Integration of Geoinformation Model with Satellite Remote Sensing Data for Land Cover Mapping In Azerbaijan

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Abstract – This paper introduce the author work on GIS applications in land use mapping and land resource management by remote sensing data. Drawing up a-priori of the model of investigated natural objects processes and post classification interpretation has become possible by GIS-technology and expert systems. Therefore optimum approach of processing of RS data is complex using of the automated and expert methods of the analysis, gathering and estimation of the received information. Using this complex method for the first time the digital model and unique database of Land Cover/Land Use for all the territory of Azerbaijan of a scale 1:50000 were formed.

Keywords: land use mapping, GIS-technology, digital model, image interpretation, automated and expert methods.

1. INTRODUCTION

The remote sensing (RS) signals the radiating image of natural objects are formed. The structure of a radiating image, obviously, is determined by structure and other characteristic properties of natural formation. So, for example, vegetation, water and soil the characteristic spectra have. However, not always it is possible to find unequivocal and strict conformity of a radiating image to his prototype. Taking into account depended to other type of space satellite and survey system space images can be have a different scale, view, spectral characteristics and geometrical resolution. Information of space images defines also natural conditions, season and time of survey, transparency of atmosphere, physical properties of investigated natural objects [1]. Usually a decision makes for natural procedure combination of various kinds of surveys (photographic, scanner, radar tracking, thermal etc.) is used. Most important is the correct choosing of the scale and spectral number of space images for reception of the maximum complete information about the investigated natural phenomenon. Therefore, we have unstable system of the space images, on which should decide a task for identification of natural formations. From the formal point of view the process of the analysis RS data includes: training on sample sites, during which is formed uniform elements of space and the images of investigated natural objects in the terms of the chosen attributes and distribution other data of training on all researched territory for allocation of natural objects, their classification etc. are described depending on a soluble task. The process of processing RS data is traditional at the decision of the concrete task will be carried out in some stages: preliminary data processing; classification of test sites; recognition of all territory. At drawing up a-priori of the model of investigated natural objects and processes the presenting concerning area of researches' basic characteristics and properties of investigated natural objects and processes are formed. At the stage of collection preliminary data and creation a-priori of model of researched object or phenomenon very perspective there is use of methods of electronic cartography.

The creation GIS on the basis of available a-priori of the data considerably raises efficiency of works reduces losses of the information and facilitates coordinate binding multilevel of data. The complex of transformations for improvement of the initial images includes photometry and geometrical correction and other procedures. Besides for exact coordinate binding of results of processing SI at this stage makes the photoplay of researched territory in chosen scale with alignment of the image on brightness. The stage of the preliminary processing of RS data at present moment almost is completely automated. The influence of the expert form definition on the initial stage of character photometry and geometrical distortion of the image, their reasons and methods of elimination is necessary. The stage of processing of sample sites is very important. The sample sites get out on the well-investigated areas having the typical characteristics from the point of view of received earlier a-prior of model. A basis of the methodological approach at this stage is the transformation and complexes of spectrum bands of the images for increase by their visual information, i.e. reception of the integrated photographic characteristics of investigated objects and revealing of separatelements of their image in space information.

2. MAIN PROCESS

2.1 Materials.

- Satellite snapshots of all territory of Azerbaijan (LANDSAT 5TM- l0 pieces, 1998 and LANDSAT 7TM,1999 - 3 Pieces);
- Top maps on the territory of Azerbaijan of a scale l:100 000;
- Thematic maps on Azerbaijan of different scales;
- Other data (statistics, instructions, theme books etc.);

2.2 Creation of the general sketch of the project. The general arrangement of materials under the project for 9-th and 8-th zones looked like on Fig.1. Large squares are the space snapshots. The part of a snapshot inside state border was the subject for processing. A grid refers to the topographic maps.

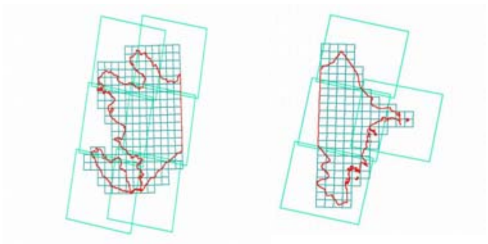

Figure1. Projection G-K, zone 8 and 9.

The effective maps utilization of different scales at their computer processing is possible only under condition of their compatibility in unified for all maps cartographic projection. This problem was decided by selection of unified for all cartographic projection (projection G - K). ENVI v.3.2 and Arc View 3.2 program conformant complexes were used.

2.3 Scheme of image interpretation process

1. The preparation phases. On this phase all available thematic and topographic maps were scanned and located on HDD of the computer. For scanning the scanner EPSON GT- 12000 of A3 format was used. Naturally, that for maps, which format is more than A3 format, the scanning implemented by parts.
2. Processing of raster data:Rectification of the scanned thematic and topographical maps. The processing of the raster data starts with rectification of all scanned thematic and topographic maps in an adopted cartographic projection. On each map 10-12 of like points were taken and the map to map transformation was implemented.
3. Rectification of the satellite images by separate. The process of rectification of the satellite images was implemented under the similar scheme. The main requirement was legible identification of like points on the image and topographic map. For each display frame the greatest possible number of points was selected and image to map transformation was executed. Besides, a number of points were necessary for picking up on perimeter of a snapshot (not less than 3 on each side) for the subsequent docking of the maps on the same points with adjacent ones.
4. Masking of the urban areas and the territory of neighboring countries. At solving the problem of classification a number of objects yield to classification with difficulty. As a rule those are the objects such as cities, villages, plants and other industrial objects. It determines tangle at classification. At the same time, having some experience in work with the maps, it is possible already at visual image analysis to define legibly enough borders of cities, villages, industrial zones, water objects etc. The large massifs of agricultural areas are also well tracked. The used software allowed executing masking operations of such objects. It was an essential moment, as the pixels, fallen in a mask, are eliminated from process of the subsequent classification. In the north Azerbaijan borders on Russia, in the west - on Georgia and Armenia, in the south - on Iran and Turkey, in East the border is determined by shore line on the Caspian Sea. On space snapshots there were sites of territories of the neighboring countries and water surface. It was necessary to eliminate the indicated information. For this purpose under the topographic maps of frontier regions the state border (separately for 9 and 8 zones) was delineated. All pixels lying outside of delineated state border of each zone were masked off on described above technology and by that were eliminated from process of further processing.
5. Formation of the unified image. The images available in our disposal, were on magnetic CD-disks with some overlapping with adjacent sites. On this cause it was necessary to form the unified (mosaic) map. This operation was executed by docking of like points on perimeter of site with the subsequent jettisoning of an overlapped part of the image.
6. The primary classification of main classes. The part, which has stayed after masking was subject for classification. Using thematic, topographic maps, and also image analysis it was possible to identify visually water objects, wood massifs, allotments etc. (according to a legend). Inside each of such objects were drawn the homogeneous sites - ROI. Statistics of such homogeneous sites was also, as a matter of fact, training classes. This statistics can be controlled and, if necessary new ROI can be removed or selected. After sufficient quantity of ROI was collected, the process of classification started.

2.4. Processing of vector data.

1. Clean-up of the resulting vector data. Classification of some number of pixels appeared unclassified. First, the flora on borders of two miscellaneous classes, as a rule, is always admixed. Second, for test classes we aimed to make picking of ROI on homogeneous sites of objects, but it did not mean, that the objects were uniform on all field of a snapshot. At last, on the image there could be objects, which were not included at all in number of test classes. One way or another at mapping of results of classification on a screen monitor they appear with some number of unidentified objects and the problem of the handler is to determine them. Thematic and topographic maps, and also the visual image analysis enable the handler to solve the indicated problem.
2. The vector data - GIS and database realization. The available in our disposal thematic maps of flora, administrative territorial division maps, geomorphologic maps etc. were of 1994-1995 yy. It is clear, that for 6-7 years flora of republic could not change cardinally. It allowed to compare visually the data of a map to results of classification and to control them in indirect mode. On the basis of physical map, for example, were updated positions of open casts and mines, to recognize which on snapshots is rather difficult. There are 56 administrative regions in the republic. This map also was subject to a contouring, as at printing of results it was planned to let out Land Cover/ Land Use maps on regions.
3. Creation of the general sketch of the project. The general arrangement of materials under the project for 9-th and 8-th zones looked like this. Large squares are the space snapshots. The part of a snapshot inside state border was the subject for processing. A grid refers to the topographic maps.
4. Visual interpretation and manual digitization. The visual analysis and manual contouring with mandatory updating of the database are indispensable attributes of processing. The updating of separate results was conducted continuously in the process of obtaining the new data, estimation of the data field trip, judgment of the specialists, coming to the organization from places. As a matter of fact, this updating can be prolonged up to the moment of a beginning of maps printing.

5. Direct verification of the interpretation in the field. At image analysis, certainly, there were disputable moments. For example, in the given site of the map the vineyards were routine, and the analysis of frame of a snapshot did not confirm it. The same situation took place with tea plantations. For the solution of such conflict situations the field trips were organized and already in place these moments were concretely rendered. By GPS borders of those fields were determined, all this was fixed on the schemes, the data were entered in the workers' notebooks etc.
6. Verification and correction of polygon vector files. On returning to the office the results of field trips, certainly, were laid down in the basis of activities on updating the results of processing. Under the indications of GPS in a field the precise place of the objects on the map was determined and already uniquely the class of the given object was indicated in the database.
7. Verification and correction of line vector files (rivers, roads, channels, railways). Separately from range of vector files dispositions of linear vector files were also made. This work was also complex one requiring large accuracy and attention. For example, the motorways very often go parallels to railway, multiply intersects it, and consequently at digitization of the railways and motorways it was necessary to be very accurate.
8. Check-up of the conformity of the image interpretation with the legend. The next step of the control was a check of conformity of the database and results of image processing.

3. RESULTS AND DISCUSSION

Under the initial information 25646 units of natural formations were allocated. Further they were generalized on the most representative classes land use of the region in a legend. It is quite understandable tendency to include the most representative classes of the region in a legend and, consequently, after numerous discussions, field trips and consulting from our experts we have stayed on a legend, which contains in a final kind 6 Land Cover types and 38 classes:

- ♦**Vegetation**
- ♦ Forest (oak)
- ♦Forest (mixed :oak, beech, grab)
- ♦ Forest (riverine)
- ♦ Forest (conifer)
- ♦ Forest (plantation)
- ♦ Rangeland /
- ♦Grassland / pasture
- ♦ Shrubs
- ♦ Steppe
- ♦Swamp vegetation
- ♦**Agriculture**
- ♦ Herbaceous crops wheat, maize, cereals, e.t.c)
- ♦Vineyard
- ♦ Cotton
- ♦Tea garden
- ♦Orchard
- ♦Food crops (potatoes, vegetable, etc.)
- ♦Rice
- ♦**Build-up areas**
- ♦Urban (town)
- ♦ Villages
- ♦industrial areas
- ♦ Oil field
- ♦ Roads
- ♦ Railways
- ♦ Airport
- ♦ Quarry / Mine
- ♦**Bare**
- ♦ Salt crust
- ♦ Soil
- ♦ Rocks
- ♦ Dry river bed
- ♦ Coastal dunes / Sandy beach
- ♦ Sandy
- ♦**Water**
- ♦Lagoon
- ♦Artificial lake
- ♦ Natural lake
- ♦ River
- ♦ Pond
- ♦ Canal
- ♦ Swamp
- ♦**Snow / Ice**

Name of agriculture classes	Count	Classification number	Code by LCSS	Area (км^2) (1998г)
Cotton	30	11	1000-S9	261,71
Food crops (potatoes, vegetable,e.t.c.)	156	12	1000-S5	1009,51
Herbaceous crops(wheat, maize, cereals)	1761	13	1000-S4	7146,15
Orchard	515	14	1000-S6	770,74
Rice	27	15	1000-S0	38,87
Tea	153	16	1004	92,71
Vineyard	128	17	10566	215,41
Common count of agriculture classes (G-K, zone 9)	2770	Common squaw for agriculture culture(G-K, zone 9)		9534,77

Very important meaning had presence occurring at different season of the information. A good example is the information class rice wherein the area can be composed of dry soil for those portions that have been harvested, wet/flooded soils for those parts that are prepared for transplanting and high vegetative cover for those portions with standing rice crops at the sprouting stage. The multispectral image data was classified using a maximum likelihood operator. Before actually performing the classification, the reparability of training classes was estimated by both statistical (transformed divergence measure) and graphical methods (histograms), also by geoinformation modeling. Using this complex method for the first time the digital model and unique database of Land Cover/Land Use for all the territory of Azerbaijan were formed. As we see in table A the obtained thematic maps of Land Cover / Land Use to scale l:50 000 were bound to a system of qualifiers, designed in FAO (LCCS) [3].

Table A. One of the classes of Land use – agriculture cultures

As we see in Fig. 2, on the basis of Land Cover/Land Use maps in one of the southern areas of Azerbaijan with subtropical climate - Lenkoran district - are carried works to control the dynamics of Land Cover/Land Use changes and reveal the reasons of these changes. The facts of decreasing of the wood areas, sharp changes in the agricultural areas and Land Cover/Land Use types are identified.

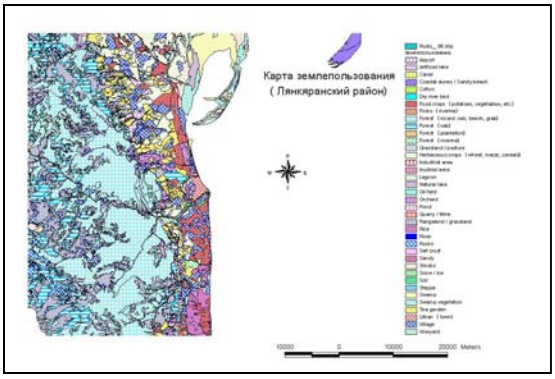

Figure2. Map of one of the southern areas of Azerbaijan district-Lenkoran.

Moreover, urbanization of lands most suitable for agriculture also takes place.

As we see in Fig. 3, the 52% of area (G-K, zone 9) is vegetation, 27% - agriculture, 12%-bare, 7% - build-up-areas, 2% - water, Snow/Ice is not in this area. And the 57% of area (G-K, zone 8) is vegetation, 21% - agriculture, 14%-bare, 6% - build-up-areas, 2% - water, 1%- snow/Ic.

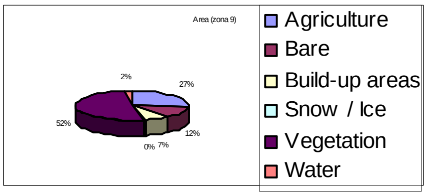

Figure 3. Diagram of the six land cover classes area (G-K, zona 9)

The formed digital model of Land Cover / Land Use can be utilized for the control of dynamic changes of a vegetative cover. The successful completion of this project was supplied by group of the ANASA employees at the practical support of the expert from FAO UN. Our own experience in solving similar tasks allows us to conclude that optimum approach of processing of RS data is complex using of the automated and expert methods of the analysis, gathering and estimation of the received information.

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