MONITORING INDICATORS FOR MEDITERRANEAN WETLAND AND AGRICULTURAL AREA USING ALOS DATA

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Environmental Monitoring

- Integral tool for wetland management

Use of Earth Observation (EO)  
ALOS Satellite Images

- As a tool for integrated monitoring of wetlands

  **Advantages**
  - consistent method of data collection
  - broadly cover the entire study area, cost effective in medium to large study areas
  - allow easy multi-temporal comparison
  - allow study of inaccessible or highly protected areas
Aim

- Select and implement indicators for monitoring the natural and agricultural environment of a Mediterranean wetland using ALOS images

Specific objectives

- Integration of multiple levels of data
- Selection of the monitoring indicators
- Application of the methodology in the study area (Ramsar site “Lakes Koronia-Volvi”, Greece)
The WETMUST Project

“Integrated multiple level wetlands monitoring system using innovative technologies”

- Investigation and implementation of innovative technologies
  - satellite images, UAV, spectroradiometer, telemetry

- Combined use of 3 monitoring levels
  - surveillance, telemetry, remote sensing

- Integrated monitoring
  - data collection, processing, information, WebIMS

- 4 wetlands of international importance (Greece, Italy)
Study Area: lakes Koronia-Volvi
ALOS AVNIR-2 (15/06/2007)
Field surveying

- Stratified random sampling
  - Red: Preliminary sampling (basin)
  - Blue: Intensive sampling (wetland)
field surveying

- In situ measurements with portable field instruments
- Data collection and subsequent laboratory analyses
Telemetry / soil and water quality

- Recording of quality elements of soil and water for:
  - evaluation of existing state, inter-relation with pressures from human activities, assessment of future state of ecosystems
  - Inter-relating pressures from basin level to impacts on ecosystem level

- Production of baseline data / Time series

- Among the measured parameters are:
  - Electrical conductivity (EC)
  - pH
  - Dissolved oxygen (DO)
  - Nitrates
  - Total P
Low flight images from UAV...

Characteristics:

- high spatial analysis → easy photo-interpretation
- small geographical coverage → sampling only
- adequate spectral analysis (visible, near infrared)
- repeatability
Usefulness of UAV images

- Partial substitution of field work
- Especially in remote areas with limited access
- During data analysis:
  - identification of indistinguishable habitats
  - algorithm training for processing of satellite images
  - verification of remote sensing results
Satellite images

2007:
- ALOS AVNIR-2 (vegetation, water)
- ALOS PALSAR (water, inundated vegetation)

2003:
- Terra ASTER (multi-temporal changes)
Data integration

Methods

Data collection

- Field survey
  - Land cover samples
  - GPS
- Remote sensing
  - UAV images
  - Satellite images
- Telemetry
  - Time series

Analysis

- Spectral signatures
- Digital image processing
  - Photo interpretation
- Trend analysis

Environmental information

- Land cover
- Habitats
- Long term changes
- Landscape metrics
- Seasonal changes
- Map

Output

- WebIMS
- GeoDatabase
Derivation of envir. indicators

- According to the DPSIR (EEA) model
  - pressure indicators (land cover, agricultural intensity, temporal changes of human activities)
  - state/impact indicators (habitat map, ecological state of ecosystems, temporal changes)
- In accordance with legislation
  - WFD, Habitats, Ramsar
- Information diffusion
Land cover map

Materials-methods:
- sampling points
- ALOS AVNIR-2
- spectral classification

Information:
- wetland delineation
- agricultural areas
- intensity of irrigated fields

Legend
Koronia-Volvi basin CRAMSAR classes
- 11 Urban fabric
- 211 Non-irrigated arable land
- 212 Permanently irrigated land
- 311 Broad-leaved forest
- 312 Coniferous forest
- 321 Natural grassland
- 323 Sclerophyllous vegetation
- 324 Transitional woodland shrub
- 334 Burnt areas

Koronia wetland CRAMSAR classes
- 311 Mixed forest
- 4111 Reedbeds and large helophytes
- 431 Tamarix
- 5113 Seasonal streams
- 512 Water bodies
- 321 Natural grassland
- Exposed lake bed
- Mixed 431 and 4111
- 331 Beaches, dunes and sand plains

ALOS Symposium 2008
Habitat map

Materials-methods:
- sampling points
- UAV-satellite images
- spectral classification
- photo-interpretation and image digitalization

Information:
- location – size – type of habitat (26 types identified)
- wetland boundaries
Landscape metrics

Materials and methods:
- habitats map
- analysis with Fragstats software (Patch Density, Edge Density, Shannon’s Diversity Index, Interspersion and Juxtaposition Index)

Information for wetland state:
- wetland dominated by relatively large habitat patches (low fragmentation)
- relatively complex shape (provides habitat for wildlife)
- relatively low adjacency (habitat classes are not interspersed).
Time series of water quality

Materials-methods:
- time series analyses (telemetry and surveillance data)
- descriptive statistics
- trend analyses (Mann Kendall test, Sen’s slope estimator)

Information for long-term trends of parameters:
- EC is increasing
- pH is increasing
- DO ...

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Lake Koronia</th>
<th>Lake Volvi</th>
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<tbody>
<tr>
<td>EC</td>
<td>0.045</td>
<td>0.010</td>
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<tr>
<td>pH</td>
<td>0.064</td>
<td>0.012</td>
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<tr>
<td>DO</td>
<td>-</td>
<td>0.007</td>
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</table>
Seasonal changes of water level

Water identification from two images:
- Infrared of ALOS AVNIR-2 (summer 2007, low level)
- ALOS PALSAR (winter 2006, high level)

Results:
- Seasonal water change 3.2%, lower than other years (100%)
- Inundated vegetation clearly visible in radar image
Land cover changes 2003-2007

Materials - methods:
- land cover map 2003
- land cover map 2007
- geographical overlay analysis

Information:
- changes in state
- water extents decreased by 5.4% (5.38 km²)
- reedbed expanded lakewards occupying an area of 2.01 km² of water and exposed sediment
Accessibility – diffusion of info

WebIMS
- Spatial representation
- Remote access
- Instant update
- Further utilization of info
Conclusions - Use of ALOS data in environmental monitoring

- Derivation of environmental indicators
- Integration in multiple level monitoring system
- Comparability with other satellite data for identification of temporal changes
- Transferability of methods from ASTER to ALOS

- Recommended for monitoring of natural and agricultural ecosystem, along with their interactions
Thank you for your attention

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