LAND COVER CONTEXTUAL CLASSIFICATION USING SPACE IMAGERY FOR WETLAND AND FOREST MONITORING

Mikhail A. Popov, Sergey A. Stankevich, Aleksey I. Sakhatsky, Anna A. Kozlova

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Outline

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Purpose

to develop a land cover classification using space imagery that consider forest and wetland spatial distribution in local environmental context
Environmental conditions are driving force of plant communities differentiation in space.

**Main contextual features**

**Forests**
- Temperature
- Humidity
- Solar irradiation
- Height above the sea level

**Wetlands**
- Humidity
Examples of Classification Systems Land Cover Types

**Global**
- IGBP Land Cover
- UMD Land Cover
- Global Land Cover 2000

**Regional**
- CORINE LCC
- GSE-Land
- PELCOME

**Space Imagery**
- EOS/MODIS
- Envisat/MERIS
  - Low spatial resolution
- Landsat/ETM+
- EOS/ASTER
  - Medium spatial resolution
Algorithm

Environment variables

Land Surface Temperature \((LST)\) \(T_0\)
Normalized Water Index \((NWI)\)

\[
T_0 = \frac{c}{\ln \left( \frac{k}{E_{TIR}} + 1 \right)}
\]

Surface Solar Irradiation \((SSI)\) \(M\)

\[
w_0(NWI, T) = a \ln \left( \frac{NWI}{T_0} + 1 \right) + b
\]

Height above the Sea Level \((DTED)\)

Soil Water Content \((SWC)\) \(w_0\)

where \(c\) and \(k\) are sensor dependent constants, \(E_{TIR}\) is a spectral density of emittance in thermal infrared range

Digital Terrain Elevations Data \((DTED)\) 

\(M(\varphi, \alpha, A) = \frac{\sin(h_0 - \alpha \cos A)}{\sin h_0} \cdot M_0 \exp(-m_0 \varphi^2)\)

\(SRTM3\ v2.0\)

\(h_0 = 90^\circ - \varphi + \delta_0\)
\(m_0 = 0.1293 \cdot 10^{-3} \text{deg}^{-1}\)
\(\delta_0 = 23.45^\circ\)
\(M_0 = 270 \text{ W/m}^2 \text{ per day}\)

(Rodriguez et al. 2005; Stankevich & Kozlova, 2007; Sakhatsky & Stankevich, 2007)
Algorithm

\[ \Theta_i = (\overline{r}_{\lambda i}, \text{cov} r_{\lambda i}) \]

\[ C_f = \text{argmax} P(r_{\lambda}, \Theta_i) \]

\[ w_0 = a \ln \left( \frac{w_{\lambda}}{T_0} + 1 \right) + b \]

(\text{Popov, et al., 2007})
Crimea, Ukraine

ASTER multispectral space image
2005/08/12; Spatial resolution: 15 m
Bands 4,3,2

Results of Initial vegetation classification (UMd)
- Evergreen Needleleaf Forests
- Deciduous Broadleaf Forests
- Wooded Grasslands/Shrublands
- Shrublands
- Grasslands
- Barren
- Shadows
- Water bodies
- Barren

Results
Input data

SRTM3 v2.0, Height above the sea level

Spatial distribution of Surface Solar Irradiation

0 1300 m

0 220 W/m² per day
Output data

ASTER multispectral space image
2004/06/04; Spatial resolution: 15 m, Bands: 2,3,1
Banks of the Dnieper river nearby Dnieprodzerzhinsk town

Results of initial land cover classification (CORINE)
- Water bodies
- Artificial surfaces
- Agricultural areas
- Land principally occupied by agriculture, with significant areas of natural vegetation
- Forests
- Wetlands
Input data

Spatial distribution of Land Surface Temperature

Spatial distribution of Normalized Water Index
Output data

Legend

- Water bodies
- Artificial surfaces
- Agricultural areas
- Land principally occupied by agriculture
- Forests
- Wetlands of different soil water content
  - Highest
  - High
  - Medium
  - Low

Result of adjusted classification of the wetlands
Conclusions

1. Local environment condition considering allows to adjust land cover classification according to thematic tasks.

2. Resulting land cover maps provide detailed spatial information for wetland and forest monitoring and could be useful for analysis of changes caused by human activity.

3. Proposed algorithm of land cover contextual classification using multispectral space imagery could be recommended as one of the remote sensing modern technique for wetland and forest monitoring.

Future work

validation of the land cover contextual classification by multiple ground-truth points and output classification improvement by time series processing for LST, SSI and NWI spatial distribution during vegetation season
Reference


Sakhatsky A.I., Stankevich S.A. About possibilities of land surface moisture estimation using space imagery optical bands for Ukraine territory (Ukrainian) // Reports of the NAS of Ukraine, 2007.- Vol.11.- P.122-129.

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