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Updating the Land Cover Map Using Satellite Data. In Order to Integrated Management of Natural Resources

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Abstract: Having updated spatial data from natural resources is essential for their integrated management. Latest available related data in our country, are land cover maps, (produced by FRWO) and range type maps (produced by RIFR) which are published gradually till 2004, emphasizing on fieldwork. Considering some contradictions in mentioned maps and the necessity of coordination and uniformity of the land cover data in natural resources areas, leads to definition of this project by FRWO. The aim of this study was updating the existent land cover map and producing the range type map via joining them. Surveying the 8 sheets of 1:250000 maps (12 million ha) which are situated in the central part of Iran, has been given to Yekom consulting engineers. At first TERRA-Aster and IRS1D-LISSIII satellite data acquired in 2001-2005 were Orthorectified with RMSE less than 1 pixel. Then appropriate spectral and spatial transformations were carried out on images. These images were interpreted using interpretation pattern derived from GCPs (a control point per 30000 ha) and other ancillary data. On-screen digitizing method was performed to edit the boundaries of primary land cover map. By doing a complementary fieldwork, as a final check probable mistakes and uncertainties had remedied. The produced final map was overlaid with the range type map and range types were transferred into the range polygons in the mentioned map. In dissimilar areas, the fieldwork determines the type of the range. The final outputs of the project are cartographic maps, database of rangeland and the final report.

Key words: Geodatabase · GIS · Land cover · Map Updating · Remote Sensing

INTRODUCTION

Natural resources, especially ranges and forests are dynamic and changeable as time passes. Therefore having accurate, precise and update data in short periods, is necessary for managing in local and national scales. Numerous studies were performed recently in related fields via different organizations and departments. Assembling, composing and updating these scattered data are resulted comprehensive information about natural resources.

Latest available related data are land cover maps, [produced by Forest, Range and Watershed organization (FRWO)] and range type maps [produced by Research Institute of Forest and Range (RIFR)] which are published gradually till 2004, emphasizing on fieldwork. Considering some contradictions in mentioned maps and the necessity of coordination and uniformity of the land cover data in natural resources areas, leads to definition of this project by FRWO. The aim of this study was updating the existent land cover map and producing the range type map via joining them. Surveying 8 sheets of 1:250000 maps (12 million ha) which are situated in the central part of Iran, has been given to Yekom consulting engineers (Figure 2).

MATERIALS AND METHODS

As illustrated in Figure 1, initially the image Orthorectification was implemented using ephemeris data, a precise digital elevation model (DEM) and ground control points (GCP) derived from digital topographic maps [1]. An affine transformation and bilinear resampleing were applied and RMSE was less than one pixel. The reliability and accuracy of geocoded images was checked in compare with the digital river and road map (Figure 4). In the gaps (study areas without the ASTER images), IRS1D images were used (Figure 3).

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Fig. 1: Processes flowchart of the project. Yellow, blue and red boxes are Inputs, Processes and Outputs respectively

These images were in BIL format that were not good enough to orthorectify by mentioned method. So, polynomial method has been used for them.

Fieldwork and surveying was carried out to achieve a general knowledge and overall view from the features and land covers. Some documents and instruments such as topographic map, image-map, GPS, digital camera and binocular were used for gathering preliminary information. General physiognomy of the study area showed an arid and warm climate which generated broad sandy and salty brackish ground. Most of the mountains were bare land or involved poor range. The study area which is a part of the Kavir desert, include vast area of sand dunes and surfaces. Fortunately proper actions have been done to stabilize sand dunes through afforestation especially with *Haloxilon spp.* and *Tamarix spp* species.

According to the guide direction and initial information about the study area, 50 control points were chosen (a control point per 30000 ha). These points include distinguishing features, obscure phenomena and marginal areas between two spectral categories.

In order to initiate interpretation pattern via fieldwork, each control point had found in the field using GPS. Land cover categories of the point and in four cardinal directions of it, had been recognized and recorded in special forms. Needed number of photos was taken in every direction. Then the gathered data from the field was converted as a point map in SHP format.

In the next stage, appropriate spectral and spatial transformations such as contrast enhancement, rationing, color composites and image fusion were carried out on the images [2-4]. These processed images were interpreted using interpretation pattern derived from GCPs and other ancillary data such as existence topographic, land cover, height, slope and aspect maps beside hill shaded images. On-screen digitizing (visual interpretation) method was performed in the display scale of 1:50000, to edit the boundaries of primary land cover map (Figure 5).

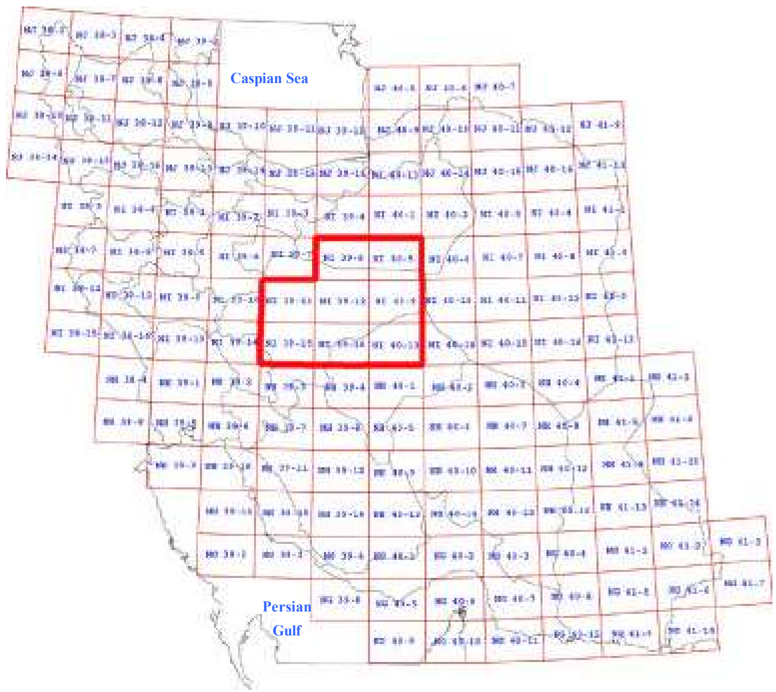

Fig. 2: Location of the study area in Iran

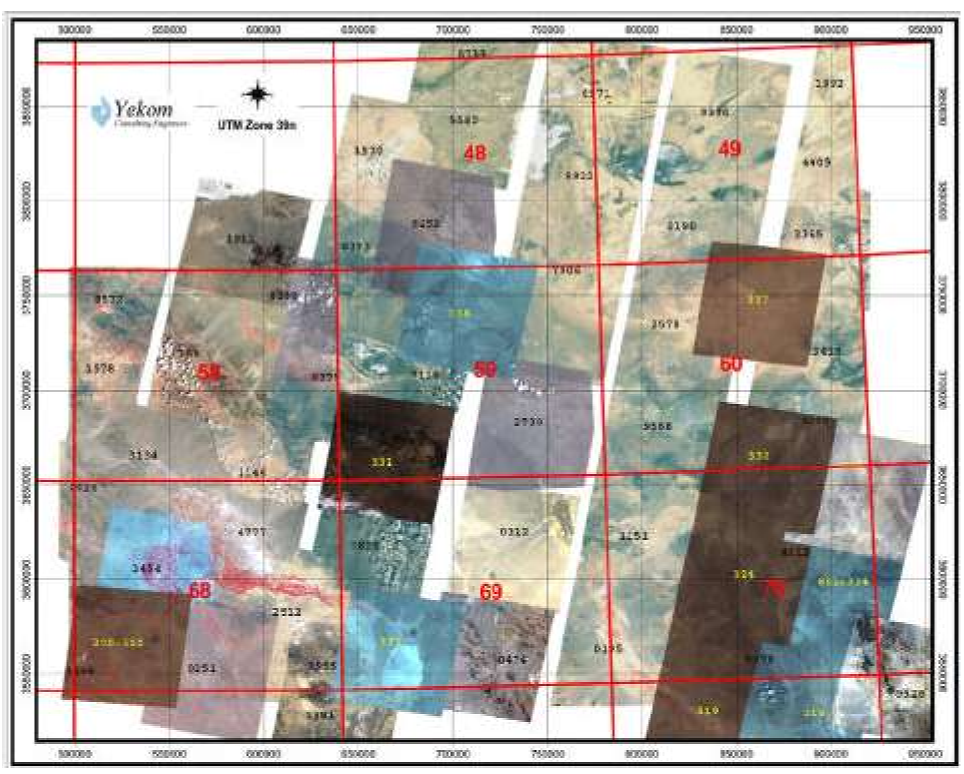

Fig. 3: The index of Aster images in the study area. Gaps were covered with IRS images

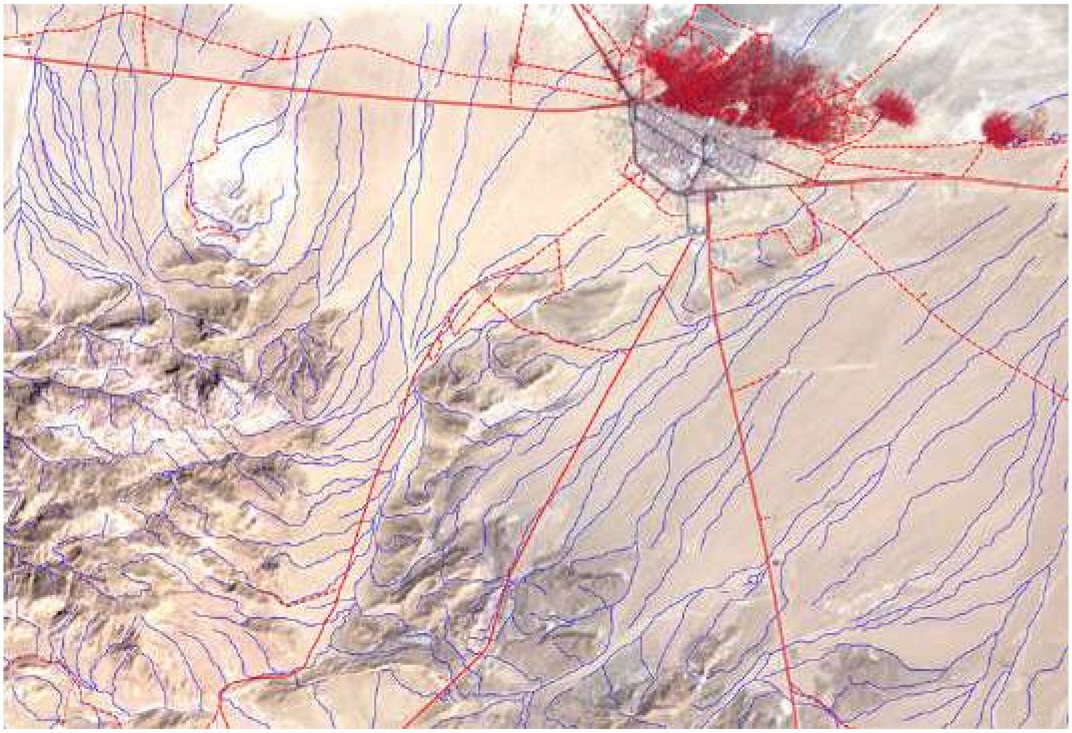

Fig. 4: High precision of orthorectified image, in compare with roads and rivers

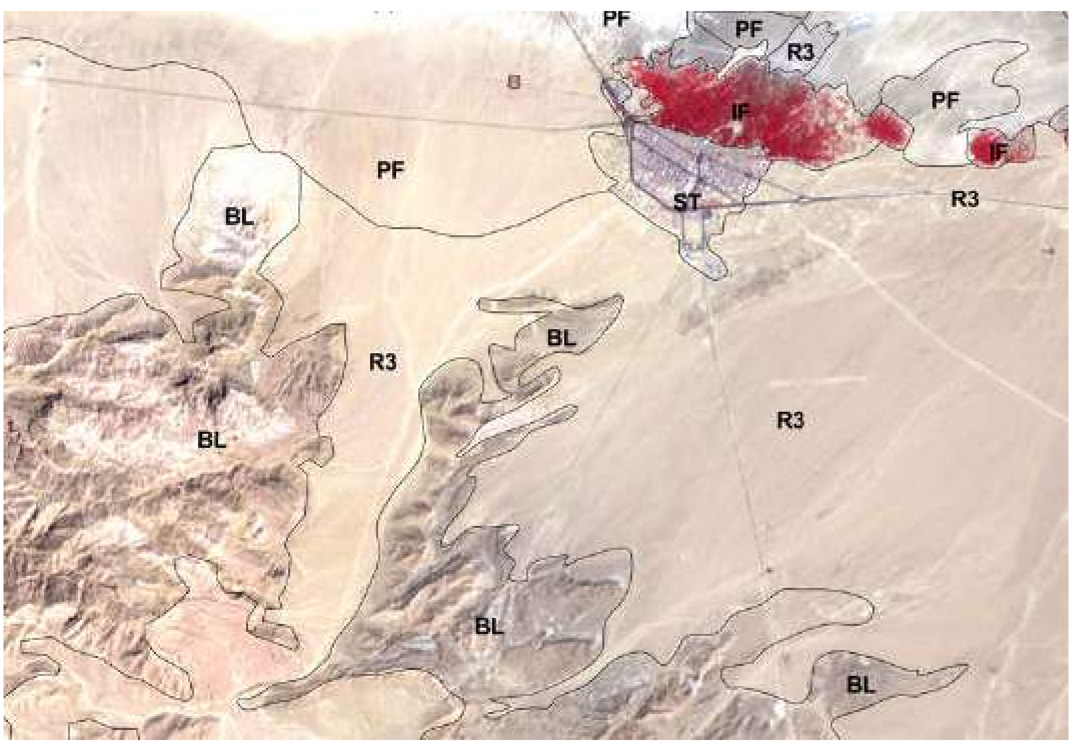

Fig. 5: A part of updated land cover map based on color composite image

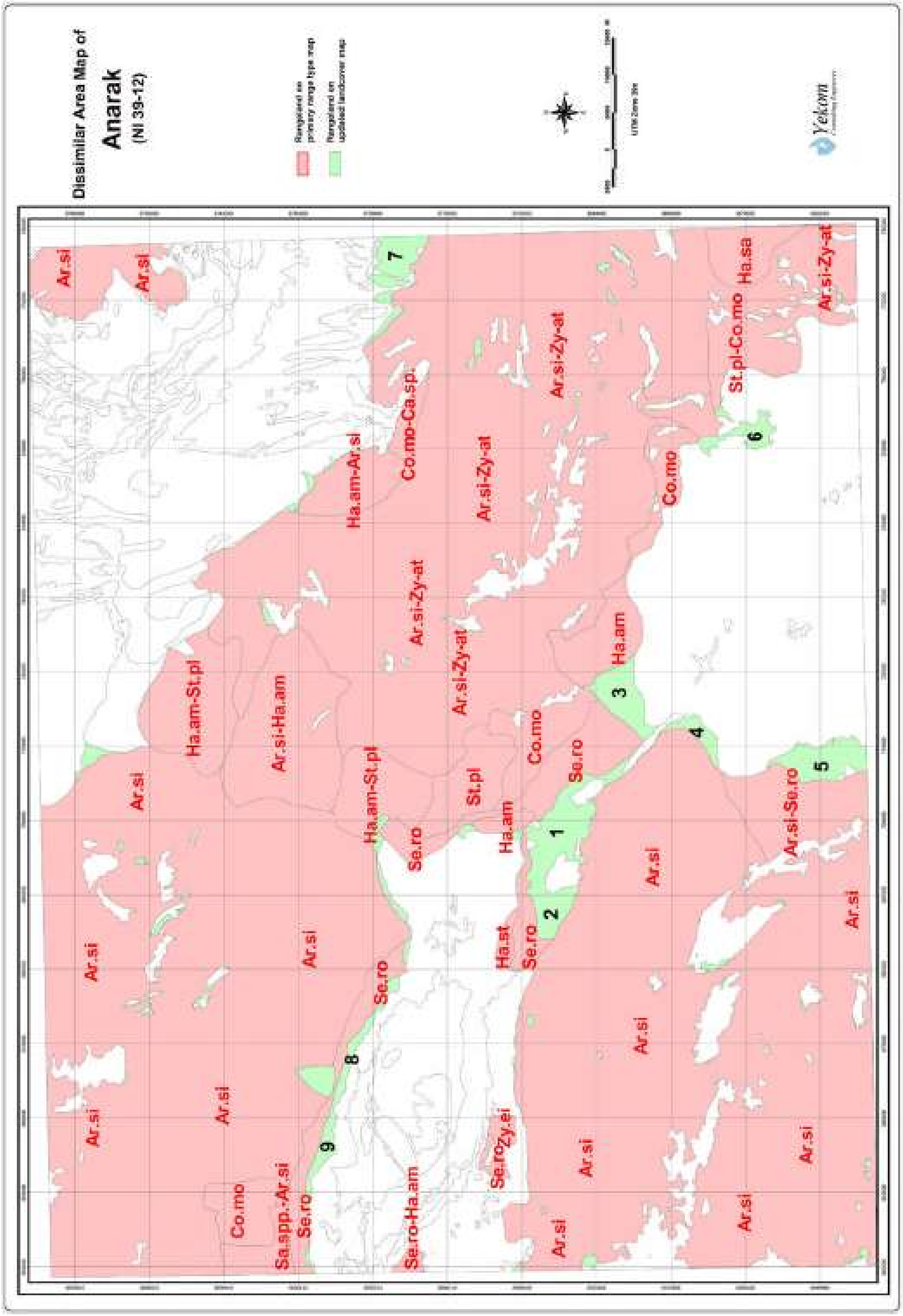

Fig. 6: Dissimilar area map of Anarak. The range type of green areas have been defined by fieldwork

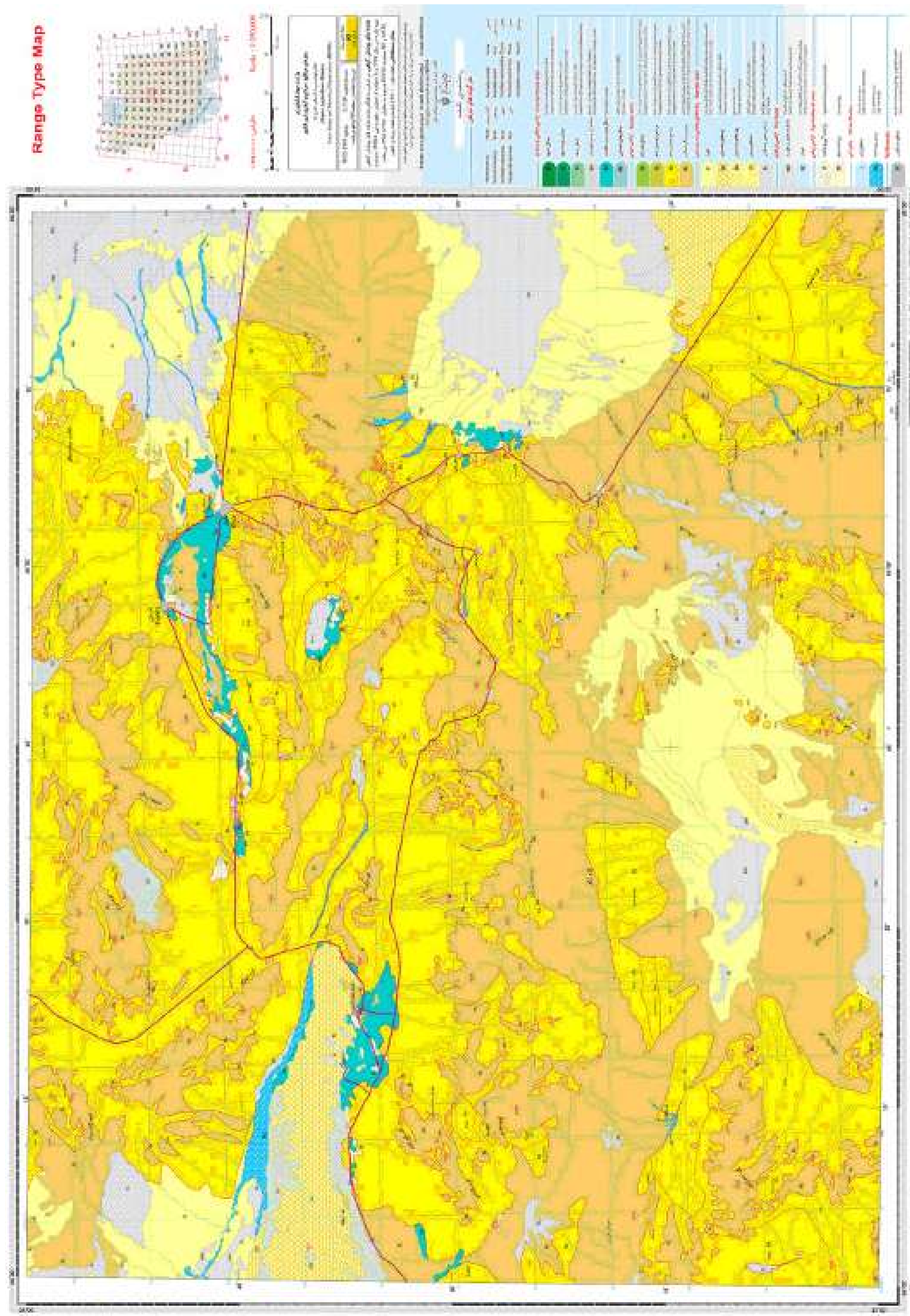

Fig. 7: A sample of final range type map

A supplemental fieldwork was done as a final check to remedy the probable mistakes and uncertainties. Finally, updated land cover maps overlaid with the range type maps and range types transferred inside of the range polygons in final map. In dissimilar areas, the fieldwork determines the type of the range (Figures 6 and 7).

Final cartographic maps and related geodatabase will be presented in the scale of 1:100000 according to guide direction of FRWO.

RESULTS

Since this project have not finished yet, produced maps and data also expected activities are listed below:

- 56 Orthorectified Aster images were prepared. Also 13 IRS1D images were used after geocoding for gaps. All the images were mosaiced in the scale of 1:100000 maps.
- 6 land cover maps, updated and finalized in the scale of 1:250000. These maps are prepared for cartography in 1:100000 scale after confirmation by executive team. A primary cartography was performed on them.
- After confirmation final maps, Land cover change maps will be produced in 1:250000 scale.
- Finally, land cover statistical statement will be presented for each sheet, beside final report.

DISCUSSIONS AND RECOMMENDATIONS

Usage of RS&GIS in this vast area, by an executive organization (that is administrator of natural resources), is an innovation, although it has not took advantages of all remote sensing capabilities and capacities. Despite of some deficiencies, it could be a hopeful initiation of using such techniques to achieve spatial data and monitoring of natural resources areas in national level. Respecting all efforts on utilization of new techniques in natural resources management by FRWO, there are some scientific-practical limitations and problems which should be mentioned here. We hope that, this article would have an effective role on FRWO positive trends in this way.

- Nonexistence of a defined standard to evaluate the precision and accuracy of produced maps caused practical problems in supervising process of executive team [2]. Preparing a compiled guide direction seems to be necessary to quantitative evaluation of produced maps [5]. As an instance; determining the dispersion manner and density of control points, acceptable error percentage and standard definition of plant cover maps in the scale of 1:100000, would be beneficial to have an optimum judgments about precision and accuracy of produced maps.
- Satellite image limitation in distinguishing some phenomena and some methodological defects in interpreting these images, causes inevitable errors which are accounted as interpretation errors. According to the guide direction, satellite image should be interpreted visually, based on 50 control points in each sheet. Undoubtedly interpreter's overall knowledge about the field phenomena and surveying the study area would be so effective. But measurement and surveying all over the field by interpretation team is definitely illogical and impossible. Also by considering of one control point per 30000 ha, there would be a 17 km mean distance between two control points and certainly distinguishing some phenomena like bare land and poor rangelands or recognition of forested areas with small trees and shrubs, by existent images (LISSIII or Aster) in such distances is so hard or even impossible and the interpreter could not recognize them. Thus these areas (which are too much) would be considered as errors while they are not really visible in satellite images. It seems that there is an illogical balance between available satellite images ability and methodology in one hand and expected precision and accuracy on the other hand. In fact there is not any standard evidence to prove that available satellite images along with this number of control points and interpreting manner could result the expected land cover density-type maps with anticipated accuracy. 10 times or even more control points would be suggested for coming similar researches to reach the expected precision and accuracy.
- Inability of these satellite images for production of density rangeland maps has been easily seen during fieldwork and surveying. As an instance; in some images we had two areas with same color, texture and NDVI code, while they had different land cover. Also in most of cases, accurate rangeland borders just could be distinguished via fieldwork and recording marginal points gathered by GPS. This difficulty could be visualized especially in plantations in salty lands and sand surfaces [6]. It should be mentioned that using visual interpretation and on-screen digitizing to classify the land cover would certainly

result such problems [7-8]. How ever common digital manners could be used in small scales by elimination of soil reflection effect, using different indexes and new object-based image classification, parallel with visual interpretation [3, 9-13].

- As said, this project could be considered as an innovation which has done by an executive organization. Respecting and believing high potential and good background of FRWO, it is obvious that profiting the specialist's ideas and opinions from research centers and universities (as consultant or supervisor) would be beneficial to improve it and make it scientifically provable.

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