data.



(a) (b)

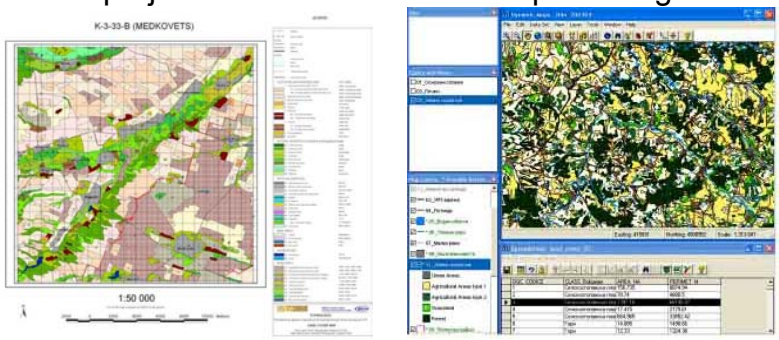
Fig. 3. 3D view of the suburbs of Sofia using DEM derived from topomaps (scale 1:25,000) (a) and SRTM (b) and Ikonos satellite image (Courtesy of European Space Imaging / © European Space Imaging GmbH).

RS/GIS in Agriculture and Forestry

The use of RS/GIS in agriculture is one of the main areas of earth observation applications. It could be in determining the exact boundaries of the agricultural parcels, monitoring of the state of the crops during the vegetation season, forecasting and modeling yeilds, monitoring changes of the vitality of the crops due to lack of fertilizers, pests, water, mapping the land use and land cover, etc.

Land cover maps are a necessary tool for development planning and management of the territory. Furthermore, land cover maps depicting the current reality are a must in countries

where, due to political changes, rapid dynamic phenomena have taken place, resulting in a complete restructuring of the agricultural and other sectors, as in the case of Bulgaria.
The FAO/ReSAC project “Strengthening Capacity in Agricultural Development through RS and GIS” has produced 14 land cover maps at 1:50,000 scale for selected test areas of the country, covering 5 600 sq km. These maps (Fig. 4(a)) were prepared using Landsat satellite data, (1998 – 1999) as the main data source and thus represent the land cover existing at that time. The land cover classification was performed using the FAO Land Cover Classification System (LCCS). To each mapped unit (polygon), soil type and erosion features were linked as attributes into the GIS system. This created a comprehensive database, which is unique in Bulgaria. The database provides very useful information for agriculture, forestry and urban development planning, for environment protection and for many other applications. The data collected in the database provide the possibility for different kinds of spatial analysis, which is necessary in land management.
The LCCS methodology was used also to map more then 1,5 mln ha in Northern Bulgaria (Fig. 4(b)) to show managed and not managed agricultural areas as well as different size of agricultural fields. The project was for the needs of a private agricultural company.



(a) (b)

Fig. 4. (a) Land cover map of the Medkovets region using LCCS of FAO; (b) Dynamic Atlas of the agricultural area in Northern Bulgaria.
Satellite images do not only provide information to create maps in smaller scale but could also serve as a source for forest and agricultural cadaster. Both are created using traditional geodetic measurements. Large-scale topographic maps were also used, as well as orthophotos taken up to 1990. The update of the cadaster is done using the same technologies and often the results are quite away from the reality that is on the ground.

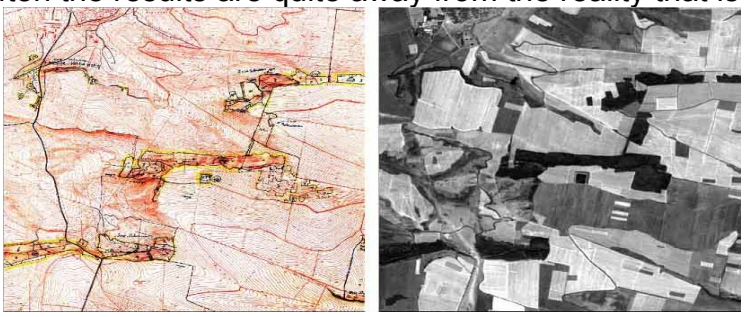
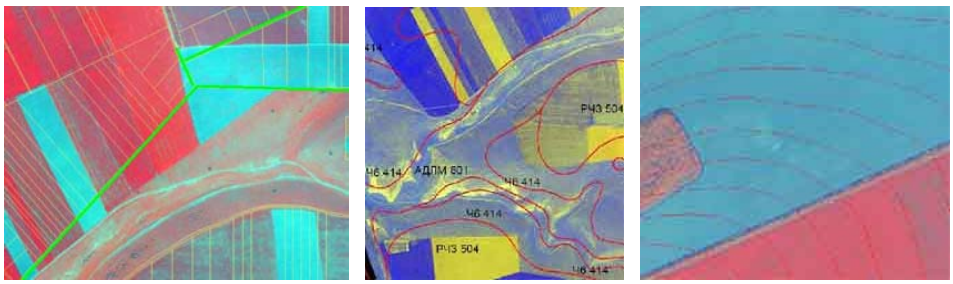


Fig. 5. Update of the Forest Management Plans using IRS images (Region of town of Sevlievo), ReSAC/Proles Eng.
As a candidate country to EU, concerning agriculture, Bulgaria must reorganise the institutions, and adopt EU procedures to be fully compatible with the common agricultural policy. A Land Parcel Identification System (LPIS) should be created until 2007 for graphic declaration of farmer’s blocks and control. This system should be integrated in GIS environment and represent the agricultural massives and parcels with an accuracy of 2.5m. The pilot project of ReSAC/JRC “Pilot Study on the Control with RS of Area Based Subsidies in Bulgaria” has clearly shown that the available cadaster in Bulgaria is not appropriate but very high resolution (VHR) satellite data or aerophotos should be used.



(a) (b) (c)

Fig. 6. Examples of the use of Ikonos images in agriculture ("Pilot Study on the Control with RS of Area Based Subsidies in Bulgaria" ReSAC/JRC): (a) discrepancies between cadaster and VHR image; (b) update of the soil map (scale 1:10,000) with Ikonos image; (c) control of crop type on hilly terrains with slope more then 12%.

In addition to the exact crop area declaration, the important cross compliance rules with good agricultural and environmental conditions (GAEC) are applicable from 2005 onwards. GAEC is meant preservation of landscape and other features helping to avoid soil erosion by wind and water (field balks, retain terraces, valley lines, windbreak strips, and contour field paths with drains). Agri-environment measures are designed to encourage farmers to protect and enhance the environment on their farmland. It provides for payments to farmers in return for a service – that of carrying out agri-environmental commitments that involve more than the application of usual good farming practice. Some of the GAEC issues connected with soil erosion and protection of soil structure could be easily managed and controled by earth observation data (Fig. 6(b) and (c).

Another area of the use of RS and GIS is the precision farming. Some of the precision farming directions is to accounting the specific characteristics of the territory (microclimatic conditions, relief, soil conditions etc.) to choose the most appropriate crop type. A pilot project for design of the vineyards fields was performed by ReSAC for the Sandanski Region using Ikonos images and GIS layers in scale 1:25,000. The system gives the possibilities to choose the best possible areas for creating vineyards using set of environmental criterious.

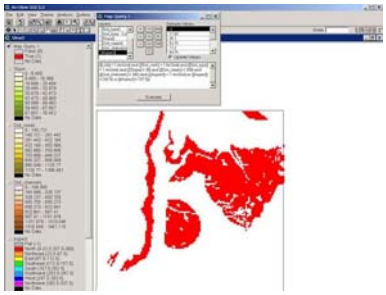


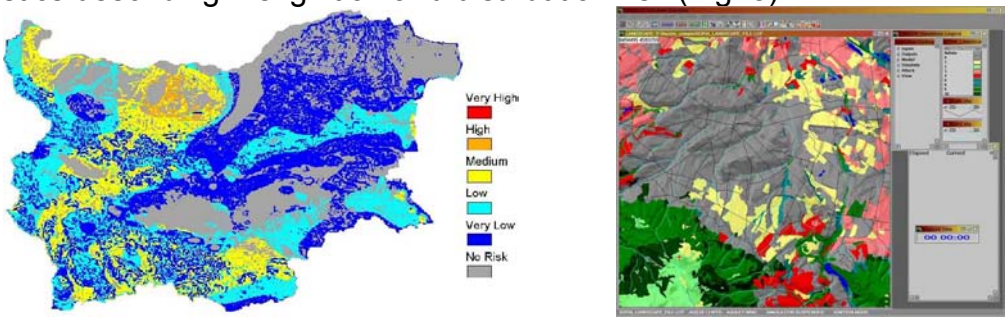
Fig. 7. GIS for optimizing vineyards fields creation - layers for soil, DEM, temperature, rainfall, exposition, slope, roads, irrigation, settlements etc.

RS/GIS in Environmental and Disaster Management

GIS is a powerful tool for environmental data analysis and planning. GIS allows better viewing and understanding physical features and the relationships that influence in a given critical environmental condition. GIS can also display and analyze RS data. GIS can provide a quick, comparative view of hazards and risks and areas to be safeguarded. On completion of data analysis GIS helps in planning and managing the environmental hazards and risks. In order to plan and monitor the environmental problems, the assessment of hazards and risks becomes the foundation for planning decisions and for mitigation activities. GIS supports activities in environmental assessment, monitoring, and mitigation. Some of the applicable areas are: land cover analysis, emergency services,

hazard mitigation, disaster management, forest fires, natural resources, oil spills, water pollution studies etc.

The number of the forest fires and the scale of the burnt out areas during the last years have reached crucial values, with no equivalent in the Bulgarian forestry history. Data shows that we have reached and in some indicators have exceeded the forest fire risk indicators for the traditionally fire sensitive season for the Mediterranean region. ReSAC together with NIMH and NFB have included into the Integrated System for Information and management of Forest Fires in Bulgaria – National Concept the use of conventional meteorological information together with RS and GIS information such as land cover/land use maps, forest database, structured according to the type, location, and inflammability classes, archive system of forest fires and their characteristics, Various physical characteristics describing fire ignition and distribution risk (Fig. 8).



(a) (b)

Fig. 8. Fire risk (a) and fire evolution (b) modeling using various types of spatial and meteorological information.

The management of the territory of Bulgaria within all of its aspects as well as the needs of e-Government development could be facilitated and supported by the use of RS and GIS. One first step in this direction could be the establishment of Unified National Database – Spatial Data Infrastructure for the territory of Bulgaria, which to serve various types of users – governmental institutions, EU structures, municipalities, NGOs, scientifical organisations, private companies and citizen. This database should be prepared using the EU standarts and recommendations and will contain the available GIS in Bulgaria as well as satellite coverage of the country.

László, I., B. Csonka, G. Csornai, L. Martinovich, G. Mikus, A. Kocsis, L. Tikász, E. Bognár, Gy. Zelei, F. Tar, T. Pribela Implementation and control of GAECs in Hungary, Annual CwRS Conference – Budapest, 2004

Sharma, Dr. V. N., J. Mohammed, S. Uppuluri, GIS in Environmental Studies - An overview, Map India 2003, 6thAnnual International Conference and Exhibition, India

Travaglia, C., L. Milenova, R. Nedkov,V. Vassilev, P. Milenov, R. Radkov, Z. Pironkova, Preparation of Land Cover Database of Bulgaria through Remote Sensing and GIS, Environment and Natural Resources Service, Sustainable Development Department Food and Agriculture Organization of the United Nations, 2001.

Vassilev, V., P. Milenov, Application of SRTM Data for the Project "Model for Sustainable Development and Eurointegration for "Sofia-East" Ecological Zone", 55 International Astronautical Congress, Vancouver, Canada, 2004

Milenova, L., V. Vassilev, TCP/BUL/8922 project methodology, results and after project activities, Land Cover/Land Use Inventory by Remote Sensing for the Agricultural Reform PROJECT FAO-TCP/ROM/2801-3001 (A), Bucharest, Romania, 2004

Milenov, P., V. Vassilev, R. Radkov, V. Samundzhi, D. Nakov, RS/GIS for Environmental and Urban Management in the Lower Danube region - Rousse pilot study, The Danube and Europe: Integrated Space Applications in the Danube, Mamaia, Romania 2004.

Milenova, L., P. Milenov, V. Vassilev, R. Radkov, A. Killmayer, O. Francois, Pilot study on the Control with Remote Sensing of Area Based Subsidies in Bulgaria – Final Report, Control site selection, LPIS, Technical tolerances, JRC, Ispra, Italy, 2005