Remote Sensing towards Transboundary Conservation of Natural Resources

Poleski National Park (Aerial image and vector layers, Adamczyk 2005)

A Man and the Biosphere Programme (MaB) of UNESCO to establish the West Polesie Transboundary Biosphere Reserve (WP-TBR)

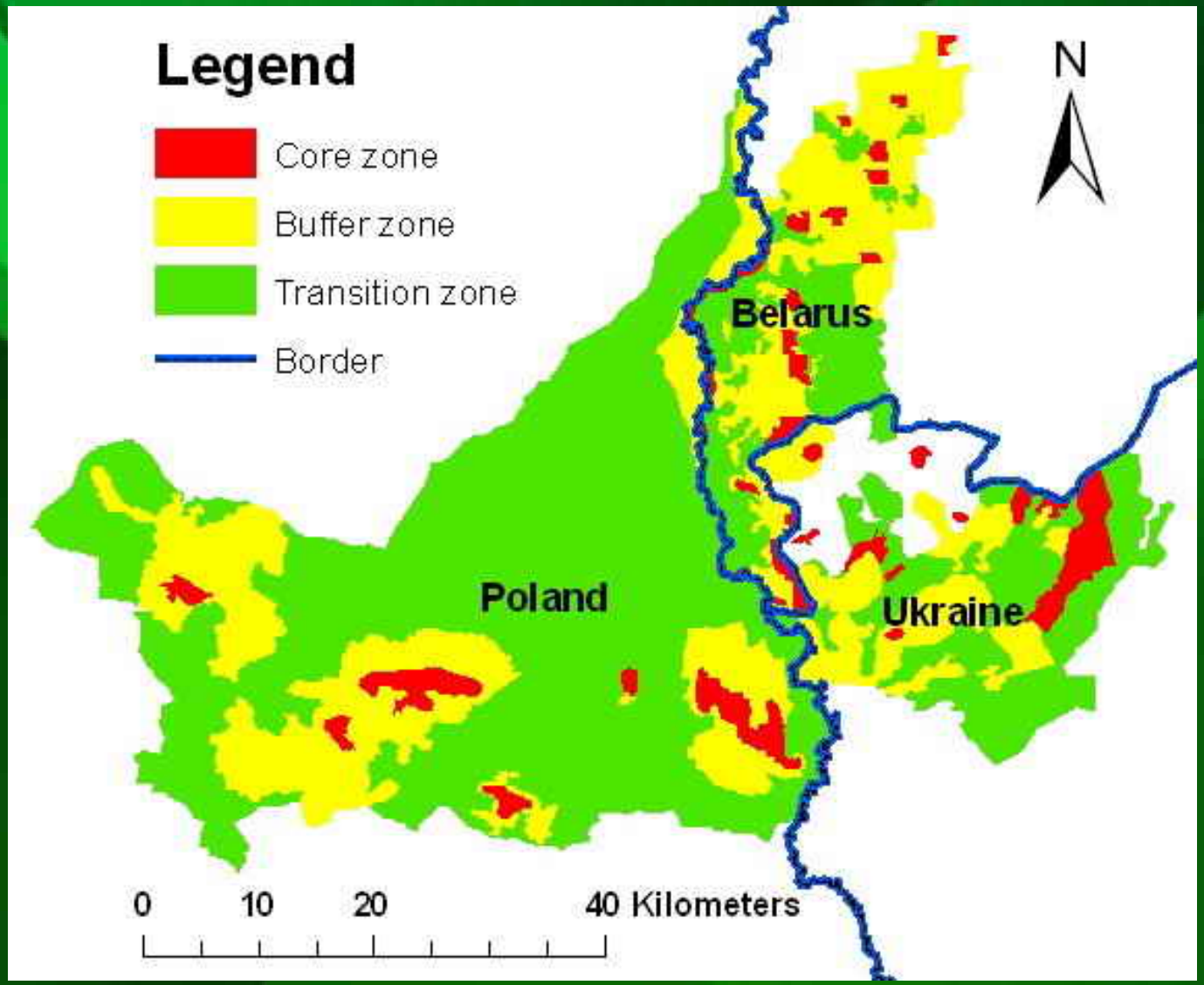
What it is about

- Major objective is to conserve water resources and biological diversity of the eastern European Polesie region shared by Belarus, Poland and the Ukraine
- The project, entitled "Establishment of a Transboundary Biosphere Reserve and a Regional Ecological Network in Polesie", is funded by the Japanese Funds-in-Trust for Capacity Building of Human Resources

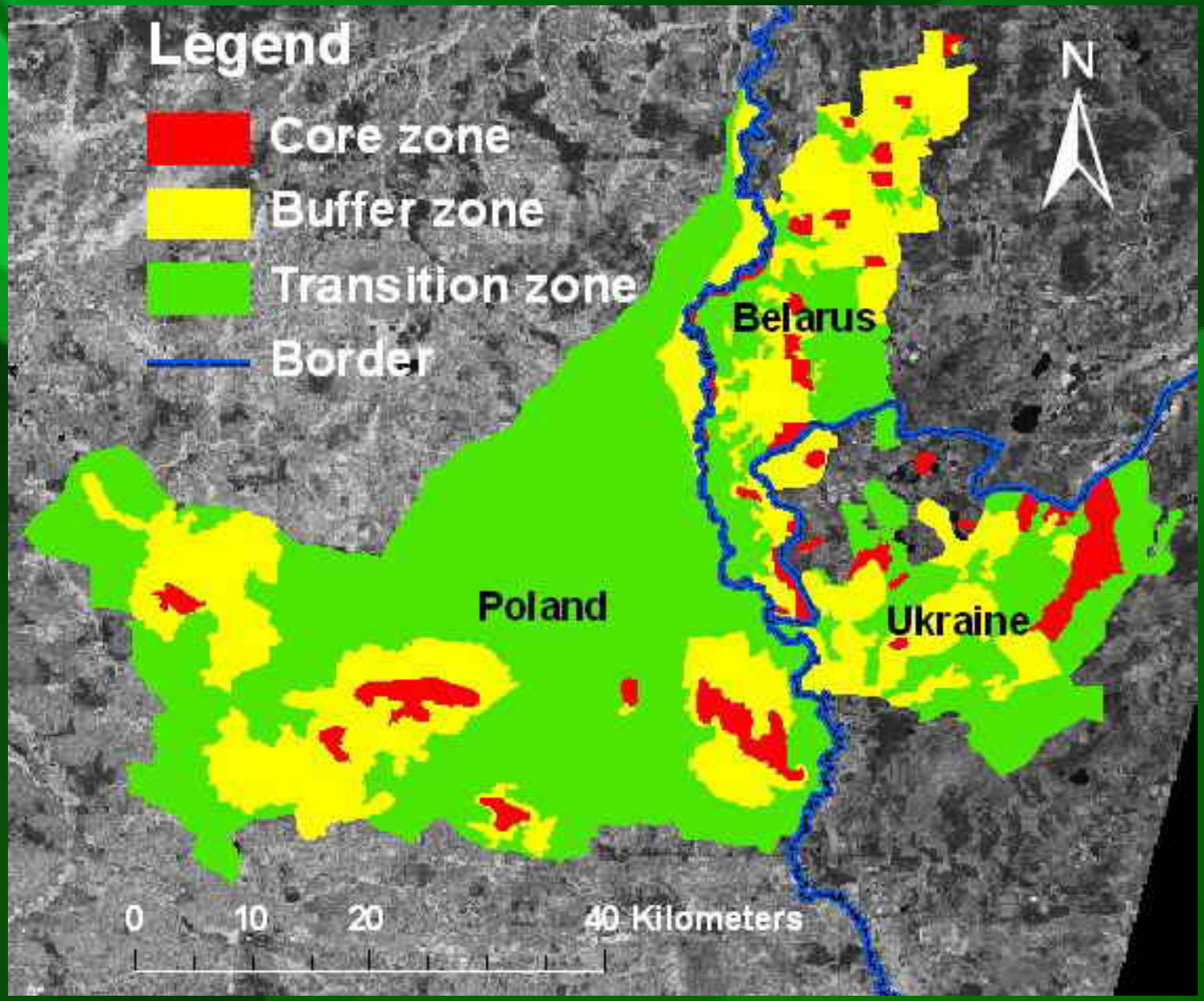
The Project consists of three parts:

1. Gathering basic scientific information for the establishment and functioning of the WP-TBR, encompassing three separate biosphere reserves: Pribuzhskoye-Polesie Biosphere Reserve (Belarus), West Polesie Biosphere Reserve (Poland) and Shatskiy Biosphere Reserve (Ukraine)
2. Applying the methodologies and approaches of (1) to set up the scientific background for a Polesie regional ecological network focussing on the Valleys of the Bug and Pripyat Rivers
3. Building on the results of the (1) and (2) to design a future potential TBR in the Ancient Pripyat Valley

WP-TBR area


Legend
Core zone
Buffer zone
Transition zone
Border
N
Belarus
Poland
Ukraine
0
10
20
40 Kilometers

WP-TBR area


Legend
Core zone
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Belarus
Poland
Ukraine
0
10
20
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WP-TBR characteristics

Outstanding marsh lands, swamp and peatbog ecosystems

- Mainly covered by small arable lands
- Several Ramsar sites (Convention of Wetlands)
- 3 Bisophere Reserves
- A high density forest including rare floodplain forest
- Dry and wet meadows
- 4 major wetland sites
- Urban areas
- Water bodies (rivers, lakes)

Wetland conservation and sustainable development!

Designated Ramsar site (Poleski National Park, Source: http://www.ramsar.org/wn/w.n.poland_five.htm)

Classification mapping

The issue:

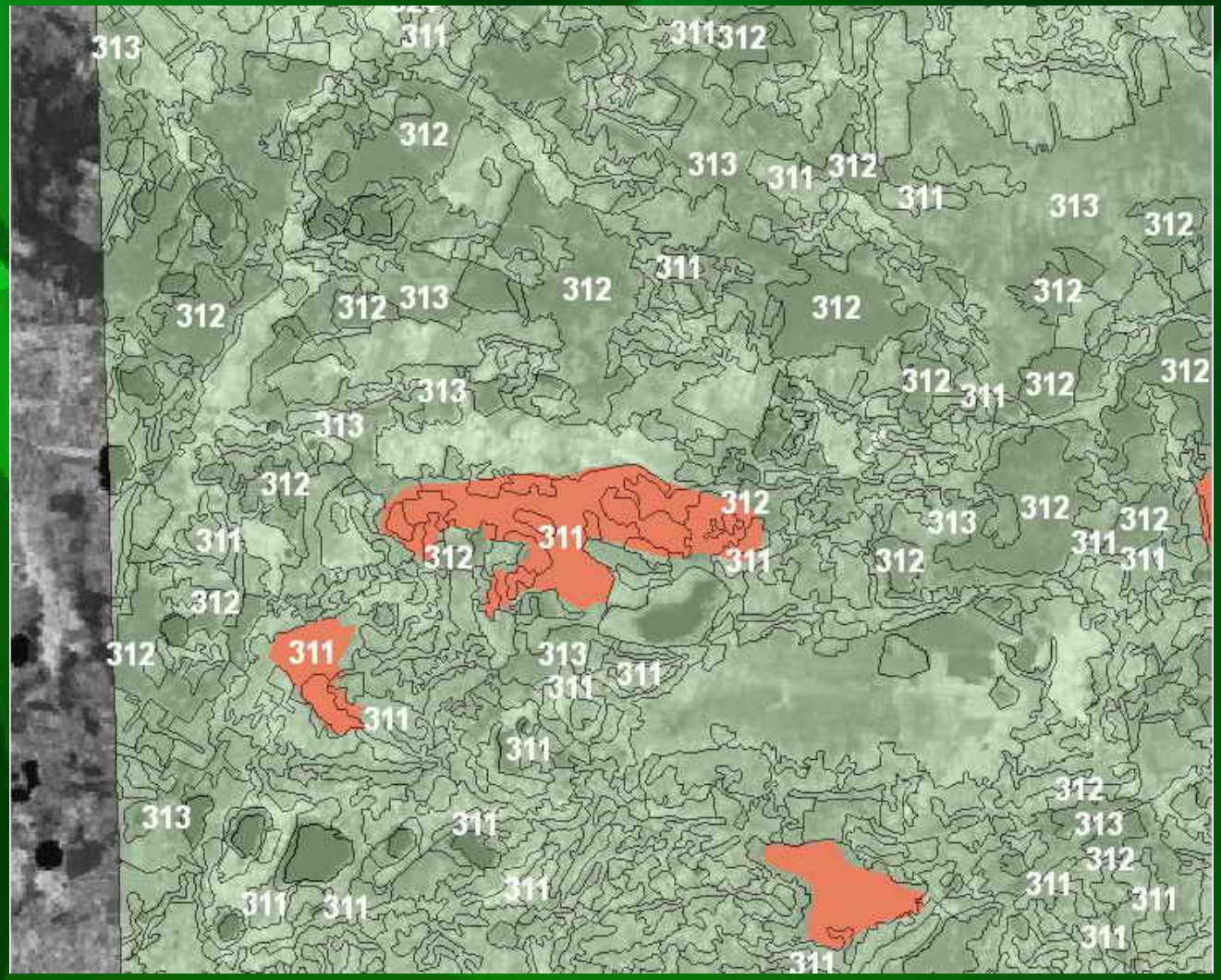
- No existing map for the transboundary area of Belarus, Poland and the Ukraine
- Only maps for the countries, but not going beyond the political borders

Data available:

- CORINE (Coordination of Information on the Environment) Land Cover
- Topographical maps for Poland and the Ukraine
- GIS database and aerial imagery for Poleski National Park
- Landsat Multispectral Scanner (MSS) and a Landsat 7 Enhanced Thematic Mapper Plus (ETM^{+}) scenes
- Web data like GoogleEarth or http://mapa.szukacz.pl/

CORINE Land Cover 2000

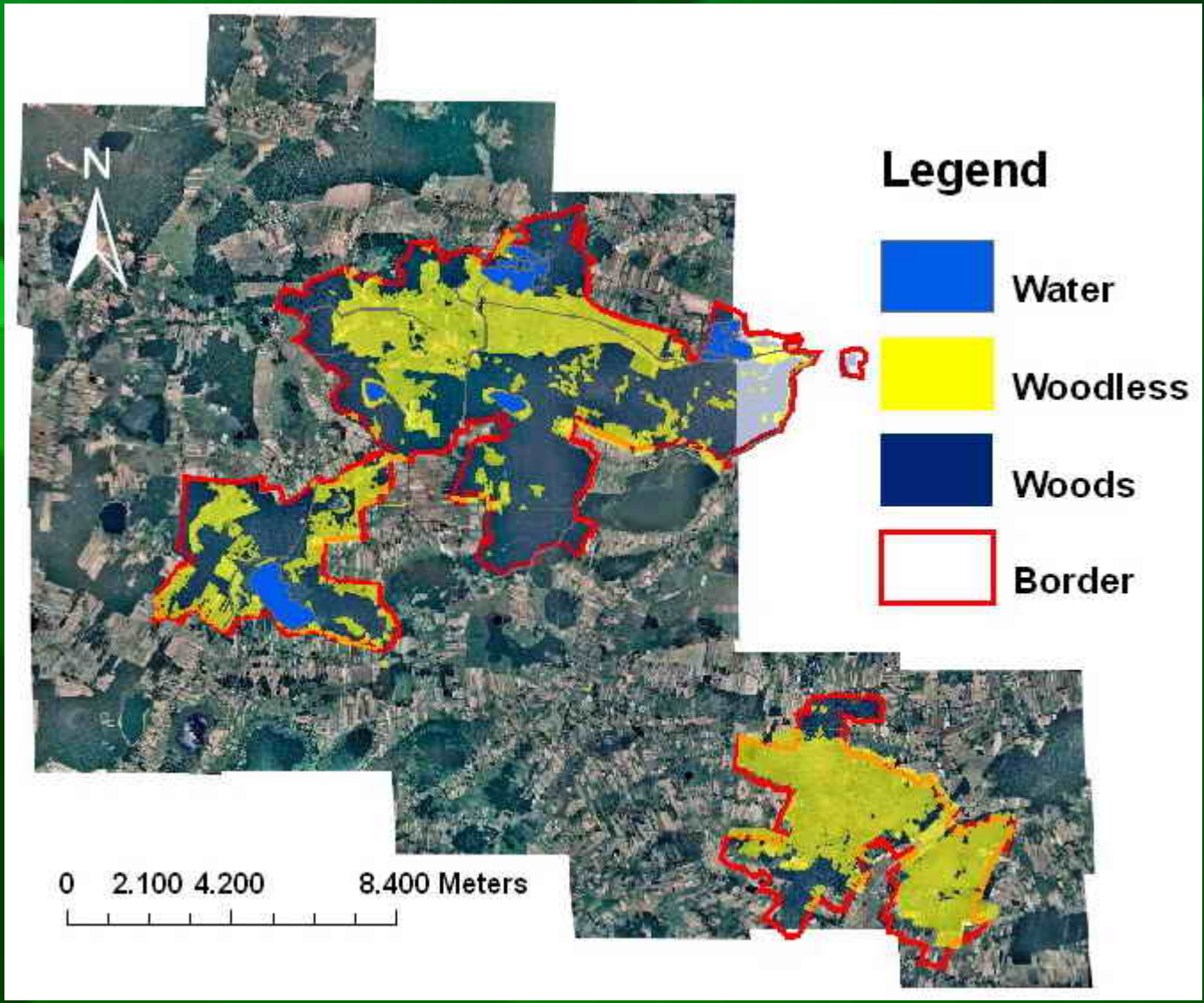
Code	Type
311	Deciduous
312	Coniferous
313	Mixed



In red, the designated WP-TBR core zones are shown, which are part of the Poleski National Park

Aerial Imagery

Poleski National Park (Images were taken thanks to the Joint Venture Phare Program (JOPP) in 1996)



Classification based on satellite imagery

Features:

- Almost cloudless
- Insignificant seasonal changes

Path/Row	Acquisition	Sensor	Resolution
201/24	04.06.1979	MSS	57x57m
186/24	02.07.2002	ETM^{+}	30x30m

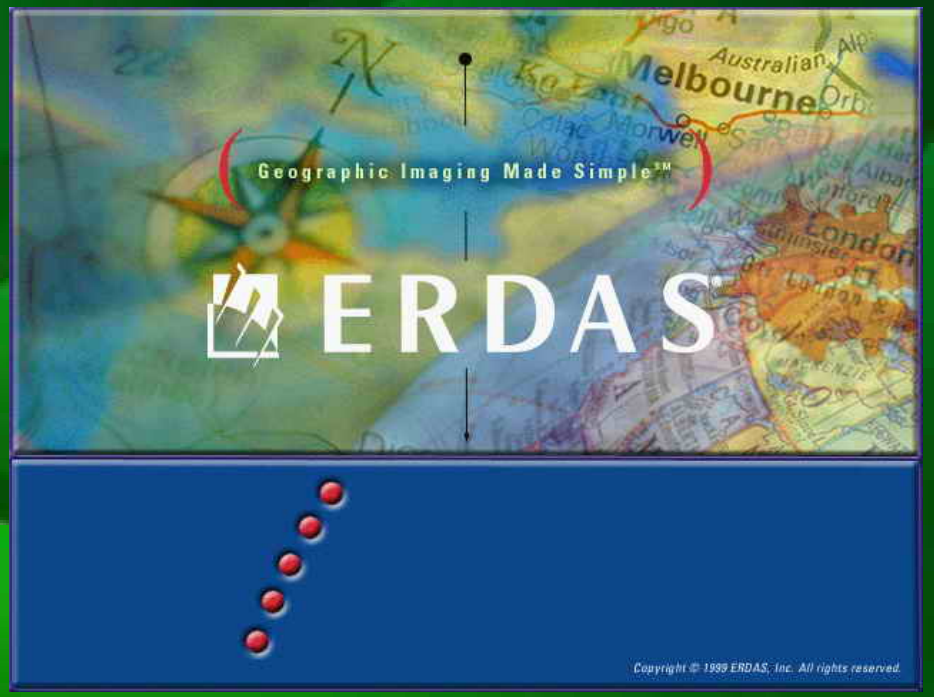
Classes:

- Agriculture
- 3 Forest type classes: coniferous, deciduous, and mixed forest
- Meadows (including dry and wet)
- Wetland (marsh, peatbog, and swamp)
- Urban
- Water bodies (rivers and lakes)

Remote sensing software programs

Erdas Imagine:

- Pixel-oriented
- High functionality
- Change detection
- Accuracy assessment
- Cheaper than Definiens and,
- Easier to use



Definiens eCognition:

- Object-oriented
- Fuzzy logic driven
- Very sophisticated classification
- Expensive
- Requires experience

Pixel-oriented post-classification

Approach (Erdas Imagine):

- On both scenes separate classifications were performed, whereas training sites were carefully selected in areas that did not change in land cover or use over time allowing the later on change detection.

- With the given different spatial resolutions (57m & 30m) classification was affected as fewer details are to be detected on the MSS scene. Out of the training sites (AOI) signatures for each particular class were calculated. Signatures were then evaluated using a contingency error matrix, feature space, and the mean plot. Finally a supervised classification using maximum likelihood as decision rule was applied. The AOI locations were held the same for both images.

- After classifying the imagery a contiguity analysis was performed in order to eliminate raster regions (clumps) that were too small to be considered for the final map. Everything less than five contiguous pixels was filtered out and assigned to neighboring classes.

Accuracy assessment

Classification results were tested against ground truth data from the CORINE database, topographical maps and data of the West Polesie Biosphere Reserve with the accuracy assessment tool in Erdas Imagine. 100 simple random sampling x, y coordinates for each classification were generated, and then identified according to ground truth data or expertise. Accuracy was then retrieved from an error matrix whereas the number of correct identified samples per class was divided by the total random sample number of the particular class.

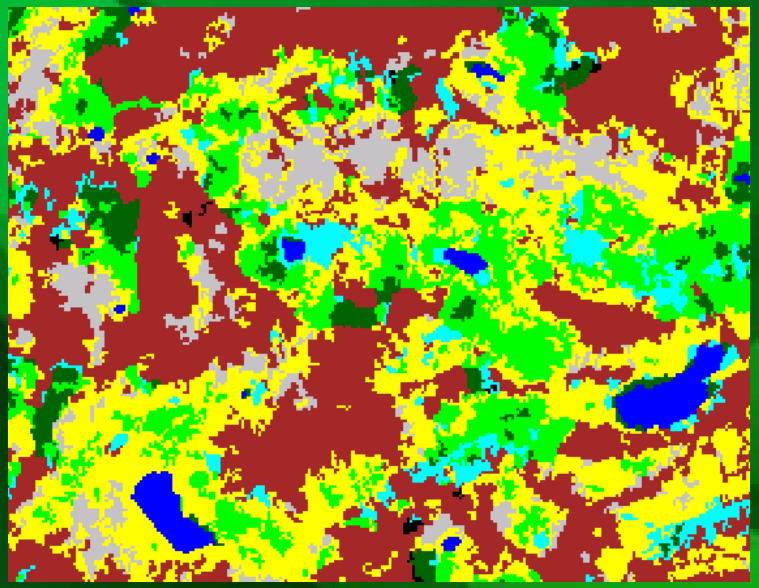
	04.06.1979	02.07.2002
Class	User's Accuracy (%)	
Urban	80	75
Water	95	95
Wetland	78	70
Meadow	75	73
Coniferous	95	95
Deciduous	60	65
Mixed	90	85
Agriculture	95	90
Total	80	75

Change Detection

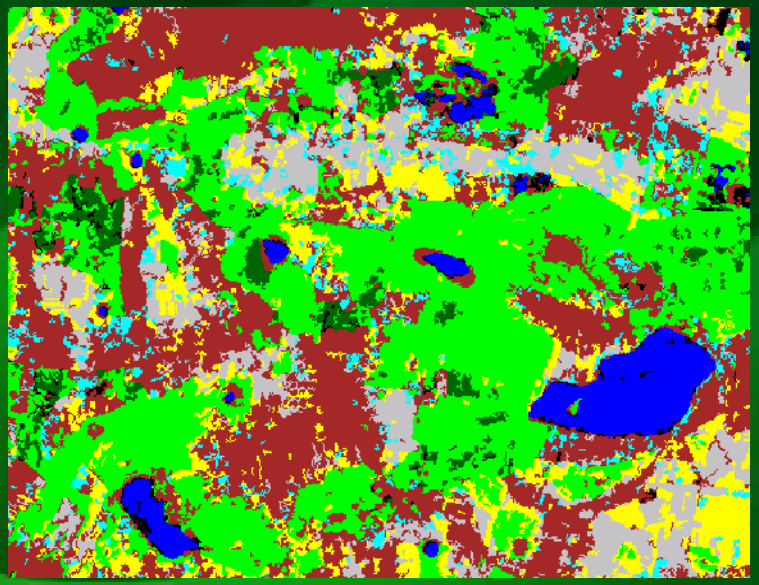
For change detection a matrix of both classifications was performed in which each class of an image was compared to all other classes from the other image, and then the area of change per class was retrieved in hectare (ha) unit. The change detection matrix accuracy was relative to the input accuracy of the classifications.

	04.06.1979	02.07.2002	Change Detection
Class	Area (ha)		
Urban	5029 (1%)	11729 (2%)	+ 6700
Water	6301 (1%)	7776 (1%)	+ 1475
Wetland	19568 (3%)	15417 (2%)	- 4151
Meadow	36761 (6%)	30220 (5%)	- 6541
Coniferous	38975 (6%)	30274 (5%)	- 8701
Deciduous	78110 (12%)	53529 (9%)	- 24581
Mixed	78684 (12%)	116672 (19%)	+ 37988
Agriculture	366373 (58%)	364018 (58%)	- 2355
Total	629801 (100%)	629635 (100%)	

Pixel-oriented post-classification



a. Landsat MSS scene classification was performed on a false color composite (green, red, and near-infrared band)



b. Landsat 7 ETM+ scene classification was performed on a false color composite (green, red, and middle infrared band)

Agriculture
Deciduous
Mixed Forest
Water Body
Coniferous
Meadow
Urban
Wetland

Polesie Biosphere Reserve on 4th June, 1979 (a) and 2nd July, 2002 (b)

Object-oriented classification

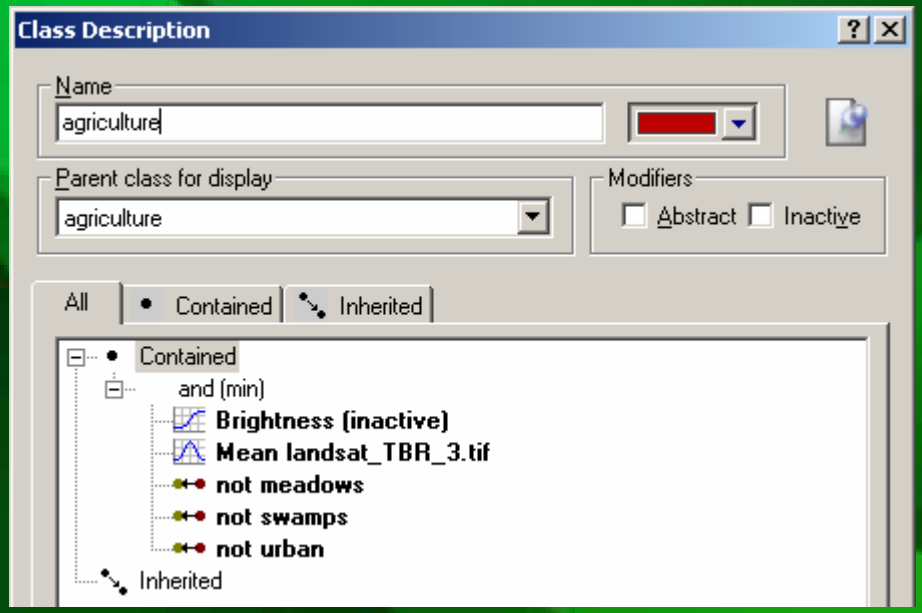
Approach (eCognition):

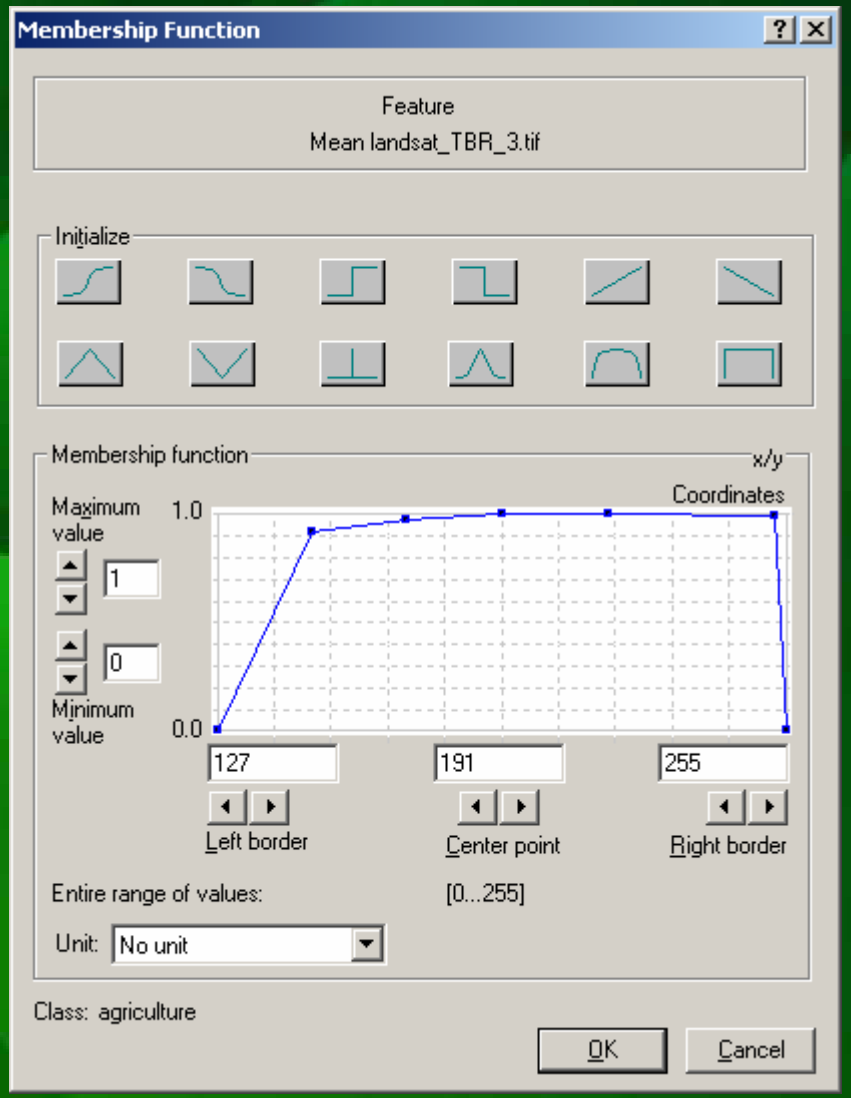
- Multiresolution segmentation was performed on a false color composite with regard to spectral (color) and spatial (shape) information. In this case, segmentation scale 60 was regarded as sufficient for the process of classification and the land cover classes detail for mapping. For the high resolution ETM^+ scene spectral criteria were more significantly weighted than spatial which is justified by the diverse reflectance in spectral resolution. According to the overlapping and fragmented classes shape heterogeneity was more heavily weighted to smoothness than compactness.

- Afterwards the actually classification was performed by class description. Classes were described by dint of different features for the bands 1-5 with brightness, mean, mean difference to scene, minimum pixel value, ratio, ratio to scene, and standard deviation using fuzzy logic.

- Classification results were evaluated using the accuracy assessment tool.

Class description





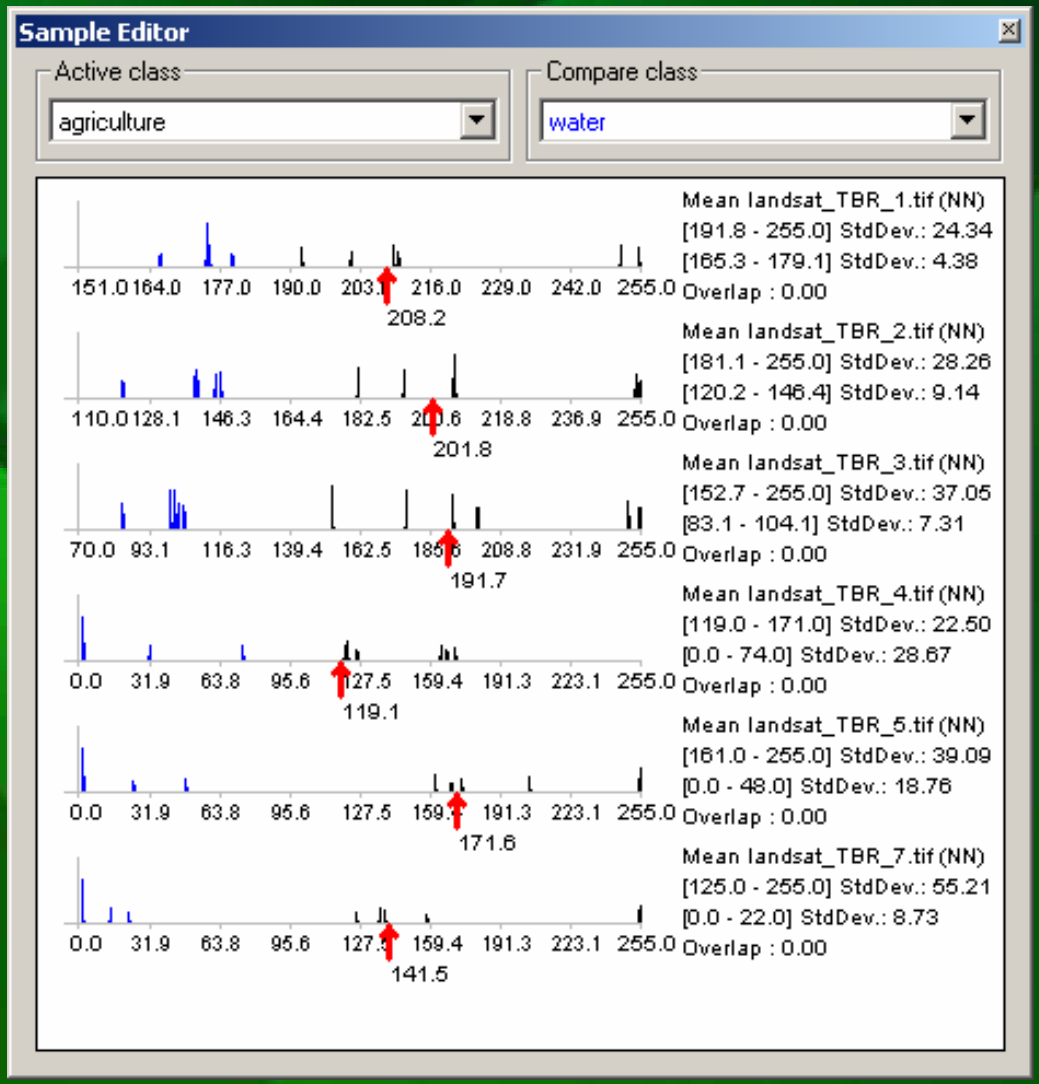
4 Feature groups:

- Object features
- Class-related features
- Global features
- Process-related features

Plus customization of features!

Sampling

- Sampling can be applied as alternative to class description or as combination with.
- In any case, each class should be described or sampled so, that it is the most distinctive to all others!

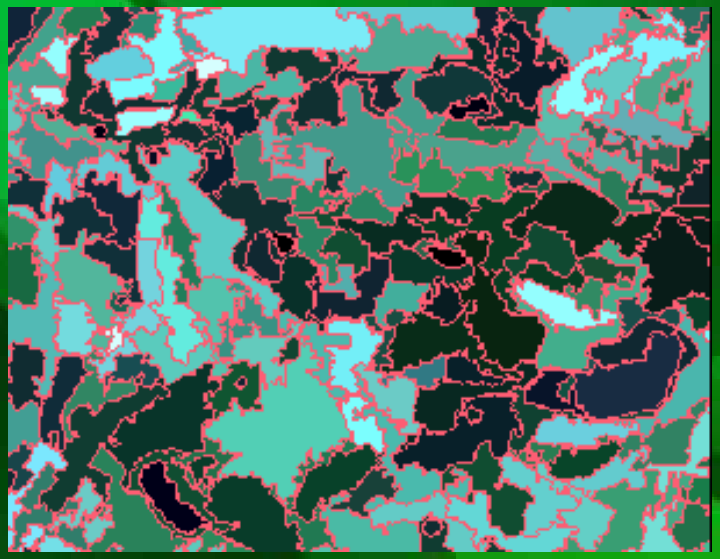


Classes and classification stability

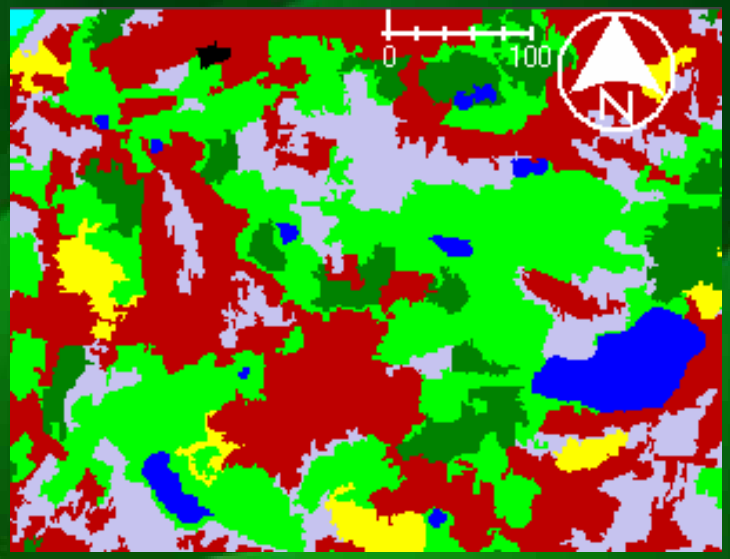
Class	Objects	Objects (%)	Mean	Standard Deviation	Minimum	Maximum
Urban	39	1	0.78	0.32	0	1
Water	186	3	0.66	0.31	0	1
Wetland	43	1	0.50	0.44	0	1
Meadow	707	13	0.61	0.38	0	1
Coniferous	520	9	0.78	0.32	0	1
Deciduous	176	3	0.26	0.27	0	1
Mixed	1029	18	0.72	0.36	0	1
Agriculture	2960	52	0.83	0.25	0	1
Total	5660	100	0.64	0.33	0	1

Classification stability was applied for accuracy assessment!

Object-oriented classification



a. Multiresolution segmentation was applied using three bands (green, red, and middle infrared) at segmentation scale 60. Segmentation process was weighted to spectral (0.8) and to spatial (0.2) information. Spatial parameter was weighted to smoothness (0.6) and compactness (0.4) in normal segmentation mode.

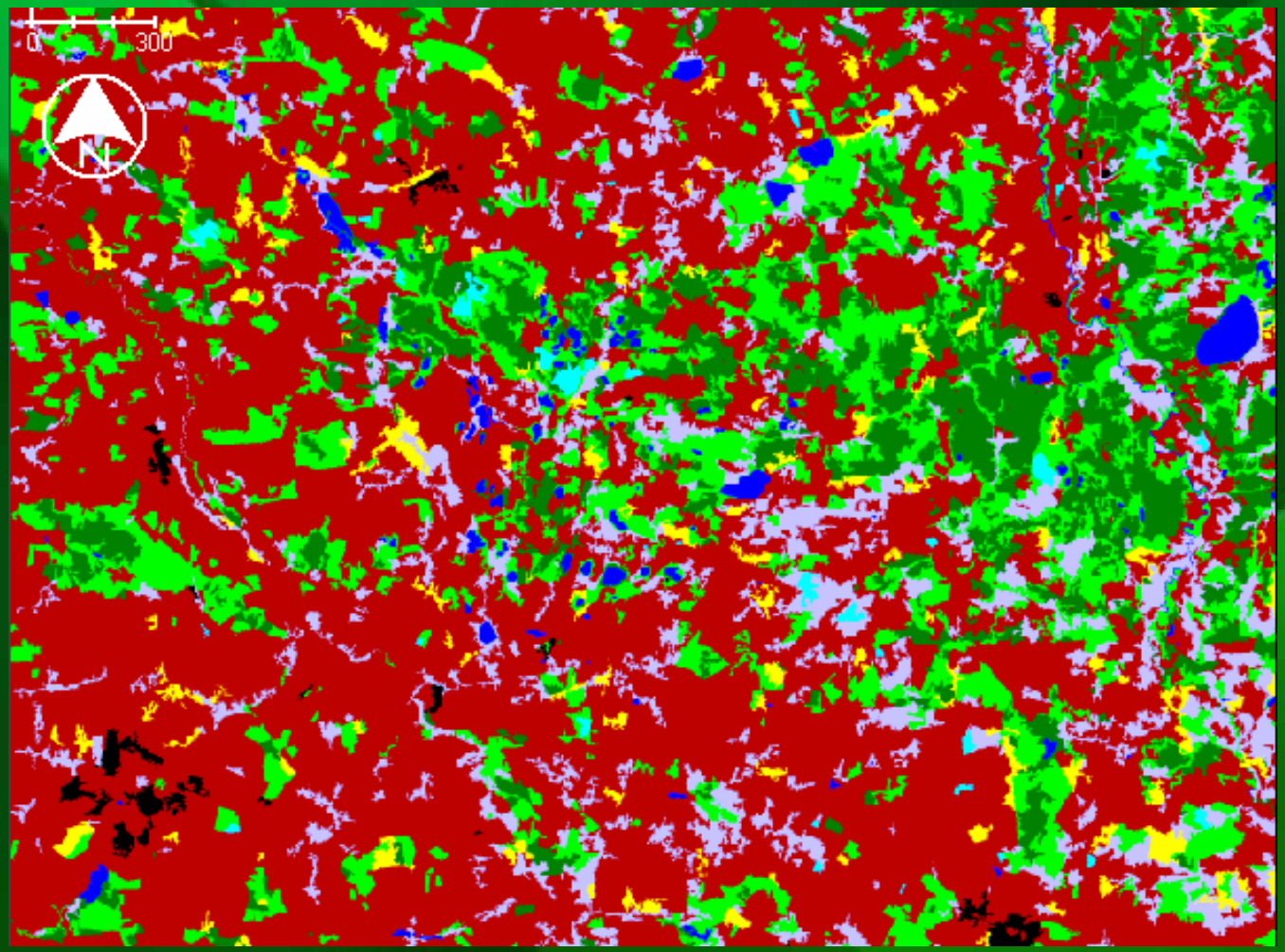


b. Classification map derived from the image segmentation (a), by class description. Scale is given in spatial resolution (30m).

- Agriculture
- Coniferous
- Deciduous
- Meadow
- Mixed Forest
- Urban
- Water body
- Wetland

False color composite classification of Landsat 7 ETM+ obtained on July 2nd, 2002

Object-oriented classification



Object-oriented classification map on 2nd July, 2002 for the total ETM+ scene covering Belarus, Poland and the Ukraine. West Polesie Transboundary Biosphere Reserve will cover the north-eastern part of the scene. For the classification 5689 objects instead of 7.184892 million pixels were used. Scale is given in spatial resolution (30m).

Agriculture
Deciduous
Mixed Forest
Water Body
Coniferous
Meadow
Urban
Wetland

Conclusion

- Classifications are time efficient and economic
- Classifications are a powerful tool in decision finding
- Classification quality is not sufficient enough yet
- Both scenes have a very high pixel reflectance resulting in misclassification
- No data continuation issues!
- Lacks in data and limited data available
- Very diverse spectral information due to fragmented and diverse landscape
- Overlapping classes → limitations of remote sensing!
- False color composites provided best results
- Atmospehric conditions probably differed → different brightness values
- Natural boundaries are fuzzy like eCognition → spatially and spectrally homogenous objects
- Improving object-oriented classification by different segmentation scales, feature space optimization and minimum membership function
- Cheers!