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# COST-EFFECTIVE RASTER IMAGE PROCESSING FOR GEOECOLOGICAL ANALYSIS USING “ISOCLUST” CLASSIFIER: A CASE STUDY OF ESTONIAN LANDSCAPES



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# RESEARCH AIM

The purpose of this study is following two aims:

1. first, a geographic (GIS) analysis of land cover types in the coastal landscapes of western Estonia, Pärnu surroundings at two various temporal dates (**1992** and **2006**);
2. second, an overview of the technical methods enabling image processing by different tools of **IDRISI GIS** software

Hence, the main research methods consists in processing and classification of **satellite remote sensing data Landsat TM** aimed at land cover types recognition and thematic mapping.

# LANDSCAPES

- ❖ South-west Estonia is known for unique environmental settings: **mild maritime climate, broad beaches, coniferous pine forests on the coastal zone.**
- ❖ Landscapes here are rich and world-known for their diversity, variability, unique composition structure and high esthetic value.
- ❖ Landscape types include, for example, mixed and broadleaved forests, traditional agricultural semi-natural landscapes, wooded meadows, plant communities, heathland, bogs and moors, complex anthropogenic areas with different land use structure, shrubland, grasslands, birch-dominating coastal areas and flooded meadows



# EXAMPLES OF LANDSCAPES: BALTIC SEA





# MARINE LANDSCAPES: PÄRNU SEA COASTS



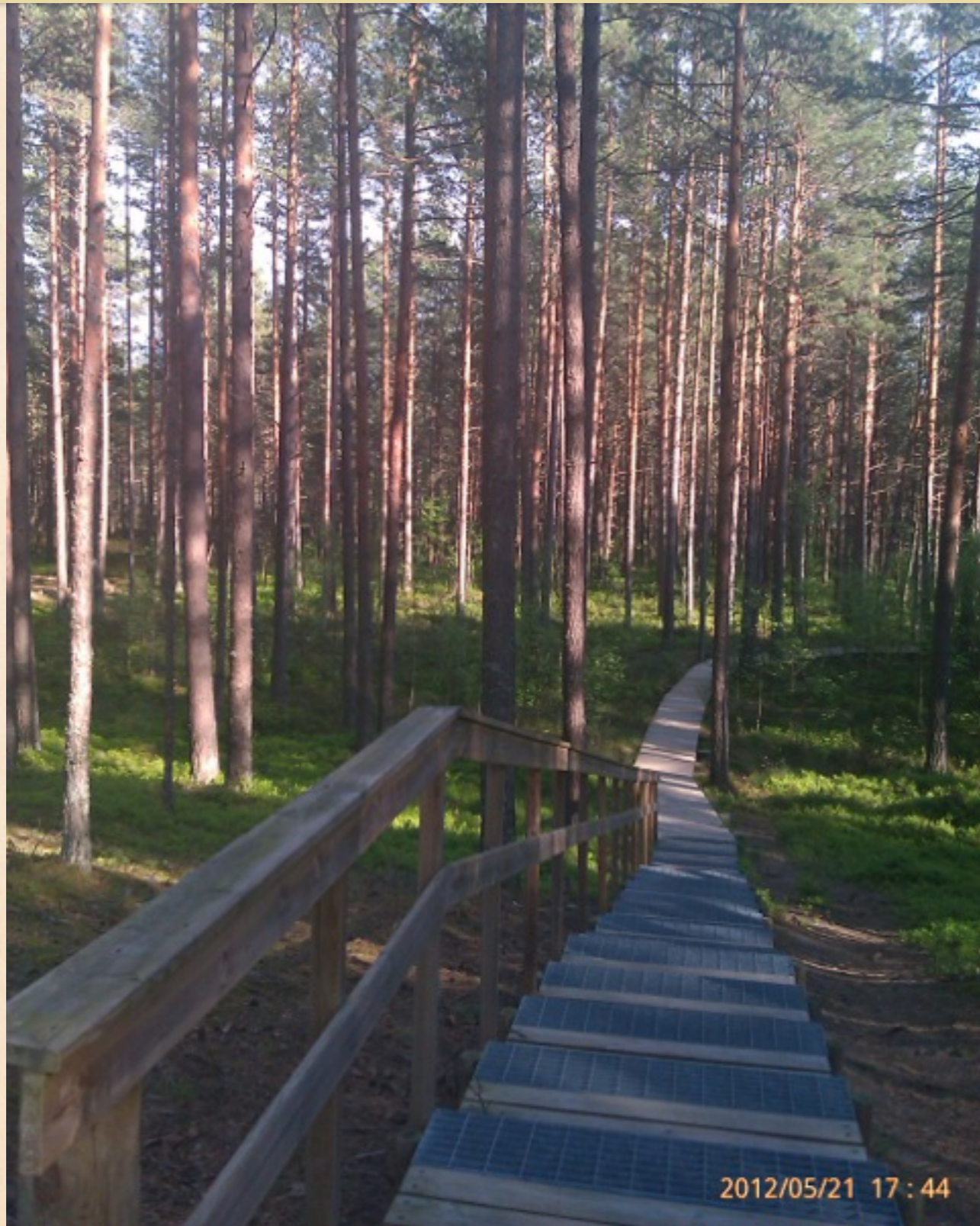


# Lacustrine landscapes: Luitemaa Nature Conservation Area





# Forest landscapes: Luitemaa Nature Conservation Area





# ANTHROPOGENIC IMPACTS

- ❖ Pärnu region is traditionally popular as a **tourism destination** due to favorable combination of factors:
  1. **geographic value:** advantageous location on the coasts of Baltic Sea
  2. **social value:** good facilities for the tourism and tourism reputation
  3. **environmental value:** unique nature (marine landscapes, pine forests)
  
- ❖ Pärnu region is also known for traditional **agricultural activities** (field crops cultivation, intensive planting, etc), as well as extensive **housing development** in the rural area.

All these factors create additional human pressure on the local ecosystems and may lead to fragmentation of the landscape structure.



# Examples of active house construction directly in the forest zones





# DATA

The research data used in this project include vector and raster types of data:

1. **Raster** data : thematic raster layers (GeoTIFF) Landsat TM including scenes taken on 18 June 2006 and 03 June 1992. Both images cover summer months, thus enabling vegetation coverage to be easily recognized. The images were downloaded from the *Earth Science Data Interface, Global Land Cover Facility*.
2. **Vector** data : CORINE vector layers (abbreviation from "**C**oordination of **I**nformation on the **E**nvironment"), developed by the European Environmental Agency, EU Commission). The CORINE data were stored in ESRI format shape-files. They contain information on land use types provided by the *Estonian Land Board* and available at the *University of Tartu*



# METHODS

The GIS projects have been organized and executed in two different software: *Arc GIS 10.0* and *IDRISI GIS Andes 15.0*.

The raster processing GIS approach and classification was applied in the current work towards Landsat TM two images.

The method is based on the ISOCLUST unsupervised classification executed by means of **IDRISI GIS**.

The ISOCLUST available in IDRISI GIS performs the most of the image processing workflow in semi-automatically regime.

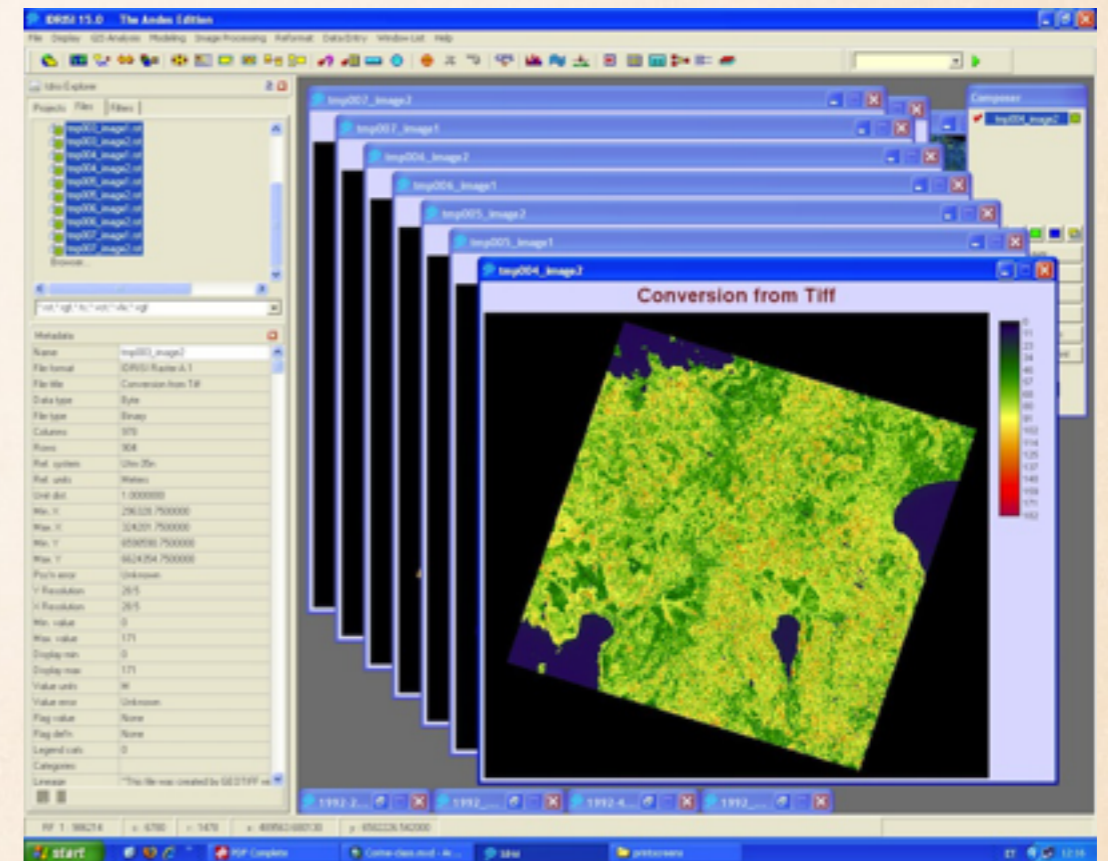
It results in a map with pre-defined number of 16 land class categories which enable to compare two different stages of landscape development: “earlier” and “now”.

The ISOCLUST method was chosen, since it enables to avoid subjectivity in classification.



# WORKFLOW STEP-BY-STEP (I)

- ❖ **IMPORT.** Initially, the data of Landsat TM were imported to IDRISI Andes GIS from GeoTIFF format to IDRISI specific format ("rst"), (*"Data Provider Format import"*). As each Landsat TM scene is a multispectral image with several spectral bands, each band was displayed and visualized as a separate image.
- ❖ **COLOR COMPOSITE.** Afterwords, the images were composed using *Color Composite* function. The combination of three bands was made as a single color composite image (bands 2-3-4). This composition displays urban areas distinctively, which enables to clearly recognize them
- ❖ **PROJECT.** Then data were organized in a created project in IDRISI GIS.



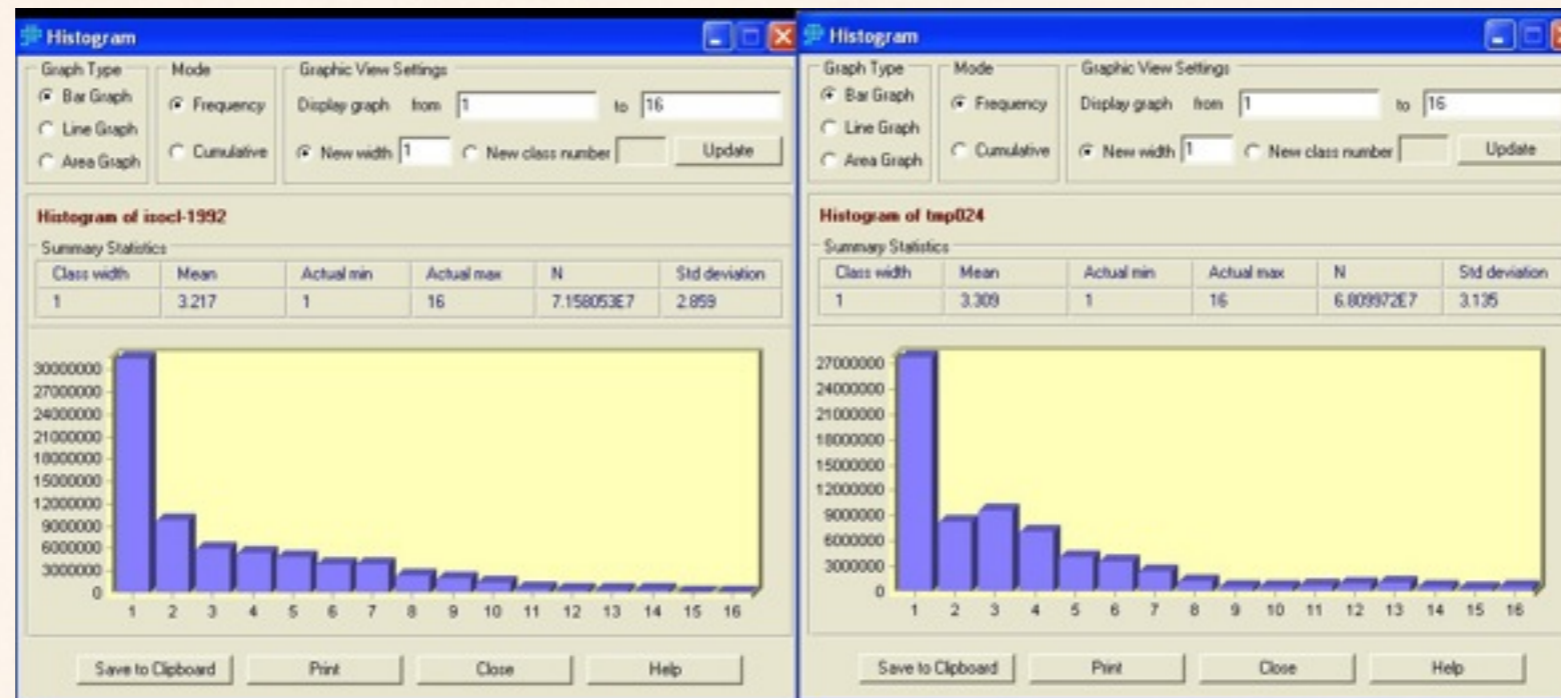


# WORKFLOW STEP-BY-STEP (II)

- ❖ **CLASSIFICATION.** The next step includes application of chosen classification method of ISOCLUST approach towards images processing. ISOCLUST classifier technique is based on the histogram peak selection technique
- ❖ The ground principle of the classification consists in the analysis of spectral signatures that are individual for each land cover class.
- ❖ The analysis of spectral reflections strongly depends on the local surface features: texture, structure, color, etc.
- ❖ Information on spectral signatures is received by the satellite sensors and recorded on the images (in this case, Landsat TM). This information is used for the image classification.
- ❖ Using individual characteristics of objects, derived from the multispectral Landsat TM bands, information from the images was extracted, analyzed and used for land classification



# WORKFLOW STEP-BY-STEP (III)



- Comparing both images, changes in landscape patterns on **1992** and **2006** can be noticed.
- It has been shown on the histograms that between 1992 and 2006 there are changes in land cover types in selected Estonian landscapes.
- In 2006 the urban area became larger than in 1992 (land cover class "3" on the histogram). This can be explained by various reasons.
- The most important reason is a process of intense **suburbanization** which became the major process in the current urban dynamics of modern Estonia: intensive construction of summer homes and development of cottage areas in the coastal area.
- New buildings and houses have been created along the shores of the Pärnu bay, which naturally increased area of urban areas.

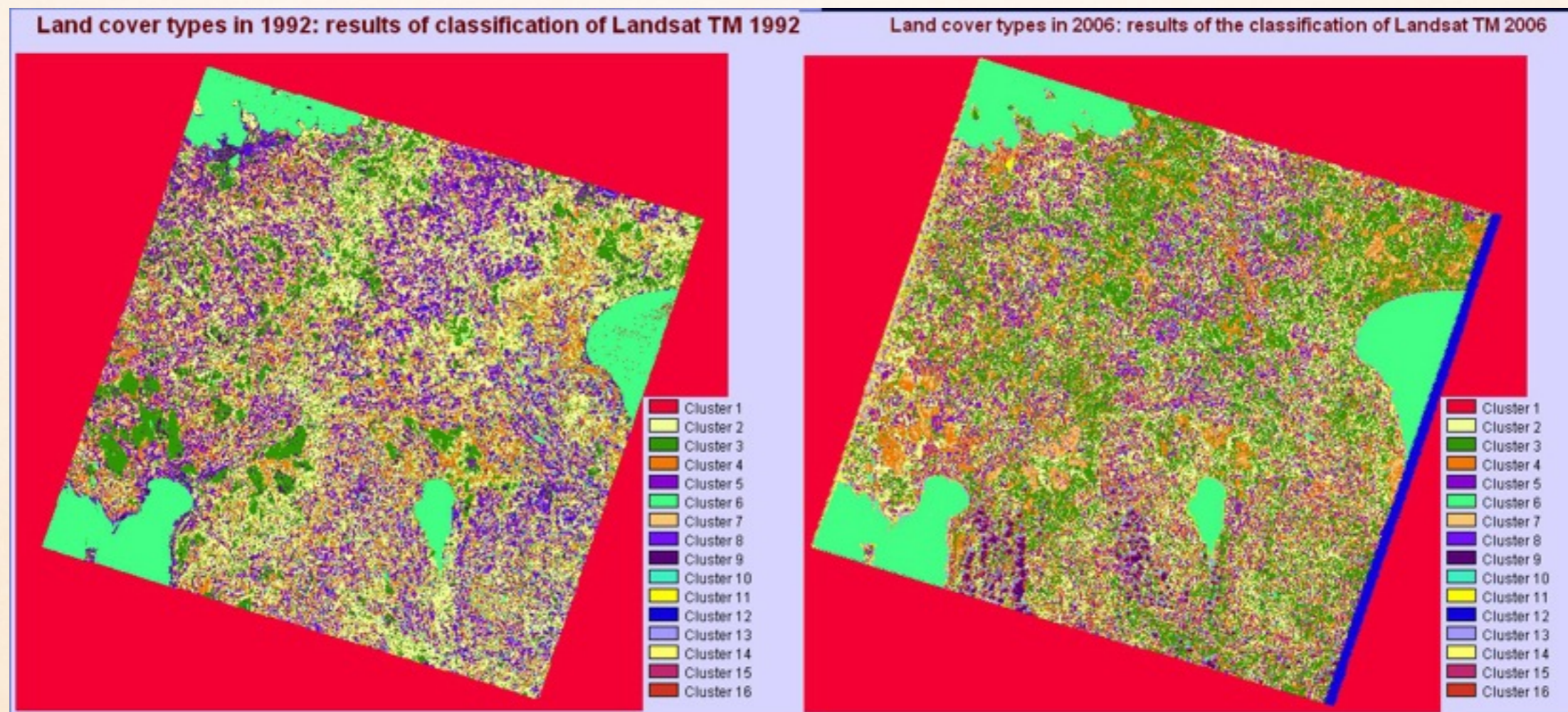


# WORKFLOW STEP-BY-STEP (IV)

## LANDSCAPES OF WESTERN ESTONIA IN 1992 AND 2006.

### THE RESULTS OF ISOCLUST CLASSIFICATION

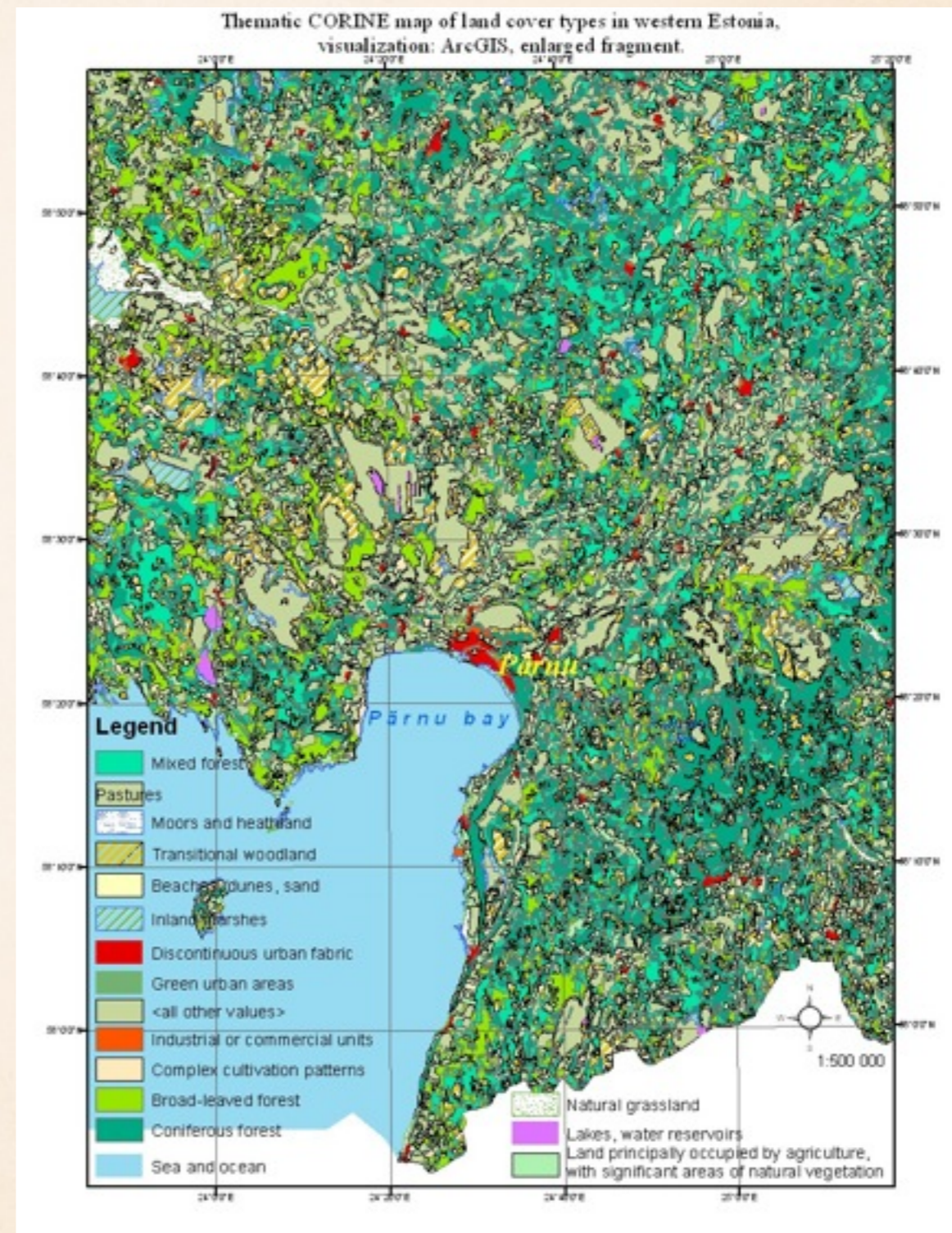
- ❖ ISOCLUST Principle.
- ❖ The ISOCLUST classification of the images enabled to create thematic maps of the same study areas.
- ❖ According to CORINE, there are 16 land cover types typical for the study area. Thus, the pre-defined number of classes for ISOCLUST classifier was 16:





# LAND COVER CLASSES

- discontinuous urban fabric
- industrial or commercial units
- green urban areas
- pastures
- complex cultivation patterns
- land, principally occupied by agriculture, with significant areas of natural vegetation
- broad-leaved forest
- coniferous forest
- mixed forest,
- natural grassland,
- moors and heathlands,
- transitional woodland,
- beaches, dunes, sand
- island marshes,
- water bodies
- sea and ocean





# Examples of active house construction directly in the forest zones





# Thank you for attention



*Questions?*

- The research has been done at the University of Tartu under support of *DoRa* grant (ESF, Estonia).
- The University of Tartu provided data and software: layers of CORINE, IDRISI GIS 15.0 and ArcGIS 10.0
- All presented photos are made by author (Lemenkova Polina)