AN OBJECT-BASED APPROACH FOR WETLAND HABITATS INVENTORY AND ASSESSMENT USING ALOS AVNIR-2 AND FIELD DATA

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Background

- Habitat fragmentation and destruction
  - impacts on biodiversity
  - severe economic, biological, societal and ethical consequences

- Habitats Directive 92/43/EEC
  - conservation of natural habitats
  - establishment of a Natura 2000 network
Habitats mapping in Greece

- Identification and mapping of habitat types in Greece (2001)
- GlobWetland (www.globwetland.org)
- WETMUST (wetmust.archimed.gr)
Methods for habitats mapping

- Transects, intensive fieldwork
- Photo-interpretation and digitizing
- Pixel based automated classification (spectral)
- Object based classification (spectral, contextual)
Landscape ecology

- The **structure of landscape** as an entity with attributes of regrouping and dynamics embedded in the character of its smaller elements can be expressed by the hierarchy theory.

- Research challenge:
  - optimise the temporal and spatial **resolution** of data-layers, for targeted organisms or communities
  - maximize the amount of **information** extracted from each data-layer
  - intelligently **combine** information from data-layers of different spatial and/or temporal resolution

*taken from Barnett and Blaschke, 2003*
Hierarchy theory

- Decomposition
- Objects on a scale are decomposition results, apparent as separable entities
- Technologically: hierarchy theory and multi-scale approach can be combined in object-based image analysis (OBIA)
Aim

- Evaluate object-based image analysis techniques for species and habitat mapping
  - ALOS AVNIR-2 image
  - Appropriate data sampling for a hierarchically structured nomenclature
- Examine three scale levels
  - species scale
  - habitats scale
  - general land cover scale
Study Area
Hierarchical Classification Scheme
Sampling Design and Plot Distribution

- Stratified proportional allocated sampling design based on existing Natura 2000 habitats’ boundaries (strata)
- Random sample plots distribution (137)
Plot Configuration

- Basic sampling unit: 10m x 10m
- Corresponds to image pixel resolution
- A cluster of 9 adjacent sampling units selected for inventory and assessment at each plot
Key parameters surveyed

- Land cover/land use types as well as their percent cover per sampling unit,
- Number, diameter and height, as well as features of the cover of all trees above a specified diameter to characterize the structure of the forested wetland,
- Ground vegetation, with special reference to all rare species,
- Environmental disturbances (pollution, fire, clearings, etc.).
Methodology

- Object-based image analysis (OBIA)
  - 1st step: Segmentation
  - 2nd step: Classification
  - Interrelated (common classification strategy)
OBIA-Segmentation

Segmentation:
- is **local heterogeneity minimisation** of all the potential image objects on a specific scale
  - Scale parameter: \( f \)
  - Spectral heterogeneity
  - Shape heterogeneity
- can be applied on different scales
  - Objects on higher scales include objects of lower scales

\[
f = w \cdot h_{\text{spectral}} + (1 - w) \cdot h_{\text{shape}}
\]

\[
h_{\text{spectral}} = \sum_{i=1}^{b} w_i \sigma_i
\]

\[
h_{\text{shape}} = \frac{l}{\sqrt{n}}
\]

taken from Karydas et al, 2005
OBIA-Hierarchy

- **Inheritance** hierarchy
  - refers to the physical relations between the classes
  - class descriptions defined in parent classes are passed down to their child classes
  - helps to reduce the necessary number of inputs and better control class descriptions.

- **Groups** hierarchy
  - refers to the semantic relations between classes
  - child classes of parent classes allows for grouping classes irrespectively if they contain very different feature descriptions.
OBIA-Classification

- OB Classification is a form of supervised classification
  - Training samples: objects classified by NN
  - Rule-based: fuzzy sets of object features
Segmentation at 1st level

- Species targeted
  - \( h=1 \) (minimum possible -> pixel)
  - spectral heterogeneity = 0.9
  - shape heterogeneity = 0.1
Segmentation at 2nd level

- Habitats targeted
  - $h=2$ (derived from statistics of level-1)
  - spectral heterogeneity = 0.9
  - shape heterogeneity = 0.1
Segmentation at 3rd level

- Fields targeted
  - $h=15$ (derived from inspection of results)
  - spectral heterogeneity = 0.7
  - shape heterogeneity = 0.3
Segmentation at 4\textsuperscript{th} level

- Vegetation and water targeted
  - $h=25$ (derived from statistics of level-3)
  - spectral heterogeneity = 0.9
  - shape heterogeneity = 0.1
Hierarchy

Inheritance hierarchy
control of class description, e.g. levels, common properties

Groups
Hierarchy semantic grouping, e.g. ‘Herbs’, ‘Non-vegetated land’
Classification at 1st level

Area of interest at the Level-1, where results are expected to be reliable
Classification at 2\textsuperscript{nd} level

- Scaling up of results of LEVEL-1
  - Rule-based classification
  - Incorporation of classes of LEVEL-1
    - Example: Herbs are these object that include either objects of High Reeds or Natural Grassland or Low herbs – Meadows at least 80% in total

Classified as HERB
Classification at 3\textsuperscript{rd} level

- Discrimination of agricultural fields from natural vegetation
  - Rule-based classification
  - Exploitation of shape or texture parameters
Classification at 4th level
Accuracy assessment *(forthcoming)*

- Classification stability (based on the fuzzy character of the mapping results)
- Error matrix using (existing) testing samples
Evaluation of OBIA with AVNIR-2

- Advantageous because habitats appear as objects
- Laborious to setup the process
- Faster than digitizing
- More accurate than pixel based classification
Conclusion

- Hierarchy theory was essential for habitats nomenclature
- Contextual information is necessary for discriminating agricultural fields from natural vegetation
- OBIA is appropriate for extracting thematic information from ANVIR-2 imagery
Thanks for your attention!!