

# Application of Remote Sensing and Geographical Information System For Land Use / Land Cover Mapping And Change Detection in the Rural Urban Fringe Area of Enschede City, The Netherlands.

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## ABSTRACT

Management and planning of urban space requires spatially accurate and timely information on land use and changing pattern. Monitoring provides the planners and decision-makers with required information about the current state of development and the nature of changes that have occurred. Remote sensing and Geographical Information system (GIS) provides vital tools which can be applied in the analysis at the district and as well, as the city level. Remote sensing becomes useful because it provides synoptic view and multi- temporal Land uses / Land cover data that are often required. Though often used only for identifying objects. This study evaluates the effectiveness of High-Resolution satellite data and computer aided GIS techniques in assessing the land use change dynamics with in the study area designated Enschede City, from 1993 to 1998. The methodology adopted involved the Visual interpretation of land use on acetate overlays according to the land use classification. Satellite images were used for the year 1993 and 1996 at scale 1:25000. A minimum delineation unit of 5 mm x 5 mm was used for mapping. Data was then digitised using ILWIS, the by creating a digital database for further analysis. Subsequently land use maps were crossed with each other to identify and quantify the land use changes types. Finally, Hot links and User Interface was developed so that the information can be provided to the user with a well-documented procedure. The system in this case will be operated from Arc / View environment.

## 1 INTRODUCTION

### 1.1 URBANISATION

Urbanisation is the process in which the number of people living in city increases compared with the number of people living in rural areas. A country is considered to be urbanised when over 50% of its population live in urban areas. During the industrial revolution in 1851, the first countries to become urbanised were Great Britain and some other European countries. The urbanisation process in the Netherlands has traditionally been dominated by the housing sector. Recent discussions on spatial planning on a national level, tend to focus on the construction of one million new residences for the coming decades, rather than considering our living environment as the departure point. To fulfil the above requirement, the rural urban fringe of the eastern part of the Enschede City is chosen for the further development. Urban land features change in both central urban area and in urban-rural fringe. Urbanisation process changed the regional social and economic activities and generates the urban impact on the natural environment. To detect the dynamic land use / land cover changes, analyse the social and cultural impacts, evaluate the influence of those changes to natural environment will increase our knowledge of understanding of human-environment interactions.

### 1.2 REMOTE SENSING AS MONITORING TECHNIQUE

Urban planning requires data on changing land use, urban sprawl and the environment. This leads to the needs for monitoring by updating the knowledge to support the decision making at the suitably frequent intervals. Monitoring of the land use / land cover requires the support of two parameters-spatial resolution and temporal frequencies. Based on these two properties, Townshend (1977) has defined four of phenomena to be monitored and consequently four types of monitoring system. The relationship among four types of phenomena and monitoring system can be elaborated as:

- Rapid changes of large object .For this a low spatial resolution and high temporal frequencies are required.
- Rapid changes of small objects. These require both high spatial and temporal resolution.
- Slow changes of large objects. This needs a low temporal frequency and low spatial resolution.
- Slow changes of small objects. For this a high spatial resolution are required and low temporal resolution are required.

## 2 GEO – INFORMATION FOR MONITORING LAND USE AND LAND COVER CHANGES

### 2.1 THE RESEARCH OBJECTIVES

The main objective is to monitor the land use / land cover changes during the period 1993-96-1998 from satellite images of Enschede, The Netherlands, within the frame of this broad objectives of the study are:

- Identification and delineation of different land use/land cover categories using high-resolution remote sensing data and rectified aerial photographs.
- To generate the statistics of the changes occur in the area in various land use/ land cover categories during the period 1993 to year 1996 and from 1996 to 1998.
- To develop a User interface and Hot links and allow accessing the required information.

### 2.2 STUDY AREA

The term “rural urban fringe “ may from an operational point of view, be defined as an area of transition between well recognised urban land uses and the area devoted to agricultural [Kurtz & Eicher 1958]. In other words, it is the area of mixed urban and rural land uses between the points where the entire range of the city services ceases to be available and the point where agricultural land uses began to predominate. There is absence of a clear break between rural and urban condition measured both in terms of land use and of the social organisation [Johnson 1972]. This study concentrates on the eastern part rural urban fringe of the Enschede City. The location of the study area is 006°54' to 007° 25' East Longitude and 052°12' to 052° 55' North Latitude .

### 2.3 DATA BASE

Following data sets were used to carry out the study. For 1998, data was collected from field survey only.

#### Remotely sensed data

- Satellite Image of COSMOS  
(Merged TM + PAN)  
Year: 1993  
Scale: 1:25,000
- Satellite Image of IRS –1C  
(Merged LISS –3 + PAN)  
Acquired on: 5<sup>th</sup> September 1996.  
Path & Row: 21 / 31  
Scale 1:25000
- Rectified Aerial Photographs Year: 1996.  
Scale: 1:54,00

#### Other data

- Topographical Map of Enschede city and its Environs.  
Year: 1993  
Number: 34 F  
Scale: 1: 25000
- Guide map of Enschede City and its Environs.  
Scale: 1:12500
- Ground Photographs.

### 2.4 SOFT WARE / HARD WARE

The following software and hardware are used to carry out the above study:

- Arc / Info 3.5.1
- Ilwis 2.1
- Arc/View 3.0
- Personal Computer Pentium
- Scanner HP Scan Jet 11 CX

### 3 METHODOLOGY

The methodology adopted in the present study to carry out the details of the land use / land cover mapping is given in the flow chart. However, the understanding of classification, interpretation, delineation, fieldwork, final mapping and area tabulation to facilitate this study is carried out in the following stages, which are as follows:

#### 3.1 Pre – field work

#### 3.2 Field work

#### 3.3 Post – field work

#### 3.1 PRE- FIELD WORK

1. Literature Review.
2. Land use / Land cover Classification .
  - Designing land use/land cover classification scheme based on the available data source.
  - Defining the different land use / land cover classes.
3. Base map formation.
  - Preparation of base map on 1: 25,000 scale, all the natural and manmade features like roads, drainage and landmarks were incorporated on the base map for easy transfer of details from interpreted overlays.
4. Interpretation.
  - Setting the minimum delineation unit (5 mm x 5mm)for classifying the different land use/ land cover.
  - Visual interpretation of the Remote sensing data by using the usual clues such as shape, size, pattern, texture, tone and associated features as well as local knowledge.
  - Transfer of interpreted information onto the base map.
  - A grid of 1cmx1cm or (250 Mts. X 250 Mts.) was drawn on the interpreted map for marking sample points.
  - Marking of the doubtful cases on the map for field checking in order to ascertain It's actual use.
  - Interpretation results of two database (1993 and 1996) are recorded in the digital form by doing scanning. These scanned maps are digitised by doing on screen digitisation to form a digital data base for computer based analysis, which will serve the base for all the information regarding the land use/ land covers statistics and as well as land use / land cover change analysis.

#### 3.2 FIELD WORK

1. Reconnaissance survey to get a general idea of the area features environment and accessibility.
2. Checking of sample points .
3. Checking of unresolved cases. After checking the polygons they were assigned in appropriate classification code.

#### 3.3 POST FIELD WORK

1. Finalisation of land use map is done after incorporating necessary corrections and modifications after field check.
2. Scanning/ digitisation of maps which are updated during the field survey.
3. Area calculation.
4. Land use / land cover change analysis.
5. Preparation of Final maps Tables and Charts.
6. Report Writing and Submission.

### 4 DATA BASE FORMATION AND LAND USE CHANGE ANALYSIS

#### 4.1 LAND USE ANALYSIS

Since 1993 a considerable change had taken place on the land use of Enschede City and its environs. From 1996 IRS image it was possible to delineate the major land use. The interpretation was cross-checked with the aerial rectified photographs of year 1996. Regarding the land use for the year 1998, it was only updated by doing the field survey. During survey main emphasis was given to the construction sites. **Table 4.1** indicates the total areas of different land uses for the three consecutive years calculated from the data input.

**Table 4.1**  
**AREA IN HECTARES OF DIFFERENT LAND USES 1993, 1996 AND 1998**

LANDUSE CLASSES	1993	%	1996	%	1998	%
RESIDENTIAL	220.1	19.50	257.2	22.80	267.7	23.73
COMMERCIAL	21.5	1.90	21.5	1.90	21.5	1.90
INDUSTRIAL	39.1	3.46	48.8	4.32	48.8	4.32
WATER BODIES	8.3	0.73	8.3	0.73	8.3	0.73
CROPLAND	202.9	17.98	107.3	9.51	107.3	9.51
GRASSLAND	401.2	35.56	445.1	39.44	442.3	39.21
FOREST	68.9	6.11	62.7	5.55	62.7	5.55
WOOD	104.4	9.28	101.6	9.04	100.3	8.88
CEMETERY	23.0	2.04	23.0	2.04	23.0	2.04
SPORT FIELDS	29.7	2.68	33.1	2.98	33.1	2.98
CONSTRUCTION SITE	0.0	0.0	10.5	0.93	4.1	0.39
COUNTRY BOUNDARY	0.2	0.02	0.2	0.02	0.2	0.02
MAJOR ROAD	0.7	0.06	0.7	0.06	0.7	0.06
MINOR ROAD	2.7	0.24	2.7	0.24	2.7	0.24
STREAM & CANALS	0.3	0.02	0.3	0.02	0.3	0.02
RAILWAY	0.4	0.03	0.4	0.03	0.4	0.03
INSTITUTIONAL	4.4	0.39	4.4	0.39	4.4	0.39
<b>TOTAL</b>	<b>1127.8</b>	<b>100</b>	<b>1127.8</b>	<b>100</b>	<b>1127.8</b>	<b>100</b>

## 4.2 LAND USE CHANGE ANALYSIS

A systematic way of analysis for land use change is first to have the total area for the different land use classes for the different duration and compare the two maps. Accuracy in interpretation and measurement of these changes is important. Using a computer program we can compare areas of different land uses cell by cell by overlaying the two maps. This can provide the basic quantitative information about the land use change that has occurred. A cross table showing the changes from and to another class can be produced. A map of these changes can also be obtained using computer programme.

### 4.2.1 CHANGES IN LAND USE FROM 1993 – 1996

(Refer to the Cross-Table No 4.2.1)

\* During the period 1993 to 1996, 12.9 Hectare. of cropland, 24.1 Hectare. of grassland and 0.1 Hectare. of wood is changed into residential. Therefore residential land use increased by 37.1 Hectare during this period.

\* During the period 1993 to 1996, 4.4 Hectare. of cropland, 4.8 Hectare. of grassland and 0.5 Hectare. of wood are changed into industrial. Therefore industrial land use increased by 9.7 Hectare. during this period.

\* During the period 1993 to 1996, 26.4 Hectare. of grassland and 3.6 Hectare. of forest are changed into Cropland. But during the same time 12.9 Hectare. of cropland is changed into residential, 4.4 Hectare. of cropland is changed into industrial, 97.8 Hectare. of cropland is changed into grassland and 10.5 Hectare. of cropland is changed into construction site. Therefore cropland land use decreased by 95.6 Hectare. during this period.

\* During the period 1993 to 1996, 97.8 Hectare. of cropland, 2.6 Hectare. of forest and 1.1 Hectare. of wood are changed into Grassland. But during the same period 24.1 Hectare. of grassland is changed into residential, 4.8 Hectare. of grassland is changed into industrial, 26.4 Hectare. of grassland is changed into cropland and 2.3 Hectare. of grassland is changed into sport fields & recreation. Therefore grassland land use increased by 43.9 Hectare. during this period.

\* During the period 1993 to 1996, 3.6 Hectare. of forest is changed into cropland and 26.4 Hectare. of forest is changed into grassland Therefore forest land use decreased by 6.2 Hectare. during this period.

\* During the period 1993 to 1996, 0.1 Hectare. of wood is changed into residential, 0.5 Hectare. of wood is changed into industrial, 1.1 Hectare. of wood is changed into grassland and 1.1 Hectare. of wood is changed into sports fields & recreation. Therefore wood land use decreased by 2.8 Hectare. during this period.

\* During the period 1993 to 1996, 2.3 Hectare. of grassland and 1.1 Hectare. of wood are changed into sport fields & recreation. Therefore sports fields & recreation land use increased by 3.4 Hectare. during this period.

\* During the period 1993 to 1996, 10.5 Hectare. of cropland is changed into construction site. Therefore construction site land use increased by 10.5 Hectare. during this period.

\* During the period 1993 to 1996, commercial, water bodies, cemetery, country boundary, major road, minor road, stream & canals, railway and institutional remains the same. It means that there is no change occurred during this period in these land use classes.

#### 4.2.2 CHANGES IN LAND USE FROM 1996 – 1998

(Refer to Cross Table No. 4.2.2)

\* During the period 1996 to 1998, 10.5 Hectare. of construction site is changed into residential. Therefore residential land use increased by 10.5 Hectare. during this period.

\* During the period 1996 to 1998, 2.8 Hectare. of grassland is changed into construction site. Therefore grassland land use decreased by 2.8 Hectare. during this period.

\* During the period 1996 to 1998, 1.3 Hectare. of wood is changed into construction site. Therefore woodland use decreased by 1.3 Hectare. during this period.

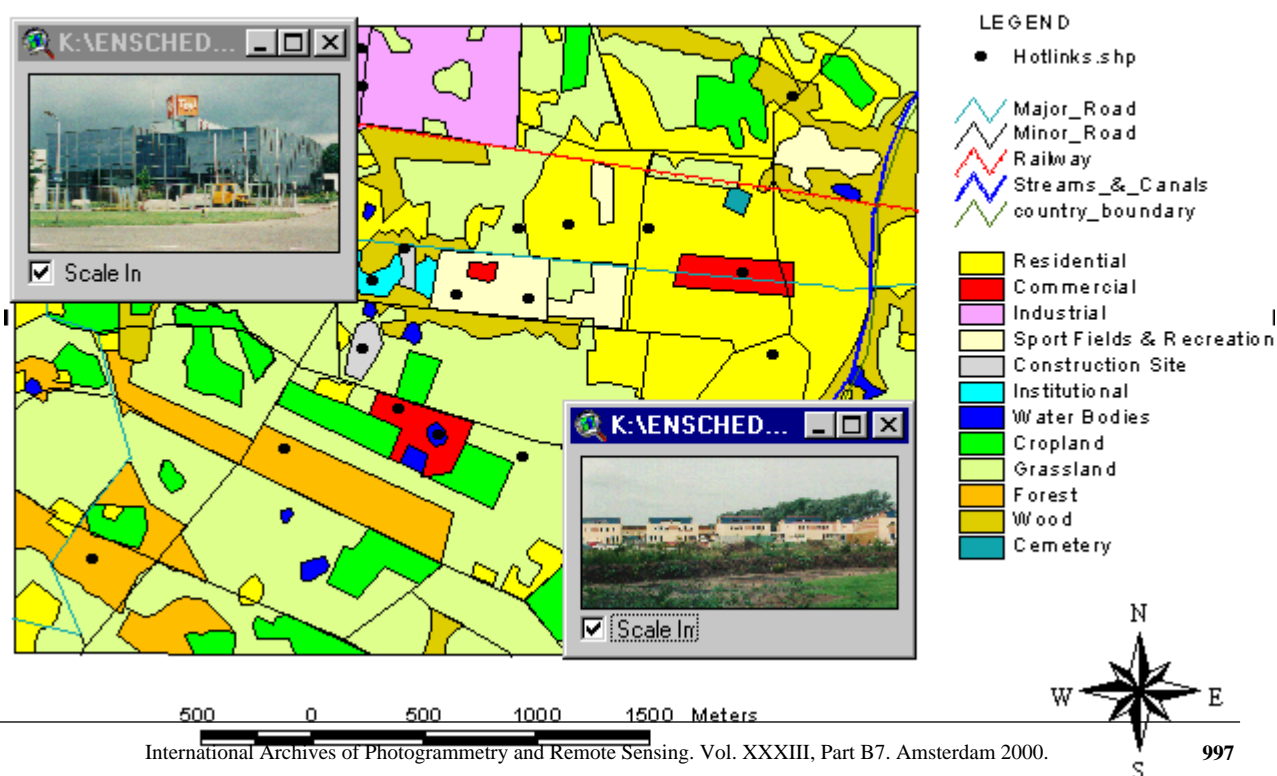
\* During the period 1996 to 1998, 2.8 Hectare. of grassland and 1.3 Hectare. of wood are changed into construction site. But during the same time 10.5 Hectare. of construction site is changed into residential. Therefore construction site land use decreased by 6.4 during this period.

## 5 DESIGNING OF A USER - INTERFACE

### 5.1 SETTING UP AND USING HOT LINKS.

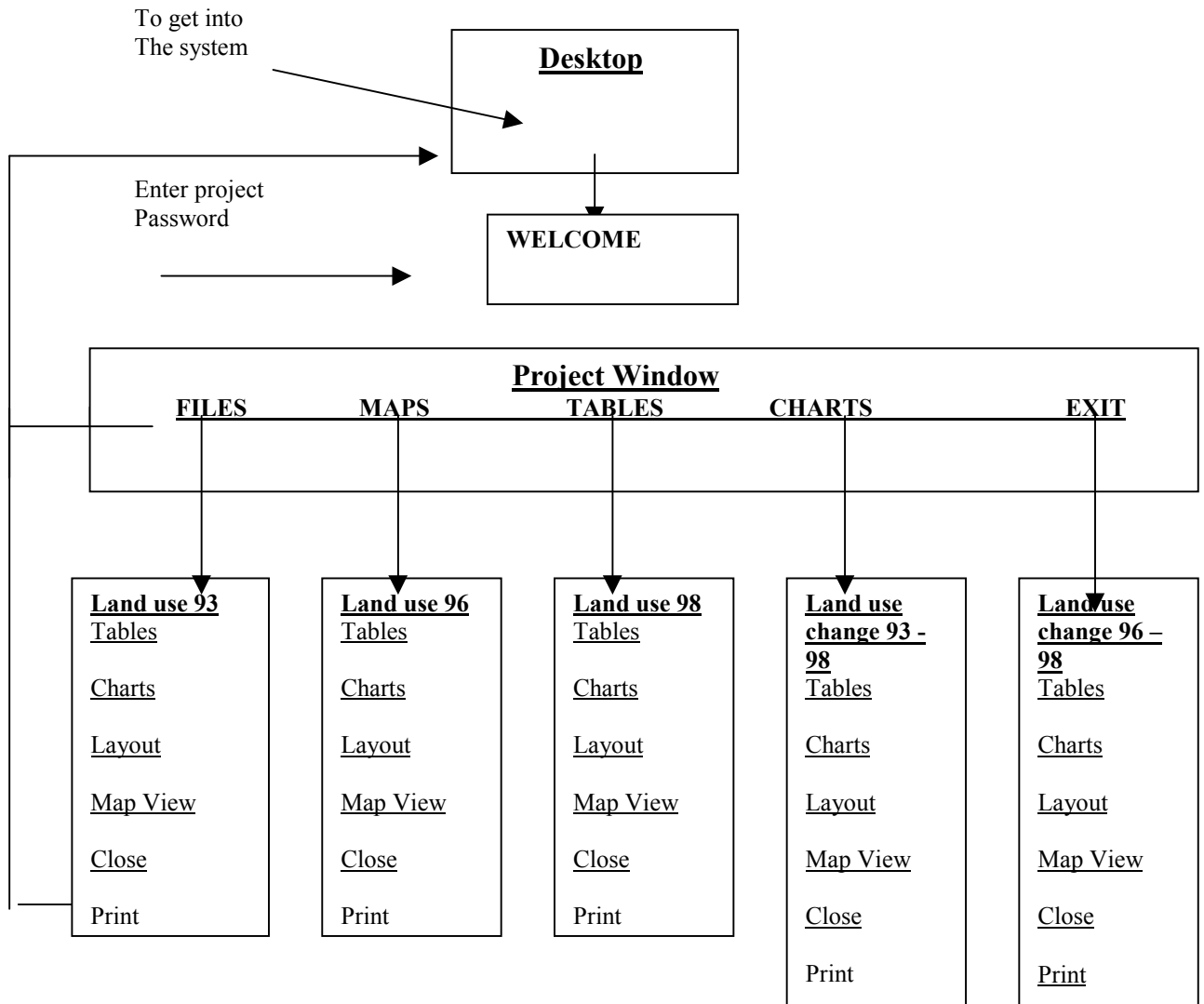
Another way to provide additional information on a view is to set up hot links between features in a theme and external files. Once a theme's hot links have been defined, clicking one of the theme's features with the Hot Link tool automatically displays the current land use (Ground Photograph) specified as the hot link for that feature.

## LANDUSE MAP 1998



## 5.2 USER INTERFACE

### Double click EIS icon



## 6 CONCLUSION

Land use / land cover change analysis using remotely sensed data has been applied to discover the trend of development of the rural urban fringe of Enschede city. The city of Enschede is experiencing physical expansion along with its horizontal intensification. Using COSMOS data (merged with TM) of 1993 and IRS Pan data (merged with LISS-111) of 1996 coupled with GIS technology can provide important information about the development which are taking place in rural urban fringe of Enschede city and there by can play an important role in planning and managing the city. The purpose of this study was twofold. First to examine the land use / land cover changes which are occurred during the period from 1993 to 1996 and from 1996 to 1998. Second, to develop hot links and User interface allows accessing the required information to the users. In spite of interpretation limitations due to the spatial resolution in IRS and as well as in COSMOS data the land use change analysis shows higher magnitude of change in Residential and Industrial land uses during the period 1993 to 1996, which constitute 37.1 ha. and 9.7 ha. respectively of the total area change. Also during the same period 10.5 ha. of cropland is changed into the construction site. During 1996 to 1998, 10.5 ha of construction site is changed into residential and new construction sites have come into picture.

## 7 REFERENCES

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