# GIS and Remote Sensing for Natural Resource Mapping and Management

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**Abstract**

The socio-economic development of any country is based on land resources and water resources. Due to increase in population, these resources are over stretched often leading to resource depletion. There is therefore need to prudently manage these delicate resources. Remote Sensing and GIS techniques can be applied effective measure to generate data and information for sustainable development. After more than twenty five years of satellite-based land remote sensing experimentation and development, these technologies reached almost all sectors of Earth science application. The use of remote sensing data and derivative information has ever promise of entering into mainstream of governing at local and regional level. The article enumerates the mapping and management of natural resource using Remote Sensing and GIS Techniques.

**Key words**

Remote Sensing, GIS and Thematic mapping

**Introduction**

Global Scan Technologies, Dubai is implementing the latest and cost effective solution for Thematic Mapping in United Arab Emirates and Worldwide. The thematic mapping services includes Geology, Geomorphology, Hydrogeology, Vegetation, Soil and Land use Land cover studies. The following article enumerates such a study carried out for the part of Middle East Region.

**Objective**

This paper seeks to demonstrate the usefulness of GIS technology in conjunction with Remote Sensing for resource mapping and its management for enhancing management decision-making capabilities.

The main objectives of the paper as follows

- examine how digital multispectral data are collected and processed
- become familiar with the basic, elementary mathematical and statistical concepts used in computer-assisted digital remote sensing data analysis
- Investigate and apply various strategies for classification of these data in extracting earth resources information such as geology, land use and land cover, soil, geomorphology, vegetation etc,
- evaluate the utility of multispectral data from one season over those from another
- become aware of emerging innovative approaches to the analysis of satellite remote sensing and ancillary earth resources data
- gain experience in the use of a popular and powerful software system for digital image processing running on high performance microcomputer
- develop an organized, logical approach to computer-assisted processing of earth resources data for effective natural resource management.

**Materials and Data:**

Satellite Data: IRS P6- LISS III and LISS IV

Collateral Data: Topographic map, Geology Map, Soil map, Rainfall map etc,

A brief methodology for execution of this project is explained as follows:

**Methodology**

**Input data**

The satellite data of the study area are procured from IRS-P6, LISS-III & LISS-IV and has been used for Geology, Geomorphological, Soil, Vegetation and Land use Land cover studies. Published soil maps, topographic maps, climatic data etc. are also collected and used as collateral data.

**Data Processing**

The IRS P6 satellite data were geo-referenced and suitable Image enhancements are applied to facilitate the delineation and interpretation of different thematic information.

**Data Interpretation**

Visual and digital interpretation methods were used to prepare pre-field interpreted map. The satellite data is interpreted based on photo elements like tone, texture, size, shape, pattern, aspect, association etc. These pre-field interpreted maps and digitally enhanced satellite data are used on the ground to identify different elements of various themes.

**Field Verification and Data Collection**

Suitable field sampling designs in terms of line transects/ quadrants are used to assess the interpreted elements and relate with satellite data. The field data collections are aided by GPS in order to locate the ground verification points on the image and for further incorporation of details. For the all the sample collection and field points visited attribute information on vegetation, geomorphologic, soil and topographic parameters are also collected.

The detailed soil-site study was undertaken in each soil-mapping unit by general traversing and by collecting surface soil, minipit and soil profile observations at intervals depending on soil variability

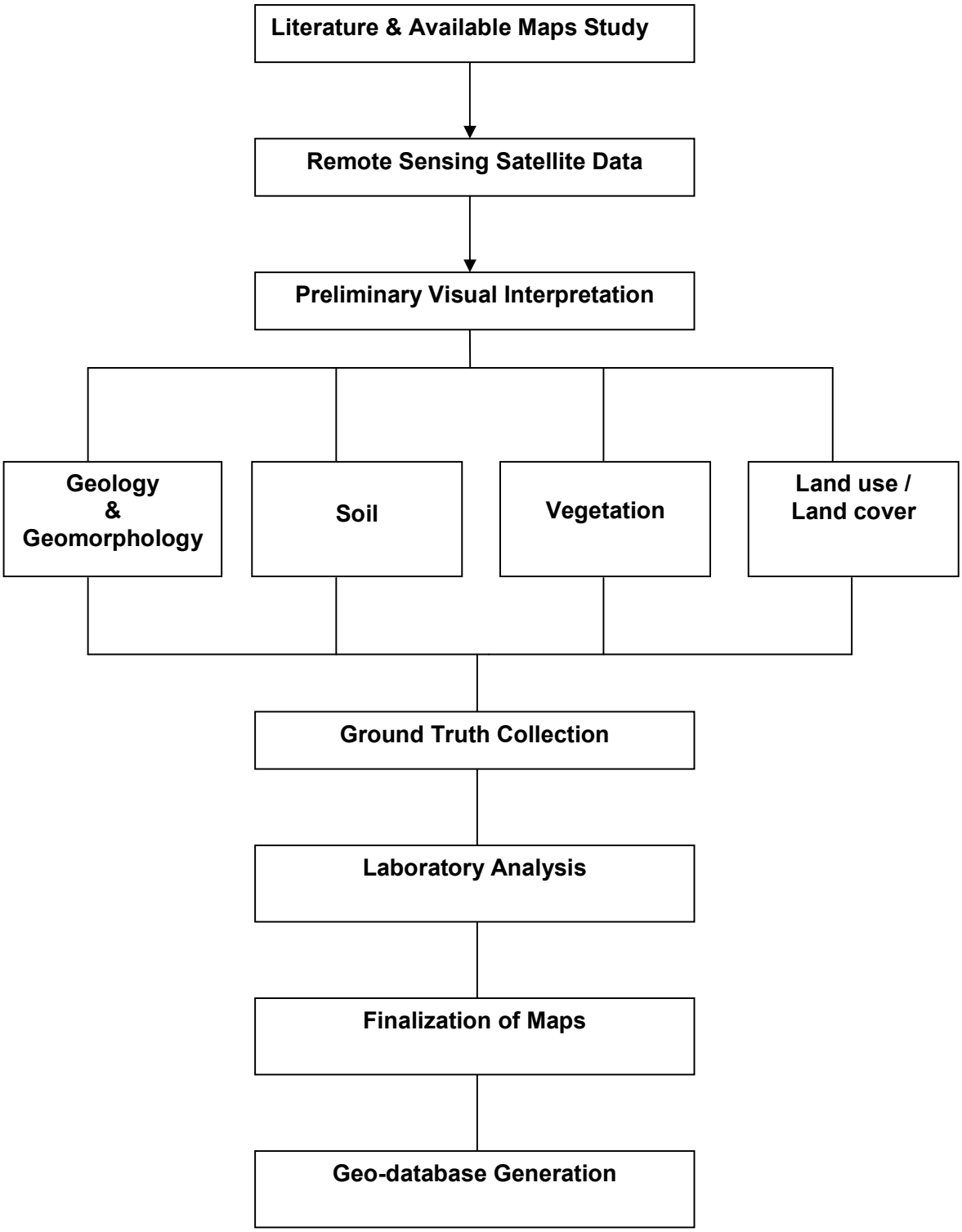
The sample points were decided based on the geological / Geomorphological / soil heterogeneity mapped from the satellite data.

**Finalization of Maps**

Based on the pre-field interpretation, ground truth verification and available secondary information final maps were prepared in 1: 25000 scales. Towards this both visual and digital approaches are conjunctively used.

The project flow chart is as follows

## Project Flow Chart



## Discussion

### Land use\ Land cover

The land use and land cover map is prepared using RESOURCESAT LISS IV satellite data. The classification scheme was designed keeping in view of the management practices addressing each land use/ land cover parcel, amenability of these parcels for identification/mapping in LISS IV dataset. Under the Level-I classification, Built up, Cultivated areas, Woody vegetation, Grasslands, Wastelands, Wetlands and Water bodies were segregated. In addition subclasses of Level-I LULC classes observed based on spectral satellite data and were evaluated on the ground, to characterize them as information classes. All the LULC classes were visually interpreted based on tone/texture, contextual and ground information. The major information class in the study area is 'built up areas' was consisting of urban and rural fringe landscapes and the urban built up areas were dominated by residential, mixed residential and industrial areas. The rural landscape essentially consisted of settlements, camel camps and cultivated areas. Statistical data of community wise built up area was generated and analyzed.

### Vegetation

The vegetation cover map is generated using IRS Resourcesat LISS III & IV. The vegetation in the study area is regulated by desert climate, seasonality, physiographic, geomorphologic and soil regimes. The vegetation is broadly demarcated into natural and managed vegetation. The natural vegetation mainly consisted of formations of Mangroves, Prosopis, Leptadenia. The managed vegetation mainly consisting of avenue plantations, grasslands, lawns, golf courses and palm /mixed plantations. Phyto-sociological analysis was carried out after collecting sufficient number of sample data from the natural vegetated areas. The vegetation mainly mangroves, Prosopis, Laptadenia are further stratified into dense and open canopy density classes. Further different categories of vegetation under each of the community has been extracted and analyzed to understand the percentage of vegetation present to that of vacant land. Such information on spatial distribution in qualitative and quantitative terms would be useful in further exploring and analyzing the aspects of biodiversity and ecological conservation

**Soils**

The soil is mapped using remote sensing satellite data IRS- P6 LISS IV. The soils of the study area were classified upto series level and their association's level as per the Keys to Soil Taxonomy (Soil survey staff, 2003). .

Essentially soil survey is a study and mapping of soils in the field. It is the systematic examination, description, classification and mapping of soils of an area and it comprises of a group of interlinked operations involving

- Preliminary visual interpretation of satellite data
- Fieldwork to study important characteristics of soils and associated land characteristics such as landform, natural vegetation, slope etc.
- Laboratory analysis to support and supplement the field observations.
- Correlation and classification of soils into defined taxonomic units.
- Mapping of soils - that is establishing and drawing soil boundaries of different kinds of soils on standard geographical base map.
- Generation of Geo-database for Soil

**Geology**

The geo-referenced satellite digital data was used to carry out 'on screen' vectorization of geological parameters. Basically three vector layers were generated in. The first vector consists of geological structure attributes with length based classification second vector consists of geomorphic attributes and the third vector consists of broad litho logical map. In the case of image processing, spatial and spectral domain enhancement was carried out using ENVI software. The following steps were involved:-

1. Satellite data has been be geo-referenced with the available map sheets.
2. LISS-3 / Liss-4 and AWIFS data were be acquired for the entire study area
3. LISS-3 was used for regional assessments and LISS-4 data was used for detail assessments.
4. These data sets were co registered with other collateral data sets by taking common Ground Control points (GCP). .
5. The satellite data was enhanced both in spectral and spatial domain.
6. A optimized image was generated for visual / Onscreen interpretation.
7. The existing geological map was not available for the area and hence using geomorphic analysis, field and published literature a broad level lithological map was prepared.

8. The geological structure map was prepared with mainly on type of lineament with emphasis on length, Faults and thrusts
9. The geomorphological map was prepared with emphasize on genetic classification of landforms. The major group are coastal landforms, aeolian landforms, and structural landforms.
10. A pre-field map was prepared using satellite data
11. Ground validation was carried out with emphasis on selective ground checks
12. The ground observation was incorporated at appropriate places to finalize post field map
13. All the three themes have been integrated in GIS environment to generate hydro-geomorphology map.

**Results and Conclusion**

The generated theme can be implemented for further planning of the urban and rural area .The action plan report can be created using the Geodata database and total decision support system can be developed to depict location and type of action / control measures recommended for sustainable development plan of Natural Resources. Zonal and Community wise Soil resource development plan, Water resource development plan, Vegetation resource development plan, Land use and Land cover plan can be developed using the personal Geodatase of the respective Theme.

**References**

Aspinall, S. (1995): United Arab Emirates. Introduction: 459-527. In: SCOTT, D.A. (ED.): A directory of wetlands in the Middle East. IUCN, Gland, Switzerland and IWRB, Slimbridge, U.K.

Aspinall, S. & B. Boer (1994): Biodiversity and ecosystems of the UAE: 85. Abstract of the Regional Environmental Symposium, UAE University.

Boer, B. (1995a): An introduction to the climate of the United Arab Emirates. -NARC Internal Research Report No.29. National Avian Research Center, Sweihan.

Boer, B.B. & R.A. Loughland (1995): Guidelines for a wetland management plan for Khor Kalba. -Tribulus,5 (1): 24.

Harahsheh, H. (2001): Development of Environmental GIS database and its application to Desertification study in Middle East, pp 155. Chiba University,

Kharin, N., Tateishi, R., Harahsheh, H. (1999): Degradation of the Drylands of Asia, pp 80. Chiba University

Western, R.A. (1982): The natural vegetation of Abu Dhabi Island. An introduction. -Emirates Natural History Group Bulletin, 17:18-25.