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Soil Mapping of the Mil Plain of Azerbaijan Based on the Aerospace Materials

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ABSTRACT: *Aerophotos, aerospace images and ortophotoplans, reflecting modern state of the surface of the earth, should be used while mapping of soils and generally natural objects (plants, water, landscape etc). In our republic, field-land investigation results and topographic maps were basically used in soil mapping before. As a long period of time passed after compiling those maps, they do not correspond to today's reality. In this regard, we for the first time compiled soil map of the Mil Plain of Azerbaijan at 1:1000 000 scale, based on the aerophoto, aerospace images and ortophotoplans, reflecting modern images of the earth's surface.*

KEYWORDS*:* The Mil Plain, aerophoto, aerospace image, ortophotoplan, map

INTRODUCTION

The Mil Plain is a part of the Kur-Araz lowland of Azerbaijan, located between the Kur and Araz Rivers. The territory is bordered by the Kur River to the north and northeast, by the hilltops of Lesser Caucasus to the southwest, by the Araz River to the east, by the Gargar River to the west. It is a geographical unit with general area of 399948 ha. The Mil Plain administratively includes the territories of Imishli, Beylegan and Aghjabedi regions.

In modern life, mapping of space objects, including soil cover, landscape complex and other natural phenomena and processes demands three basic elements: 1) exact geographical principles (different-scale topographic maps); 2) aerospace and orthophoto images; 3) corresponding computer programmes during the electronic mapping (ArcGIS, mapINFO, CorelDRAW etc). *Related to the exact geographical principles (different-scale topographic maps)*. As it is obvious, exact geographical principles (topographic map at the required scale) are the main part of the geographic basis of different-theme maps, including soil maps. For long years, paper topographic maps were used in soil mapping. It has been started to focus on different-scale electronic topographic mapping, using aerospace materials along with the surface investigations during past decade. However, according to the experiments, as paper or electronic options of topographic maps are subject to generalization, the existence of exact topographic principles are not sufficient for the mapping precisely reflecting reality. For this, the usage of aerophoto and aerospace materials upgraded from time to time is important as well.

Related to the usage of aerospace and ortophoto materials and corresponding computer programmes. In our republic, there is not enough experience in compiling of different-theme maps, including soil maps by using aerospace materials and corresponding computer programmes. As to us, this can be explained with several reasons: 1) unavailability of aerospace materials by many specialists. 2) lack of usage ability of aerospace materials and computer programmes by some specialists.

However, it is impossible to deny the important role of the soil maps and other types of maps prepared by means of traditional ways in the development of many science fields and in the

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management of the country's economy. Soil mapping was started in the late 19th century in Azerbaijan. However, large scope of the investigations in this field were stimulated in 1920-1930's. During these years, a lot of detailed, large, medium and small scale soil, soil-erosion, salinisation etc maps were prepared in our republic. And Aliyev (Aliyev *et al* 1991), Volobuyev (1965), Abduyev (Abduyev 1961,1973), Salayev (Salayev and Jafarova 1985), Hasanov (Hasanov 1972), Mammadov (Legend of the Azerbaijan State Map. 2003; Ecological Atlas of Azerbaijan Republic. 2009.; The Atlas of lands of Azerbaijan Republic. 2007), Babayev (Babayev *et al* 2006), Hasanov (1978), Jafarov, Jafarova (Jafarova *et al* 2006) and other investigators had great role in the preparation and interpretation of the republic's soil, soil-erosion, salinisation and other maps at 1:500000, 1:600000, 1:200000, 1:100000, 1:1000000 and 1:1500000 scales. Soil maps of the republic's separate economic and administrative regions at 1:10000 and 1:50000 scales were compiled in the corresponding institutes (e.g. The Ground Structure Project Institute of Azerbaijan) by the scientific support of the Institute of Soil Science and Agrochemistry. During the decades, field-laboratory investigations were basically focused on for the obtaining of the preliminary soil information and different-scale soil mapping in the Soil Science and Agrochemistry Institute and in other institutes related to soil investigations. General scheme of the investigations in soil mapping was as follows:

1) In the first, cameral-preparation stage, before starting field-laboratory investigations, the researchers defined the route of the investigations on the topomaps (in some cases on the maps with unknown date of compiling) or on the soil maps prepared in previous years and determined the places of sections to be done during the field work.
2) In the second, field-laboratory stage, the researchers who would work as scheduled, made soil sections repeatedly on the places defined beforehand, took soil samples from soil horizon and tested them at the laboratory.
3) In the 3rd, generalising-finalising stage, on the basis of the obtained results in the laboratory, soil contours were drawn or the existed ones were specified and soil mapping was realised at the required scale.

Depending on the experience of the researchers and some other subjective and objective reasons, maps prepared by this method had accuracy in this or that sense and kept their importance only for short periods (5-7 years). However, rapidly cultivation of the territories, amelioration work, construction of collector-drainage systems and water reservoirs, transformation of agricultural areas, extension of settlements, construction of connection lines etc, changed space information elements and in some cases the conditions of soil formation in the territories. And all these required new soil mapping or correction of the soil maps by coping the existed changes on them.

ANALYSIS AND DISCUSSION

From the late 20th century, the wide usage of the computer technologies and GIS, specially aerospace materials in soil investigations founded the technological change in soil mapping. The newer technologies have been created recently enable us to compile any kind of maps as well as soil maps at different scales in more perfect and accurate options. Several countries have rich experience in this field. Chernousenco and his coauthors (Chernousenco *et al* 2011)while evaluating salinised and alkali territories in Ural federal district (Russia) compiled electronic digital maps of the territory at 1:2500000 scale, using ArcInfo programme. Other researchers, Rukhovich, Korolyova, Calinina (Rukhovich *et al* 2013), compiled digital version of the state soil map of Russia, using aerospace materials. Using aerospace materials in soil mapping is also under great concern in other countries of the world (Compiling and utilization of the soil maps. 1987).

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The necessity of electronic (digital) soil mapping at 1:100000 scale (fig.2) of the Mil Plain soils (the territory is highly cultivated and irrigated) was firstly related to that the geographical elements (irrigation network, roads, swamps, salinised soils, settlements etc) as well as soil contours of the Mil Plain is very dynamic. Secondly, soil map (1:100000) of the territories belonged to the Mil Plain was compiled by Salayev and Jafarova (Salayev, Jafarova 1985) in 1920's, using the topo maps of 1980's. Therefore, the soil map required to be upgraded.

Taking this fact into account, in the first stage of our investigations, our goal was to compile upgraded electronic soil map of the Mil Plain at 1:100000 scale, based on the aerospace and ortophoto materials and electronic topo maps (Heydarova 2012,2014). A number of issues were solved while soil mapping at 1:100000 scale of the Mil Plain based on the aerospace and orthophoto materials.

I. *Editing of the higroraphy-related information on the old topographic principles.* Since many geographical elements related to the described hygrography elements (river-beds, collector-drainage system, swamps etc) in the territories belonged to the Mil Plain on the Azerbaijan state soil map, compiled by Salayev and Jafarova (1985), reflect the state of the soil in 1980's, the electronic soil map we compiled was subject to fundamental corrections.

The changes, occurred during these years (past 20-30 years), i.e. the changes in the river-beds, beds of the lakes, irrigation network and collector-drainage system at the territory, were represented on the new electronic soil map.

II. *Editing of the information that is not related to hygrography on the old topographic principles.* The advantages of the soil maps, compiled using the aerospace materials and electronic topographic maps, from the "traditional soil maps" are based on the description of the other information unrelated to hygrography. If the contours of the geographical elements, (forests and gardens, salinised soils, settlements, roads etc) unrelated to hygrography in compiling of "traditional soil maps", are taken from the generalised topographic maps (paper versions), the aerospace materials enable us to define more accurate patterns of those contours in the existed period of time (real period of time). From this point of view, one of the most important cartographic issues on the Mil Plain was to define precise contours of the natural geographic elements, swamped areas, river banks' alluvial (alluvial-forest-tugai) areas and the corresponding soils and salinised soils, (fig. 1, fragment 1).

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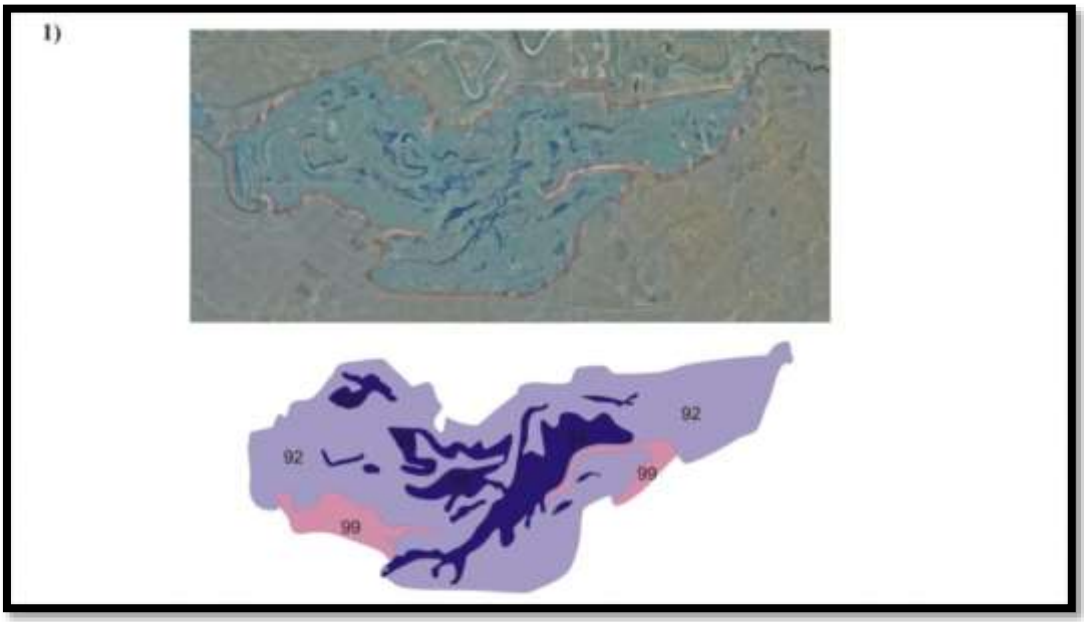

Fig.1. (Fragment 1 - from the electronic soil map of the Mil Plain). Soil contours: 92 - salinised meadow-swampy; 94 - swampy-meadow; 99- takyr-like salinised soils; 100 - crusted salinised soils.

As it is clear from the image, the real state of the territory, represented by the aerophoto images, enabled to display the borders of the four soil contours stated on the "traditional" map, salinised meadow-swampy (92), swampy-meadow (94), takyr-like salinised soils (99), crusted salinised soils (100), more accurately.

III. *Editing of the contours of the irrigated soils*. One of the most important issues is to determine the exact borders of the irrigated soils when soil mapping of the plain territories, where the irrigation tillage is widely used and the majority of the lands are irrigated (fig.2, fragment 2). This problem was more obvious during the electronic soil mapping of the Mil Plain. In comparison to other contours, there are much bigger opportunities to determine the exact borders of the irrigated areas. The irrigation canals, ditches, collector-drainage network, ploughed areas are more visible on the aerospace images. And this gives us an opportunity to define more precise contours of the irrigated lands.

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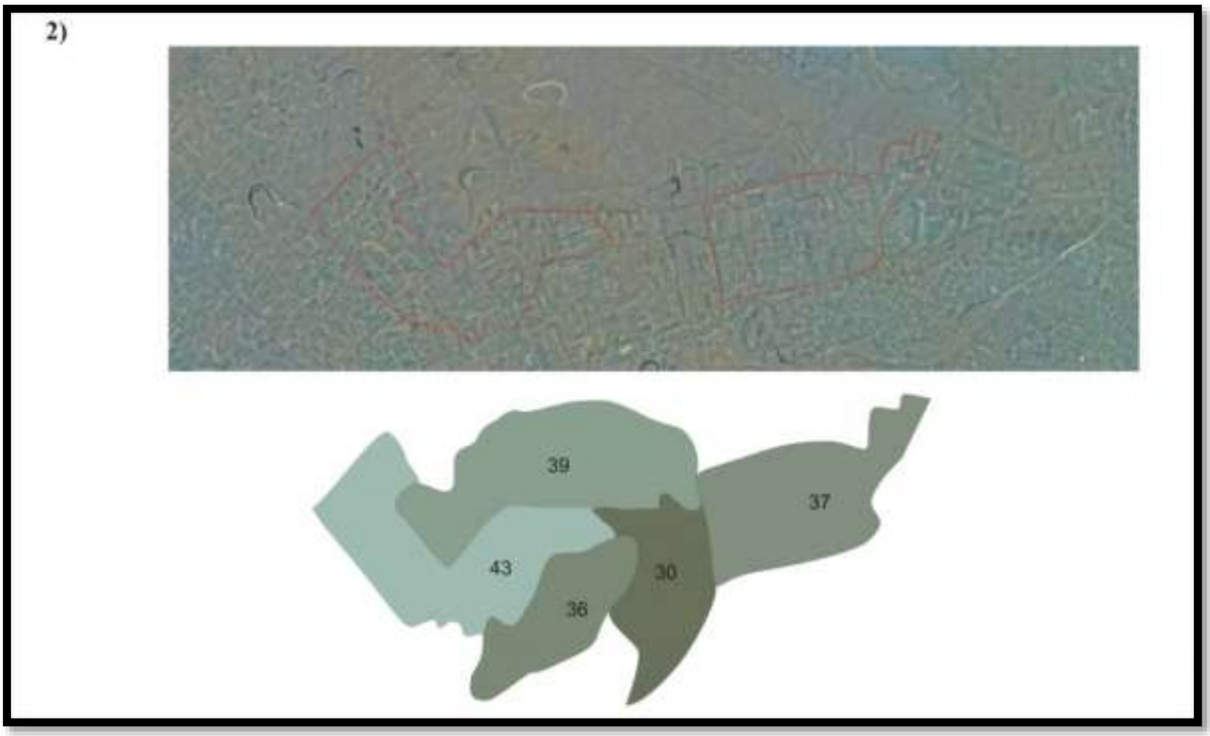

Fig.2. (Fragment 2 - from the electronic soil map of the Mil Plain). Soil contours: 30 - irrigated alkali-like ordinary meadow-grey; 36 - irrigated light meadow-grey; 37 - irrigated alkali-like light meadow-grey; 39 - salinised light meadow-grey; 43 - irrigated salinised light meadow-grey

RESULTS

1) During the survey of the "traditional soil map", based on the aerospace and aerophoto images, it became clear that the borders of the irrigated lands were subject to serious changes in past 20-30 years. Two opposite processes were defined here:

- The borders of the irrigated zones crossed the traditional areas and penetrated into the territories of the former winter pasture areas and alluvial and alluvial-forest soils along the Kur and Araz Rivers (fragment 2).
- In some places, in the irrigated lands from the old times, on the contrary, the traces of the former irrigation network (ditches, drainages etc) were observed due to the irrigation had been ceased. It is not so difficult to determine "the irrigation period" of those territories observed as fragments and became stronger in the place gradually.

2) The analyses of the fragments state that unlike the maps prepared in a traditional way, the maps based on the aerophoto, aerospace images and ortophotos have both technical and information privileges.

3) In the further stage of our investigations, the areas of the soil contours, irrigated and non-irrigated soils, salinised and alkali lands were calculated at 1:100000 scale soil map of the Mil Plain, prepared on the basis of the aerophoto, aerospace images and ortophoto materials. 42.0% (or 62211 ha lands) of the irrigated soils on the Mil Plain was subject to salinisation to this or that degree. It forms 13% of the total area of the territory. 41.2% or 25615 ha of the irrigated lands was subject to weak, 29.6% or 18427 ha - to average and 29.2% or 18169 ha - to severe salinisation.

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