REMOTE SENSING IN CIVIL ENGINEERING ISSUES

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ABSTRACT

The rapid technological advances in the scientific area of Remote Sensing have attracted the interest of several sciences, including civil engineering, regarding the basic principles, methods and applications that may offer a rich source of information valuable to a wide range of issues.
Regarding civil engineering science, Remote Sensing may offer a wide area of applications covering the main fields of interest of a civil engineer as: regional planning and urban development, water resources and hydrological models, site investigations (recording changes or movements etc.), study of natural hazards and environmental issues (landslides-floods-earthquakes), road alignment studies, land cover/land use studies, monitoring of monuments and historical centers, etc.
In particular for the specific research, a suitable study area was selected and the appropriate satellite data were collected. As a next step, an investigation of various methods of digital processing of satellite images was done (enhancement, fusion, classification) and the results were evaluated statistically, as well as in combination with visual image interpretation. A critical consideration of the pixel-level fusion methods was done and a selection of methods for the specific study area followed. Additionally, classifications of the original image and the image resulted from the selected fusion method (pansharpened image) delineated land cover. The classification images were also evaluated both by visual interpretation and statistically (classification accuracy). As a further step, the surface temperature of a part of the study area was estimated using thermal spectral regions of two different time periods. Changes in surface temperature were also estimated through classifications at intervals corresponding to a selected range of representative temperatures. The contribution of visual image interpretation was essential to study also changes through time.

INTRODUCTION-OBJECTIVE

The constant evolvement of the scientific area of Remote Sensing due to the fast technological developments, the wide range of applications that are offered combined with the large amount of data that can be acquired in a high frequency, as well as the fact that remote sensing is a relatively 'new' science for Greek engineering community that is not used widely yet for studying civil engineering issues, were the main factors that triggered the idea to explore the possibilities of the above framework and its connection with civil engineering science.

Fig 1. Study area in the north western part of Greece

Study area is located in medium-high altitude (630m) in the north western part of Greece, region of Western Macedonia (Figure 1) and concerns the surroundings of the Lake of Kastoria (Lake Orestiada).

METHODS

Different color composites were synthesized and image enhancement techniques were applied (decorrelation stretch & histogram equalization) to make imagery more interpretable (Figures 2-4). The rich spectral context of the multispectral image is combined with the high spatial resolution of the panchromatic image, applying image fusion-pansharpening (Ehlers fusion technique), facilitating in this way visual image interpretation to delineate land cover. Further processing concerns supervised classification of the original image and the image resulted from the selected fusion method (Figures 5-8). The evaluation of the pansharpened image was done using visual analysis and statistical measures. The fused image can be photointerpreted easier than the original and preservation of spectral characteristics of the multispectral image makes it suitable for image classification as classification accuracy indicates in Table 1. Along with visual image interpretation of changes through time in the study area, surface temperature and changes in surface temperature were also estimated using thermal spectral regions of two different time periods and generating classifications at intervals corresponding to a selected range of representative temperatures (Figures 9-12). Satellite data that were used (path:185, row:32):

- Landsat 8 multispectral & panchromatic imageries (acquisition date: 2014-03-14), resolution 30 m (Bands 1-7,9), 15 m (Band 8-panchromatic)
- Landsat 5 TM multispectral & thermal image data of two time periods (acquisition dates: 1987-09-12 & 2011-09-14), resolution 30 m reflective, 120 m thermal

RESULTS

Fig 2. Landsat 8 true color composite (4,3,2)

1. city of Kastoria
2. villages
3. drainage network
4. road network
5. road under construction
6. quarry
7. cultivated land
8. mountains

Fig 3. Landsat 8 false color composite (5,4,3)

Fig 4. Landsat 8 after decorrelation stretch & histogram equalization

Fig 5. Landsat 8 true color composite subset

Fig 6. Pansharpened image of the study area

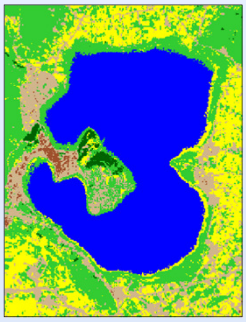
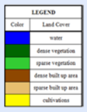


Fig 7. Multispectral image classification

Table 1

Overall Classification Accuracy	
Fig. 8	91.11%
Fig. 7	84.44%



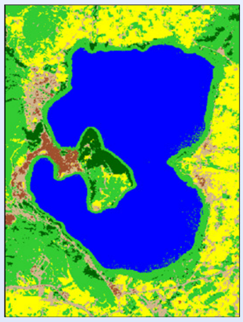


Fig 8. Pansharpened image classification

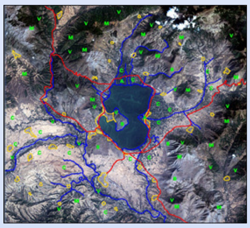


Fig 9. Landsat 5 true color composite & interpretation (1987)

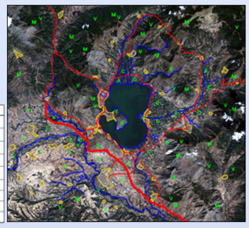


Fig 10. Landsat 5 true color composite & interpretation (2011)

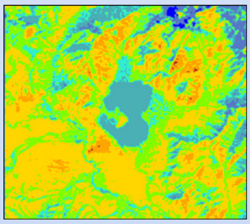
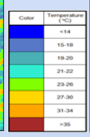


Fig 11. Classified LST image of 1987



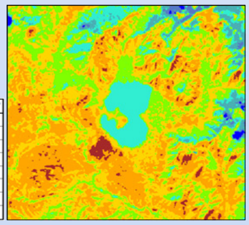


Fig 12. Classified LST image of 2011

DISCUSSION-CONCLUSIONS

Remote sensing techniques have proven to be powerful tools for Earth's surface observation on a global, regional, and even local scale, by providing important coverage, mapping and classification of land cover features, building footprints and monitoring abilities. Land cover information contributes significantly to the study of urban and regional planning, hydrological modelling, study of hazards, transportation planning, road construction and other issues that are related to civil engineering. Multispectral image interpretation in combination with digital processing of satellite images acquired at the same or at different time periods can be used for monitoring and development issues, as well as change detection issues.

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