REDUCING UNCERTAINTY ON SATELLITE IMAGE CLASSIFICATION THROUGH SPATIOTEMPORAL REASONING

Panagiotis Partsinevelos[1], Natassa Nikolakaki[1], Periklis Psillakis, George Miliaresis[2], Michail Xanthakis[3]

[1]*School of Mineral Resources Engineering, Technical University of Crete, Chania, Greece, Email: ppartsinevelos@isc.tuc.gr*

[2]*Open University of Cyprus, Environmental Conservation & Management*

[3]*Management Body of Mt. Ainos National Park, Cephalonia, Greece*

Introduction

The natural habitat constantly endures both inherent natural and human-induced influences. The continuous monitoring of these influences, through land-use alterations, offers remarkable advantages for the determination of actions regarding the management and protection of endangered areas. Processing and analysis of multi-temporal satellite images for monitoring land use changes often include classification and change-detection techniques. These error prone procedures are influenced mainly by the distinctive characteristics of the study areas, the remote sensing system limitations and the image analysis processes.

The present study takes advantage of the temporal continuity of multi-temporal classified images, in order to reduce classification uncertainty, based on reasoning rules. More specifically, pixel groups of classified images that temporally oscillate between classes are liable to misclassification or indicate problematic areas. Additionally, constant pixel group changes indicate pressure prone areas between classes. Computational tools are developed in order to disclose the alterations in land use dynamics and offer a spatial reference to the pressures that land use classes endure and impose.

Study Area & Datasets

The case study area is the Hellenic National Park of Mt. Ainos in Cephalonia island, which belongs to the "Natura 2000" European Ecological Network of Protected Areas. Its main feature is its Cephalonian Fir forest (*Abies cephalonica*), which is unique in the Ionian Islands and constitutes the reason for the foundation of the National Park in 1962.

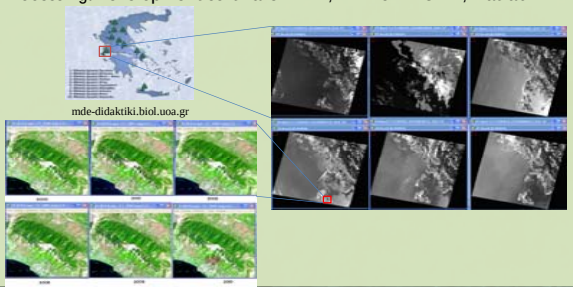
www.foreasainou.gr

Satellite images: Landsat 5 and Landsat 7
Dates: Summer 2000 to 2011.

Preprocessing of satellite images

- Processing level: L1T radiometric and geometric corrections,
- Histogram matching, geo-referencing,
- Classification: Maximum Likelihood,
- Additional data: CORINE 2000, in situ training data.

Processing/Development software: ENVI, ERDAS IMAGINE, Matlab.

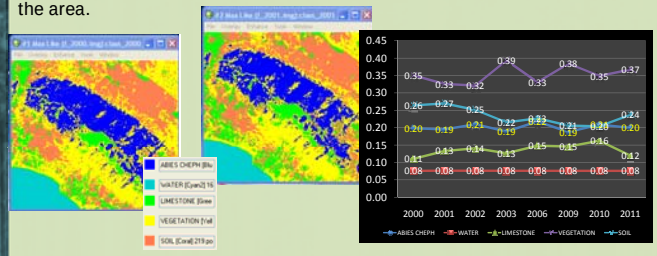


mde-didaktiki.biol.uoa.gr

Classification-change detection results

Land cover classes: *Abies cephalonica*, Water, Limestone, Vegetation, Soil.

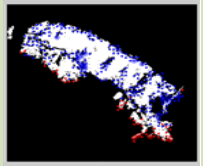
The results of classification and change detection were eight land use maps of the National Park of Ainos and statistical tables showing class changes of the area.



Visualization of class change pressures

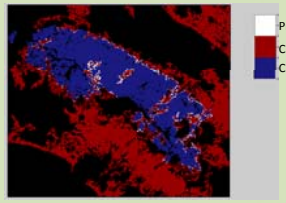
A. Single class - General pressure

The aim is to spatiotemporally locate the effects of each class from/towards neighboring classes on classified images. For the class of *Abies cephalonica*, the blue dots refer to pressures from other classes and the red dots the pressure towards other neighbor classes.

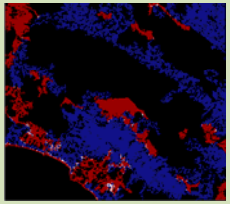


B. Class pairs - Specified spatiotemporal pressure

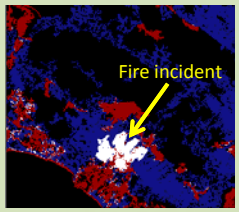
The aim is to visualize the class pressure between any two classes and temporal increments.



Pressure of Vegetation to *Abies cephalonica* between 2000-2001



Pressure of Soil to Vegetation between 2006-2009



Pressure of Soil to Vegetation between 2009-2010.

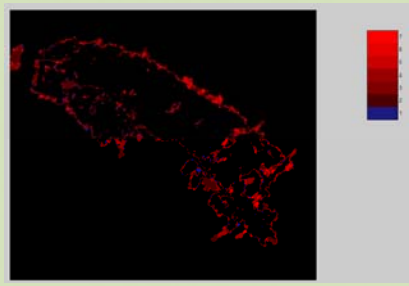
Along with the minor changes and pressures indicated in the test area due to harvesting and other human interventions, the developed algorithms successfully captured fire incidents that have been historically confirmed.

Uncertainty reduction of classification

There is no secure way to evaluate the classification accuracy by conventional validation point assessment. Moreover, common change detection is accomplished through subtractions of multi-temporal classification maps and thus inherits classification errors. In order to improve accuracy in classification, we take advantage of temporal continuity of the images. We algorithmically detect areas that exhibit a random behavior through time and oscillate between classification classes. In other words when areas appear and disappear in an erratic fashion, then these areas are suspect of classification errors.

E.g. for the *Abies cephalonica* class, pixel groups are monitored through time. When changes occur repeatedly they are suspect of error (red circles).

A final uncertainty map is automatically generated showing no (black) to large (light red) error possibility while blue regions are confidently indicative of true land use change.



Results shown a significant rise in classification accuracy based on validation sites.

Conclusions

Overall, the results have shown that the use of the suggested procedures contributed to the reduction of the classification uncertainty and supported the existing knowledge regarding the pressure among land-use changes.

Moreover, by revealing areas that are susceptible to misclassification, we may propose specific target site selection for training during the process of supervised classification.