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

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Outline

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3. ALGORITHM
4. RESULTS
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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

Approach

Environmental conditions are driving force of plant communities differentiation in space.

Main contextual features

Forests
- Temperature
- Humidity
- Solar irradiation
- Hight above the sea level

Wetlands
- Humidity

Algorithm

Examples of Classification Systems Land Cover Types

Global	***Regional***
IGBP Land Cover	CORINE LCC
UMD Land Cover	GSE-Land
Global Land Cover 2000	PELCOME

Space Imagery

EOS/MODIS
Envisat/MERIS

- Low spatial resolution

Medium spatial resolution -

Landsat/ETM+
EOS/ASTER

Algorithm

Environment variables

Land Surface Temperature (*LST*)

Normalized Water Index (*NWI*)

Surface Solar Irradiation (*SSI*)

Height above the Sea Level (*DTED*)

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

Land Surface Temperature (*LST*) T_0

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

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

Soil Water Content (*SWC*) w_0

where ***a*** and ***b*** is regression coefficients estimated for each scene on the basis ground truth data with ground control points (GCP)

Surface Solar Irradiation (*SSI*) *M*

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

$h_0 = 90° - \varphi + \delta_0$ $\quad m_0 = 0.1293 \cdot 10^{-3}\,\mathrm{deg}^{-1}$

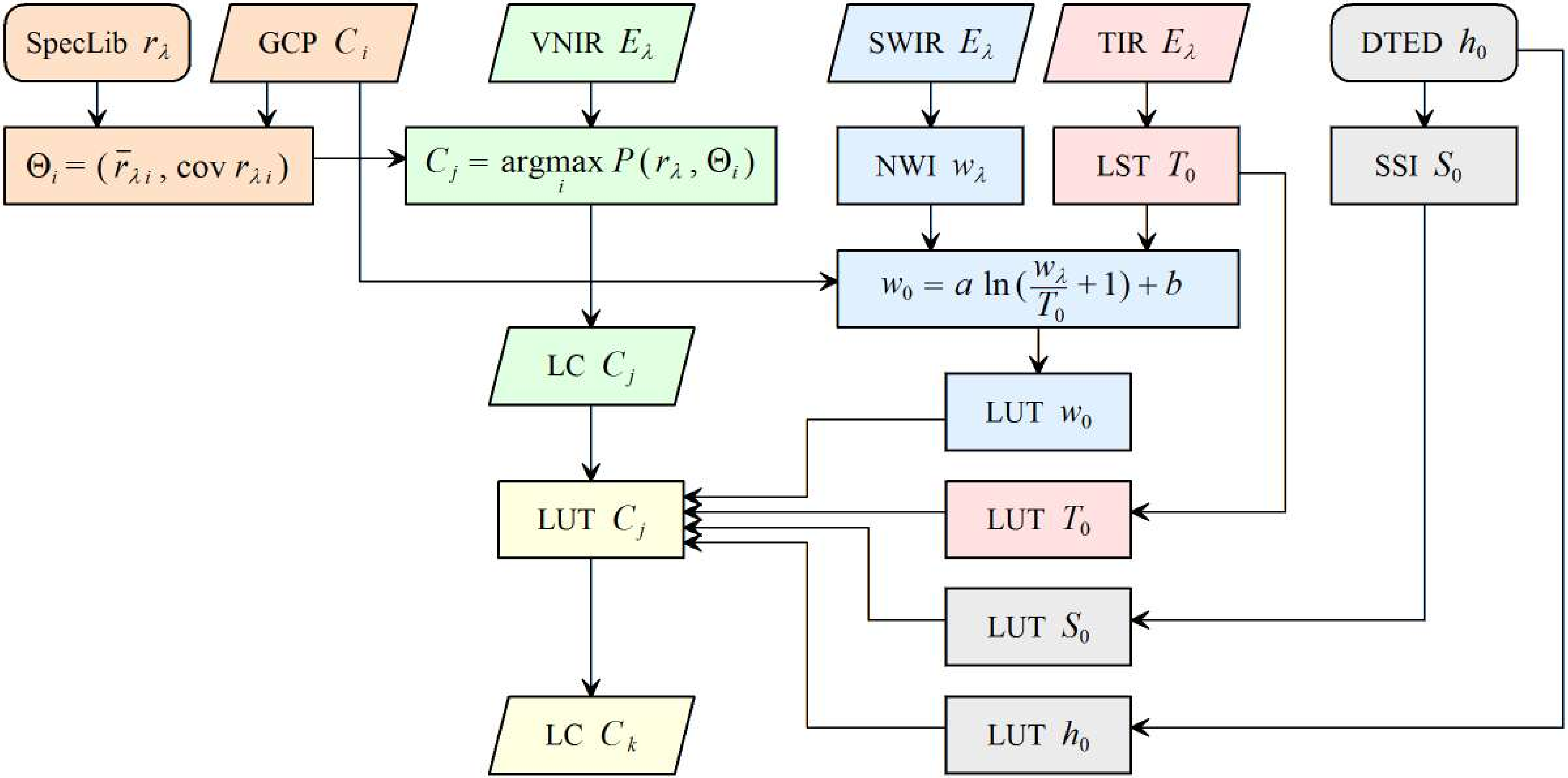
$\delta_0 = 23.45°$ $\quad M_0 = 270\ \mathrm{W/m^2}$ per day

SRTM3 v2.0

Digital Terrain Elevations Data (*DTED*)

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

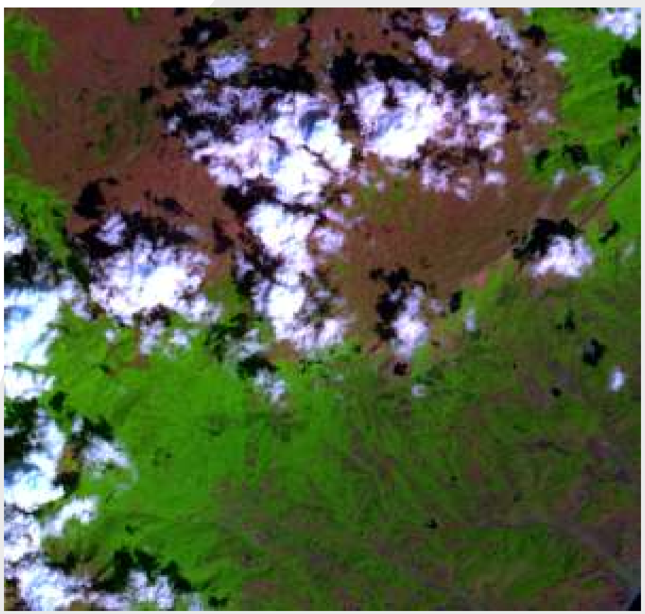
Algorithm



(Popov, *et al.*, 2007)

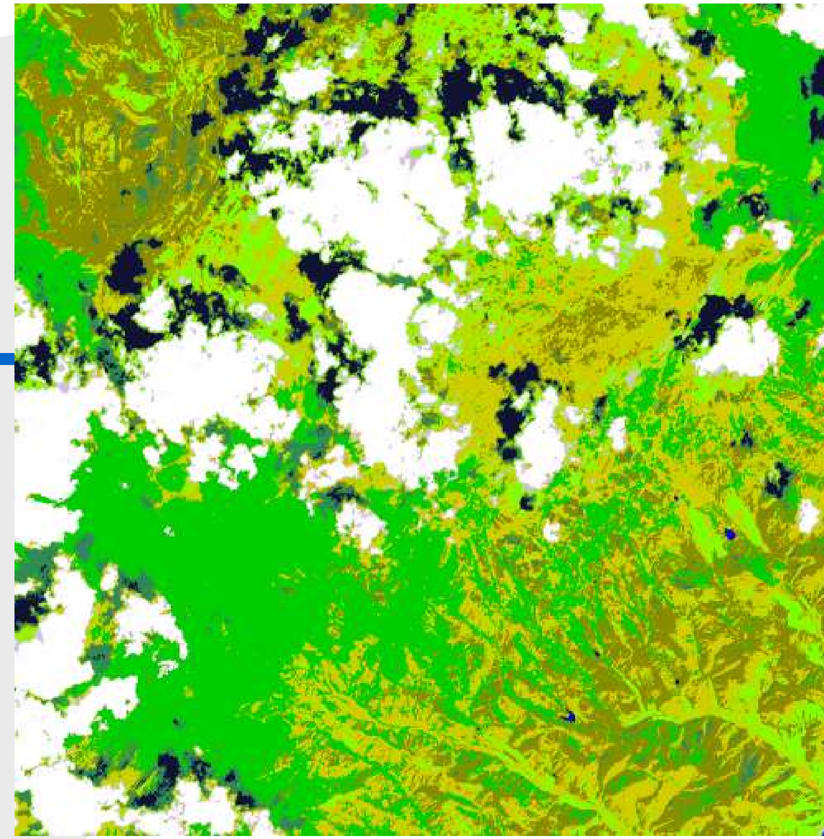
Results

Crimea, Ukraine



ASTER multispectral space image

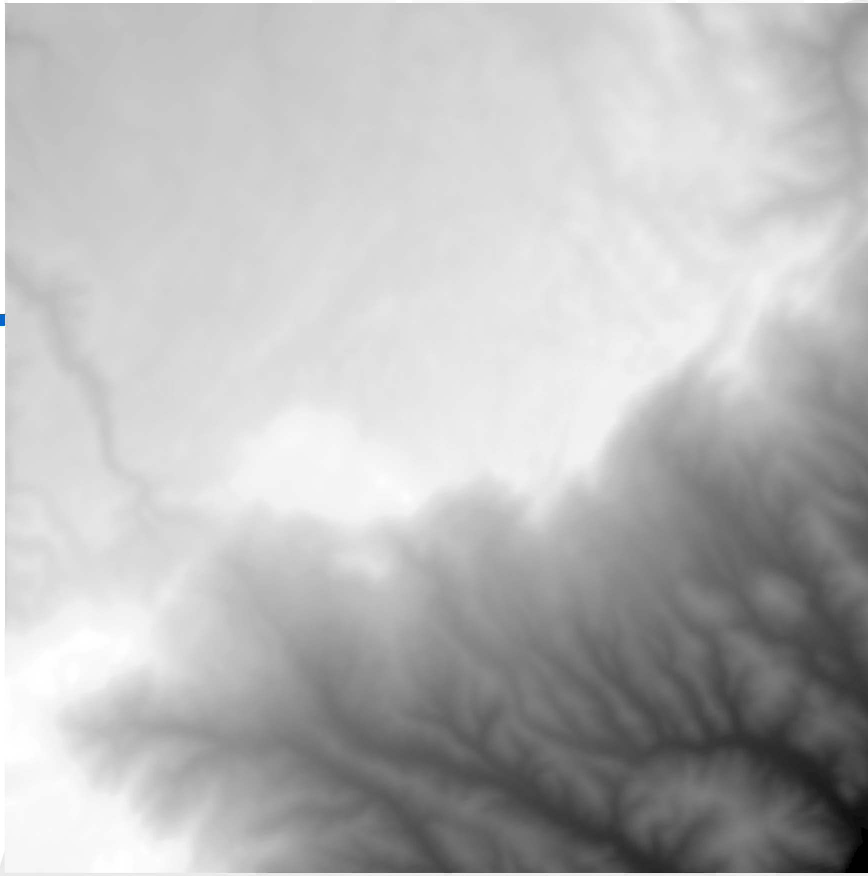
2005/08/12; Spatial resolution: 15 m
Bands 4,3,2



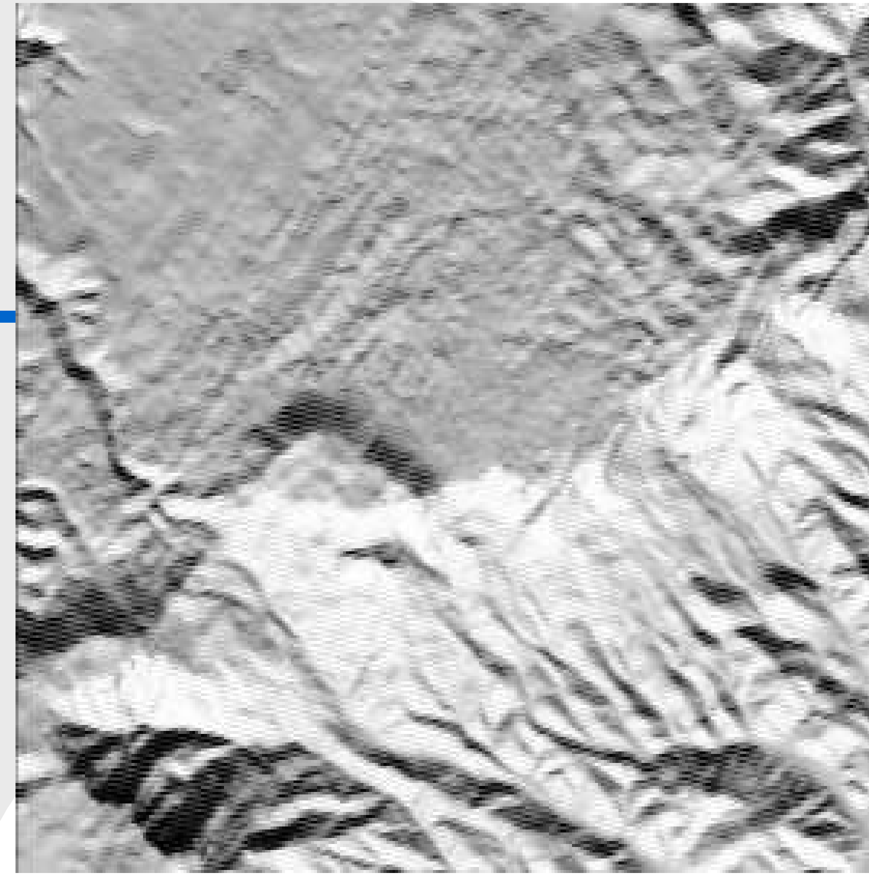
Results of Initial vegetation classification (UMd)

- Evergreen Needleleaf Forests
- Deciduous Broadleaf Forests
- Wooded Grasslands/Shrublands
- Shrublands
- Grasslands
- Barren
- Shadows
- Water bodies
- Barren

Input data

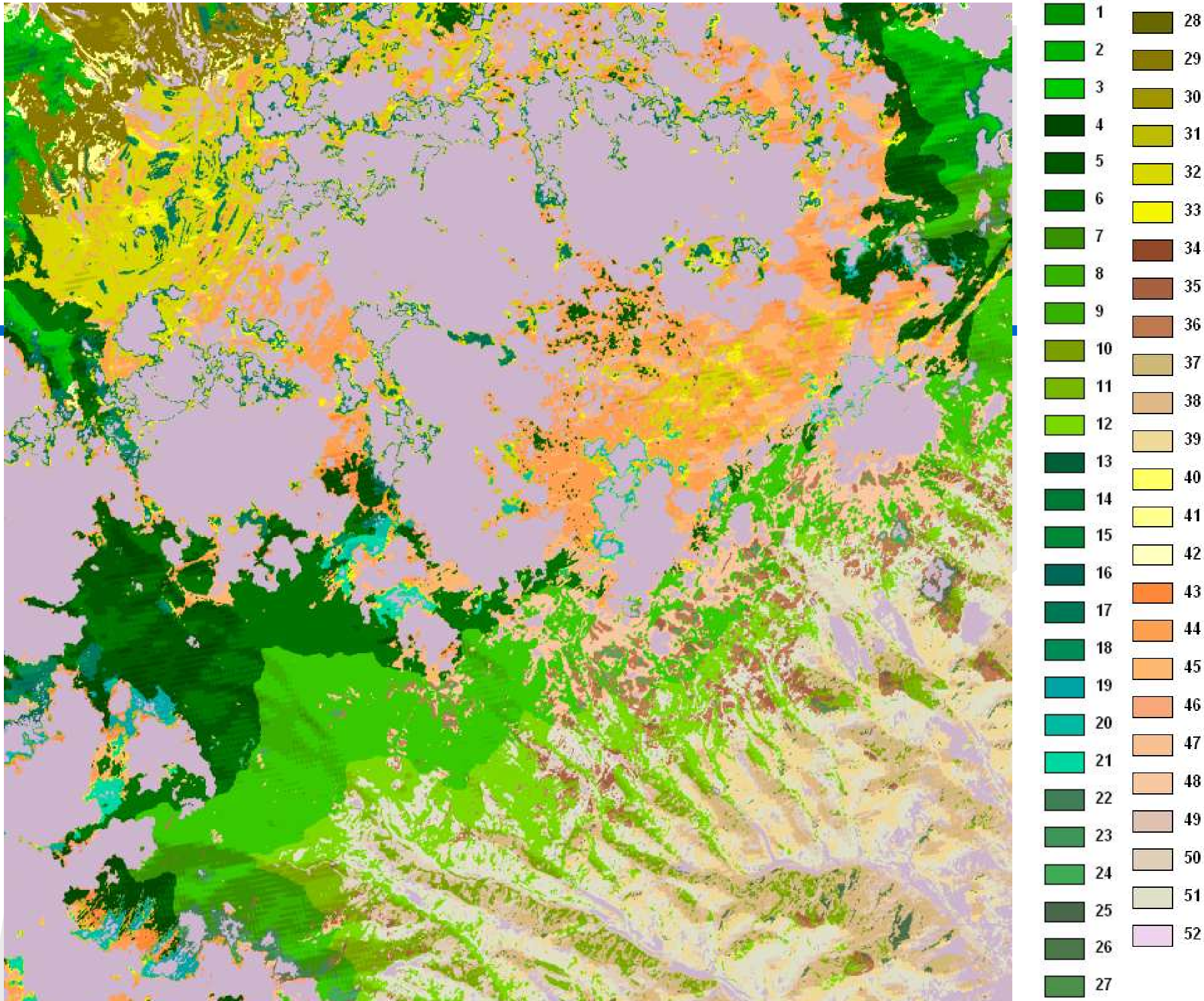


SRTM3 v2.0, Height above the sea level



Spatial distribution of Surface Solar Irradiation

Output data



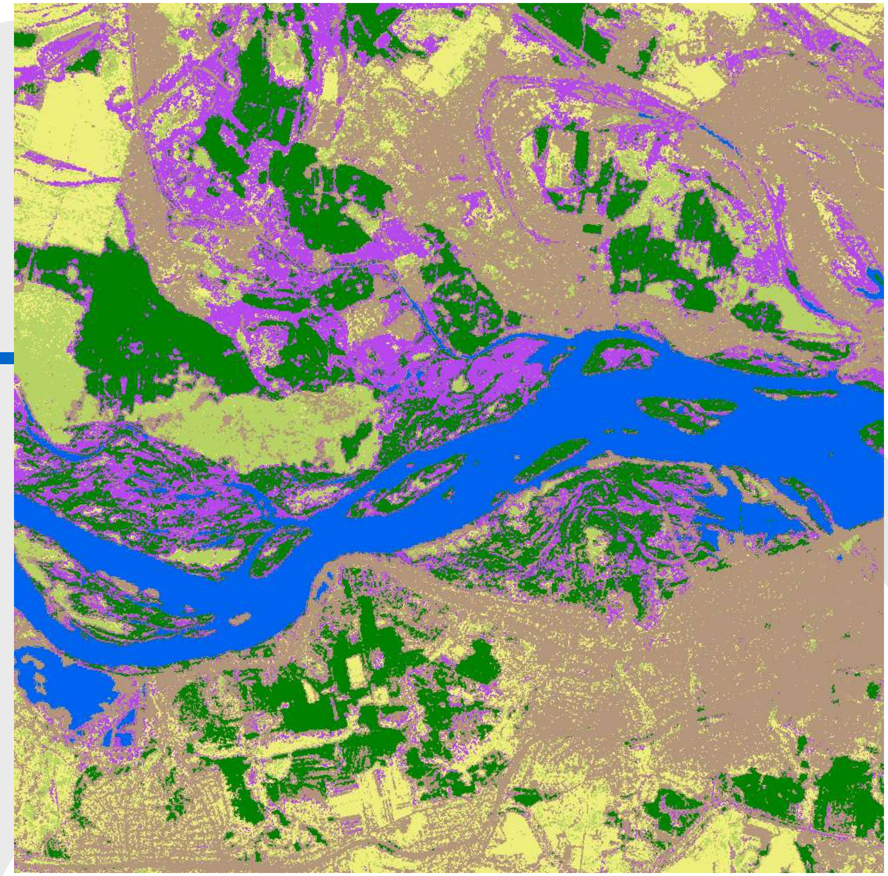
1. Low irradiated Durmast oak (*Quercus petracea*) forests of the northern macroslope, 2. Medium irradiated Durmast oak (*Quercus petracea*) forests of the northern macroslope, 3. High irradiated Durmast oak (*Quercus petracea*) forests of the northern macroslope, 4. Low irradiated Beech (*Fagus*) forests, 5. Medium irradiated Beech (*Fagus*) forests, 6. High irradiated Beech (*Fagus*) forests, 7. Low irradiated Durmast oak (*Quercus petracea*) forests of the southern macroslope, 8. Medium irradiated Durmast oak (*Quercus petracea*) forests of the southern macroslope, 9. High irradiated Durmast oak (*Quercus petracea*) forests of the southern macroslope, 10. Low irradiated Oak (*Quercus pubescens)* forests of the southern macroslope, 11. Medium irradiated Oak *(Quercus pubescens)* forests of the southern macroslope, 12. High irradiated Oak *(Quercus pubescens)* forests of the southern macroslope, 13. Low irradiated Pine (*Pinus*) forests of the lower belt of the northern macroslope, 14. Medium irradiated Pine (*Pinus*) forests of the lower belt of the northern macroslope, 15. High irradiated Pine (*Pinus*) forests of the lower belt of the northern macroslope, 16. Low irradiated Pine (*Pinus*) forests of the middle belt of the northern macroslope, 17. Medium irradiated Pine (*Pinus*) forests of the middle belt of the northern macroslope, 18. High irradiated Pine (*Pinus*) forests of the middle belt of the northern macroslope, 19. Low irradiated mountain Pine (*Pinus*) forests, 20. Medium irradiated mountain Pine (*Pinus*) forests, 21. High irradiated mountain Pine (*Pinus*) forests, 22. Low irradiated Pine (*Pinus*) forests of the middle belt of the southern macroslope, 23. Medium irradiated Pine (*Pinus*) forests of the middle belt of the sourthen macroslope, 24. High irradiated Pine (*Pinus*) forests of the middle belt of the southern macroslope, 25. Low irradiated Pine (*Pinus*) forests of the lower belt of the southern macroslope, 26. Medium irradiated Pine (*Pinus*) forests of the lower belt of the sourthen macroslope, 27. High irradiated Pine (*Pinus*) forests of the lower belt of the southern macroslope, 28. Low irradiated closed shrubs of the middle belt of the northern macroslope, 29. Medium irradiated closed shrubs of the middle belt of the northern macroslope, 30. High irradiated closed shrubs of the middle belt of the northern macroslope, 31. Low irradiated mountain closed shrubs, 32. Medium irradiated mountain closed shrubs, 33. High irradiated mountain closed shrubs, 34. Low irradiated shiblayk of the southern macroslope, 35. Medium irradiated shiblayk of the southern macroslope, 36. High irradiated shiblayk of the southern macroslope, 37. Low irradiated shiblayk with evergreen undergrowth, 38. Medium irradiated shiblayk with evergreen undergrowth, 39. High irradiated shiblayk with evergreen undergrowth, 40. Low irradiated open shrubs of the middle belt of the northern macroslope, 41. Medium irradiated open shrubs of the middle belt of the northern macroslope, 42. High irradiated open shrubs of the middle belt of the northern macroslope, 43. Low irradiated open mountain shrubs, 44. Medium irradiated open mountain shrubs, 45. High irradiated open mountain shrubs, 46. Low irradiated open shrubs of the middle belt of the southern macroslope, 47. Medium irradiated open shrubs of the middle belt of the southern macroslope, 48. High irradiated open shrubs of the middle belt of the southern macroslope, 49. Low irradiated open shrubs of the lower belt of the southern macroslope, 50. Medium irradiated open shrubs of the lower belt of the southern macroslope, 51. High irradiated open shrubs of the lower belt of the southern macroslope, 52. Unconsidered areas)

Result of adjusted classification of the Crimean mountain forests

Results

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)

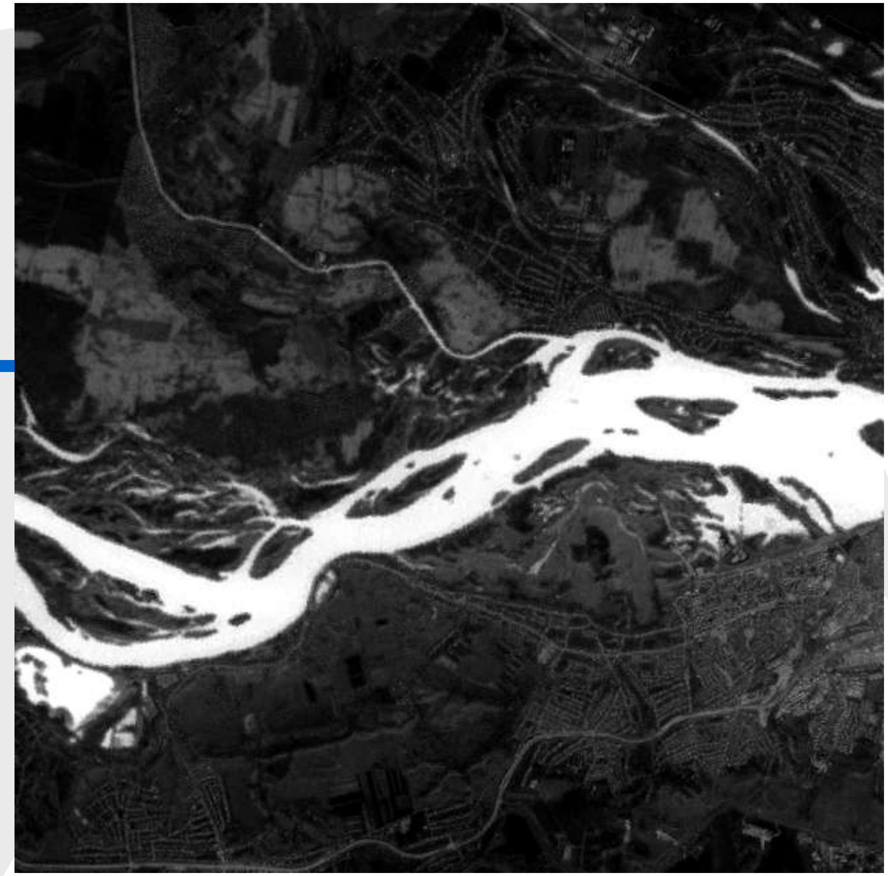
- Water bodies
- Forests
- Artificial surfaces
- Wetlands
- Agricultural areas
- Land principally occupied by agriculture, with significant areas of natural vegetation

Input data

Spatial distribution of Land Surface Temperature

273 310

K



Spatial distribution of Normalized Water Index

0 1

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*

T LCC **Result of adjusted classification of the wetlands**

INTAS

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

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