DATABASE OF SAR IMAGES OF MONGOLIA AND ITS ROLE FOR UPDATE OF DIFFERENT LAYERS IN A GIS

D.Amarsaikhan[1,2] and M.Ganzorig[1]

[1]Institute of Informatics and RS
Mongolian Academy of Sciences
Ulaanbaatar-51, Mongolia

[2]Center for Northeast Asian Studies
Tohoku University, Kawauchi, Aoba-ku, Sendai
980-8576 Japan
amar@cneas.tohoku.ac.jp and ganzorig@arvis.ac.mn

Abstract. The aim of this study is to describe the problems and solutions for creating a synthetic aperture radar (SAR) mosaic covering the total territory of Mongolia and highlight the role of the available SAR database for updating different thematic layers stored in a geographical information system (GIS).
Keywords: SAR image, database, digital mosaic, thematic maps, GIS.

1. Introduction

In recent years, synthetic aperture radar (SAR) products have been effectively used for environmental monitoring and natural resources mapping, because of the advantage of the used microwave wavelengths to penetrate through cloud cover and most weather conditions. Moreover, as the radars are the active sensors they can image the Earth's surface anytime, day or night.

Until recently, only optical satellite images with different spectral and spatial resolutions, and aerial photographs have been used in Mongolia for mapping and detailed resources studies, and there was a very limited application of the microwave remote sensing (RS) data sets. In 1997, the German Aerospace Research Establishment (DLR) installed a C-band ground receiving station in Ulaanbaatar, the capital city of Mongolia to fulfill one of the existing data gaps. Since that time, successive ERS-1/2 SAR data related to the Central Asian Region have been acquired. Now, for the Mongolian scientists multitemporal ERS-1/2 SAR GEC PRI images covering total territory of Mongolia and also interferometric ERS-1/2 data sets of some selected sites are available.

These data sets will have a number of applications, for example, they can be successfully used for mapping of different natural resources and updating the old thematic layers stored in a GIS. The aim of this study is a) to highlight some problems for creating a digital SAR mosaic covering the whole country and their solutions, b) to highlight the role of SAR database for update of some thematic layers stored in a GIS.

2. SAR Database and Digital SAR Mosaic of Mongolia

Since the establishment of the ground receiving station in Ulaanbaatar, a great number of ERS-1/2 SAR images covering total territory of Mongolia have been acquired. The data archive includes mainly PRI SAR images, some of which are multitemporal. For some test sites located in central and eastern regions, interferometric ERS-1/2 tandem pass SLC images, some of which are multitemporal, are available. The database containing such different types of SAR products can be used for different purposes. In many cases, the users are interested in a digital SAR mosaic covering a large area, when huge data sets are available.

In radar images, topography and incident angle dependence cause considerable radiometric and geometric distortions, because of the side looking geometry of SAR systems. In order to create a digital image covering the whole country, different image frames should be mosaicked. In such a case, the first frame's near range will be mosaicked with the second frame's far range, *ie*, the same objects represented under different incidence angles are to be merged. In this case, because of the topography and changing incidence angles the following problems would appear:

- In larger scales, the change of the object dimension and size in relation to the incidence angle. It is fine in a far range than in a near range, *ie*, the same objects occurring in the near and far ranges contain different number of pixels. The objects are represented by a fewer number of pixels in the far range than in the near range.
- The same objects occurring in the near and far ranges have different radiometric appearances. The reasons might be a) the data calibration, b) according to the theory of microwave RS, in a far range more specular reflection, which results in lower backscattering (*ie*, in darker appearance of the objects), should be expected [3].

In order to solve the above mentioned problems, the following can be proposed:

- In order to create a digital mosaic of larger scales, apply terrain correction procedures to the SAR images that are to be mosaicked. The terrain corrected images will be represented in true map coordinates, thus creating ortho-rectified SAR images.
- For creation of digital mosaics of smaller scales, it is not necessary to apply terrain corrections, because at smaller scales most of the terrain distortions can be neglected.
- In general, radiometric correction of SAR images can be carried out by projecting the mosaics to a common incident angle. However, in many cases the users are not sure about the incident angles to be used for the projection. An alternative method can be found via histogram matching by transforming the histogram of the overlapped region to the other frames.

3. SAR Data for Update of GISs

At present there are some state and private organizations in Mongolia dealing with different RS and GIS activities. Many of these organizations use the traditional topographic and thematic maps for their decision making processes or development of thematic layers in GISs. However, most of these maps (both topographic and thematic) were created in 1970s and 1980s. These map data sets have different quality indicators and many of them need to be updated. The available SAR database can be used for creation of new thematic maps or update of some layers in GISs. For generation of new layers or update of existing layers in GISs using RS data, three different methods namely: manual, automatic and knowledge-based (KB) approaches can be applied [2]. Before the thematic information is extracted, it is highly desirable to apply terrain correction procedures to the SAR images in order to extract spatially accurate thematic information [1].

Now in Mongolia, topographic maps of 1:100,000 are available for the whole country, but 1:50,000 and larger scales are available for only limited parts. Recently, in different organizations of Mongolia dealing with RS and GIS activities, digital elevation models (DEM) with varying certainties of accuracies have been developed using mainly the contours digitized from the traditional (old) topographic maps. The available interferometric data sets acquired from ERS-1/2 satellites can be successfully used to update or check the accuracy of these DEMs. In order to derive DEMs from the raw SAR images, the following procedures need to be applied:

1. Coregistration of the 2 complex SAR images;
2. Coherence evaluation and interferogramme formation;
3. Phase unwrapping;
4. DEM construction.

When reliable DEMs are extracted, the results can be stored in GISs as separate layers.

Besides being used for DEM generation, the available interferometric data sets can be used for the following studies:

- Land use classification and forest monitoring.
- Landslide analysis -prediction and quantification.
- Hydrological modeling.

The general diagram for making a linkage between different types of the ERS-1/2 SAR data and operational GISs is shown in Fig. 1.

4. Conclusions

The purpose of this paper was to describe a methodology for creating a digital SAR mosaic covering the total territory of Mongolia and highlight the role of the SAR data sets for creation of new layers or update of existing layers in GISs. For this aim, the present situation of the existing thematic and topographic information and their need to update were briefly reviewed.

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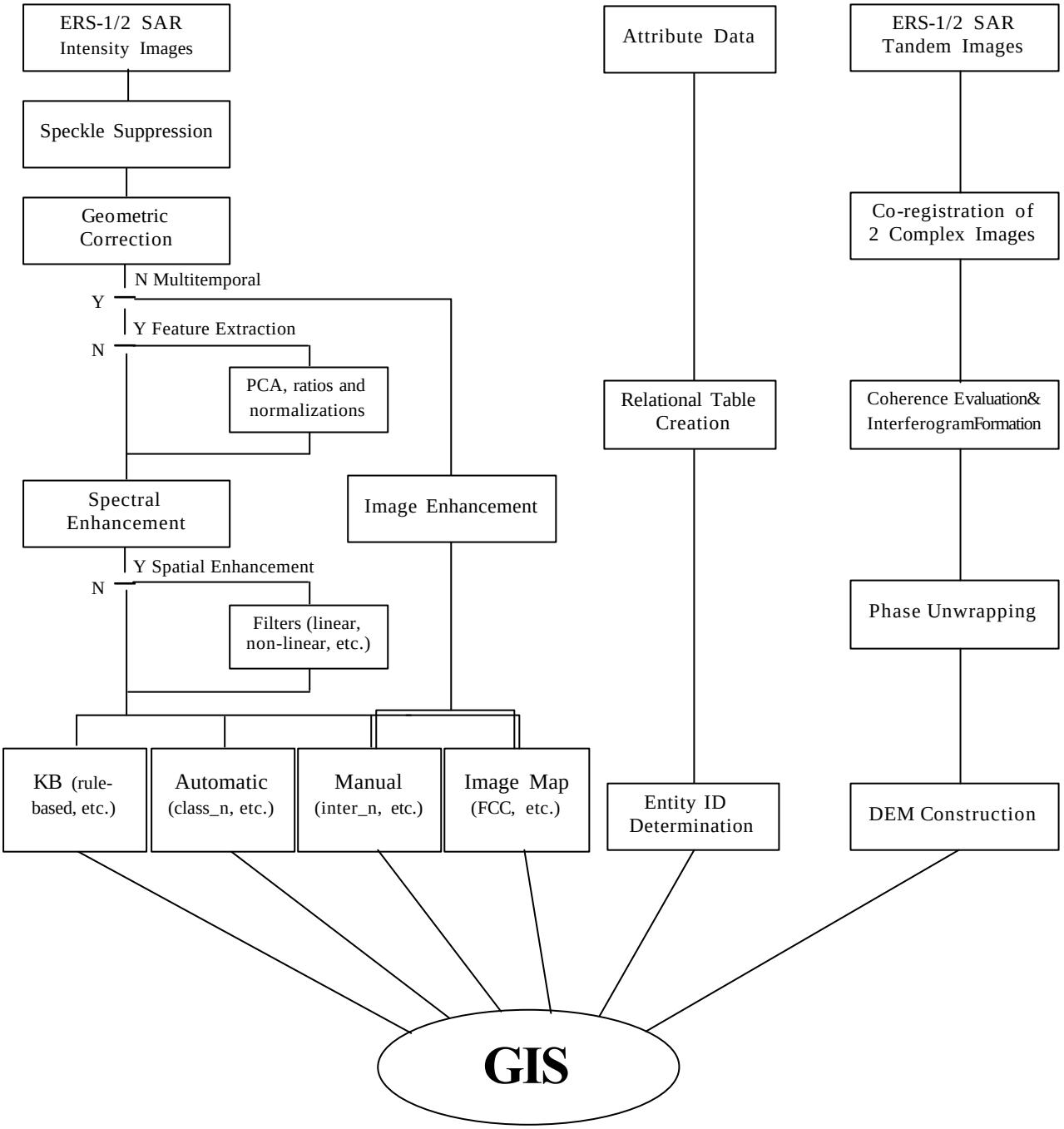

Fig. 1. The linkage between ERS-1/2 SAR data and GIS.