PIMS

**Multispectral Image Processing Tool
for Semantic Information Detection
Based on Vegetation Indices**

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Overview

- PIMS Project description

- Vegetation indices computation

- Implementation

- Experiments

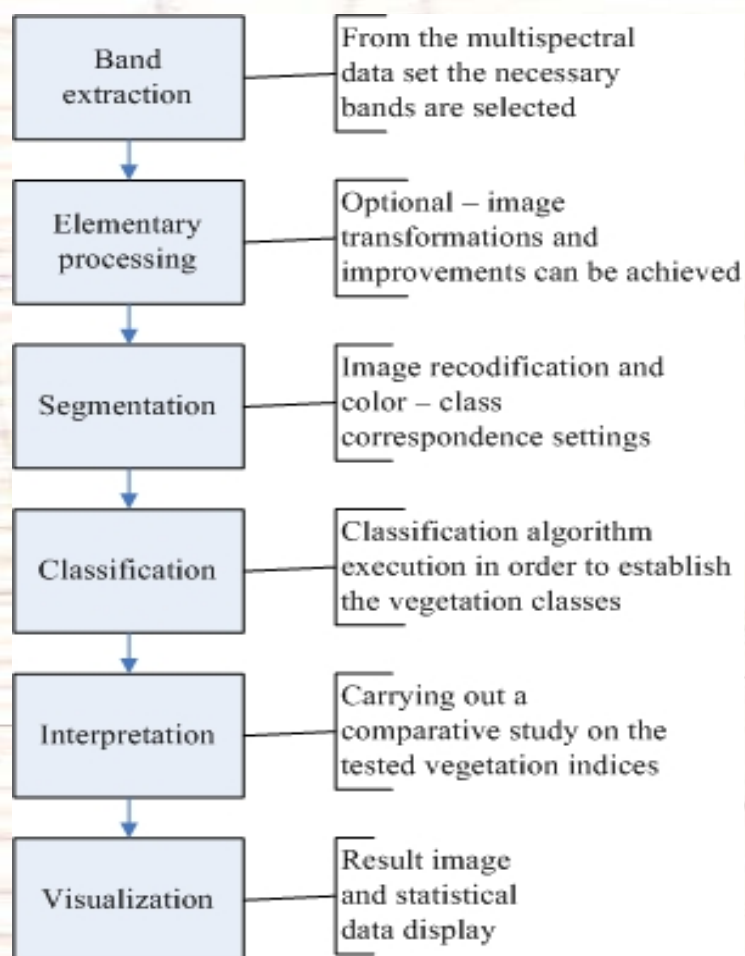- Conclusion and future works

PIMS Project description

- PIMS Project – Multispectral Image Processing Tool for Semantic Information Detection Based on Vegetation Indices

- Subject:

    uses the medium and high spatial resolution satellite images to study the extent and structure of the vegetation cover for a certain geographic area

- Approach:

    - Computes vegetation indices by processing multispectral satellite images
    - Classifies vegetation based on vegetation indices
    - Statistical analysis
    - Updates geodatabase

PIMS Project description

- Classifies vegetation based on vegetation indices
    - DVI – difference vegetation index
    - RVI – ratio vegetation index
    - NDVI – normalized difference vegetation index
    - SNDVI – scaled vegetation index
    - TVI – transformed vegetation index
    - IPVI – infrared percentage vegetation index
    - OSAVI – optimized soil adjusted vegetation index
    - GEMI – global environmental monitoring index

PIMS' block diagram

Block	Description
Band extraction	From the multispectral data set the necessary bands are selected
Elementary processing	Optional – image transformations and improvements can be achieved
Segmentation	Image recodification and color – class correspondence settings
Classification	Classification algorithm execution in order to establish the vegetation classes
Interpretation	Carrying out a comparative study on the tested vegetation indices
Visualization	Result image and statistical data display

Vegetation indices oriented processing

PIMS' implemented methods

- CDibView::OnImaginisatelitareNir() extracts the fourth band's pixel matrix (near infrared) and displays the corresponding image on screen.
- CDibView::OnImaginisatelitareDVi() calculates the vegetation diference index
- CDibView::OnImaginisatelitareTvi() calculates the transformed vegetation index
- CDibView::OnImaginisatelitareRvi() calculates the ratio vegetation index
- CDibView::OnImaginisatelitareNdvi() calculates the normalized difference vegetation index
- CDibView::OnImaginisatelitareNdviscalat() calculates the scaled normalized difference vegetation index
- CDibView::OnImaginisatelitareGemi() calculates the global environmental monitoring index
- CDibView::OnImaginisatelitareIpvi() calculates the infrared percentage vegetation index
- CDibView::OnImaginisatelitareOsavi() calculates the optimized soil adjusted vegetation index

Vegetation indices – Experiments

Tests on a multispectral image of Cluj-Napoca's west side, Romania

"False color" image
(bands 1,2,3)

Vegetation indices – Experiments
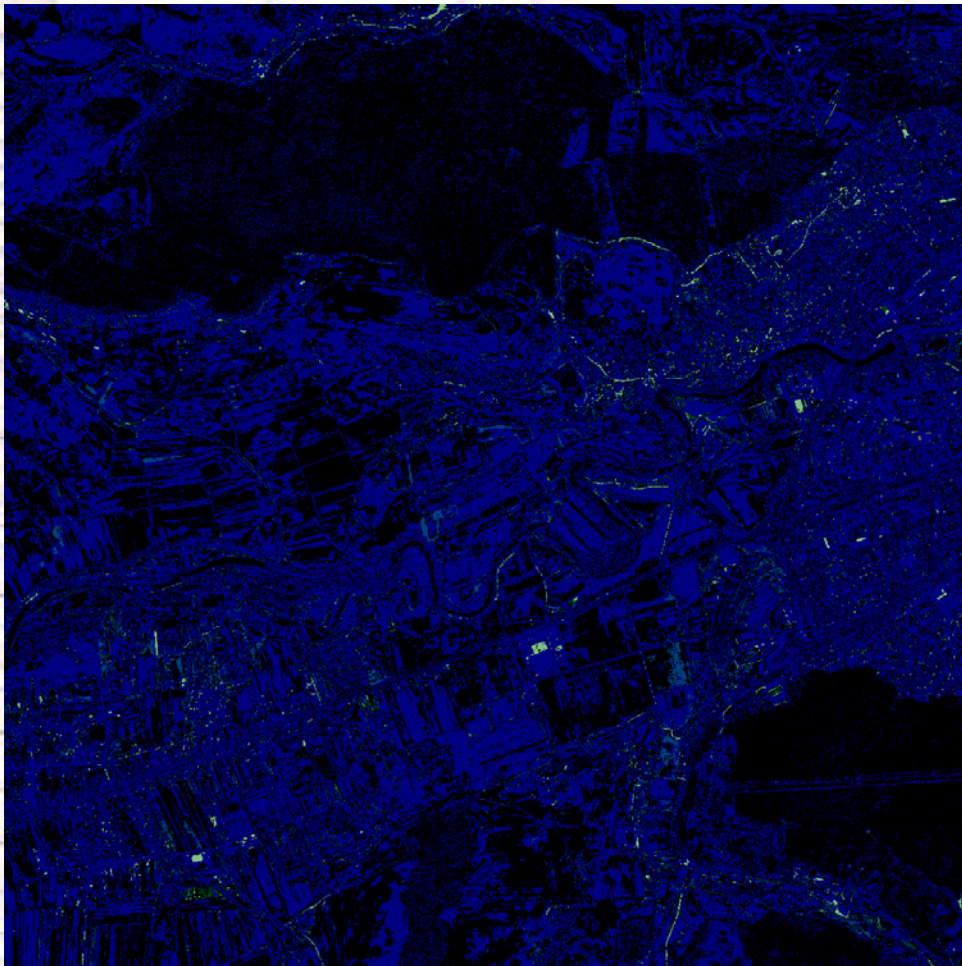
DVI (difference vegetation index) based classification algorithm

$$DVI = NIR - Red$$

• Classification based on DVI is made by subtracting band three from band four, i.e. NIR-Red.

• This results in a highly segmented image, with gross errors in the separation of classes, which is ineffective in establishing and interpreting vegetation classes.

Vegetation indices – Experiments
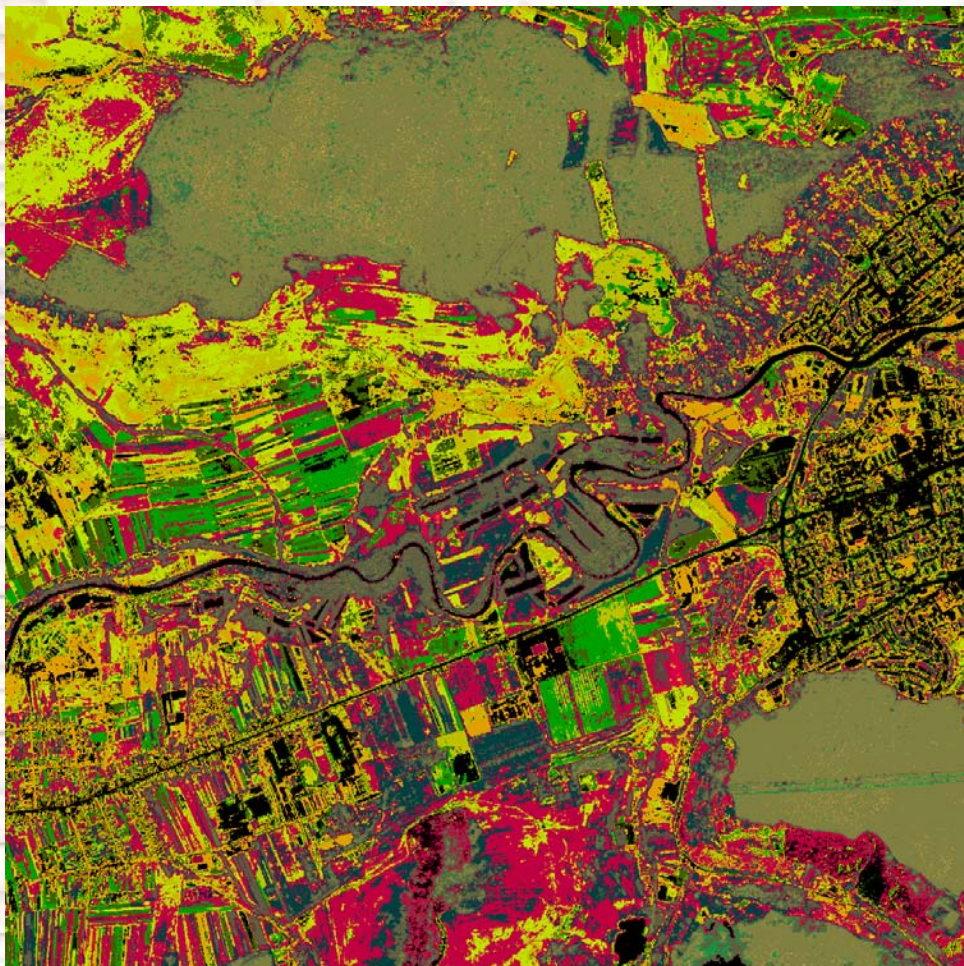
TVI (transformed vegetation index) based classification algorithm

$$TVI = (NDVI + 0.5)^{1/2}$$

- The algorithm based on TVI allows a refinement of DVI, but the detected classes cannot yet be considered effective in detecting vegetation.

- TVI poorly differentiates the vegetation types in the tested images.

Vegetation indices – Experiments
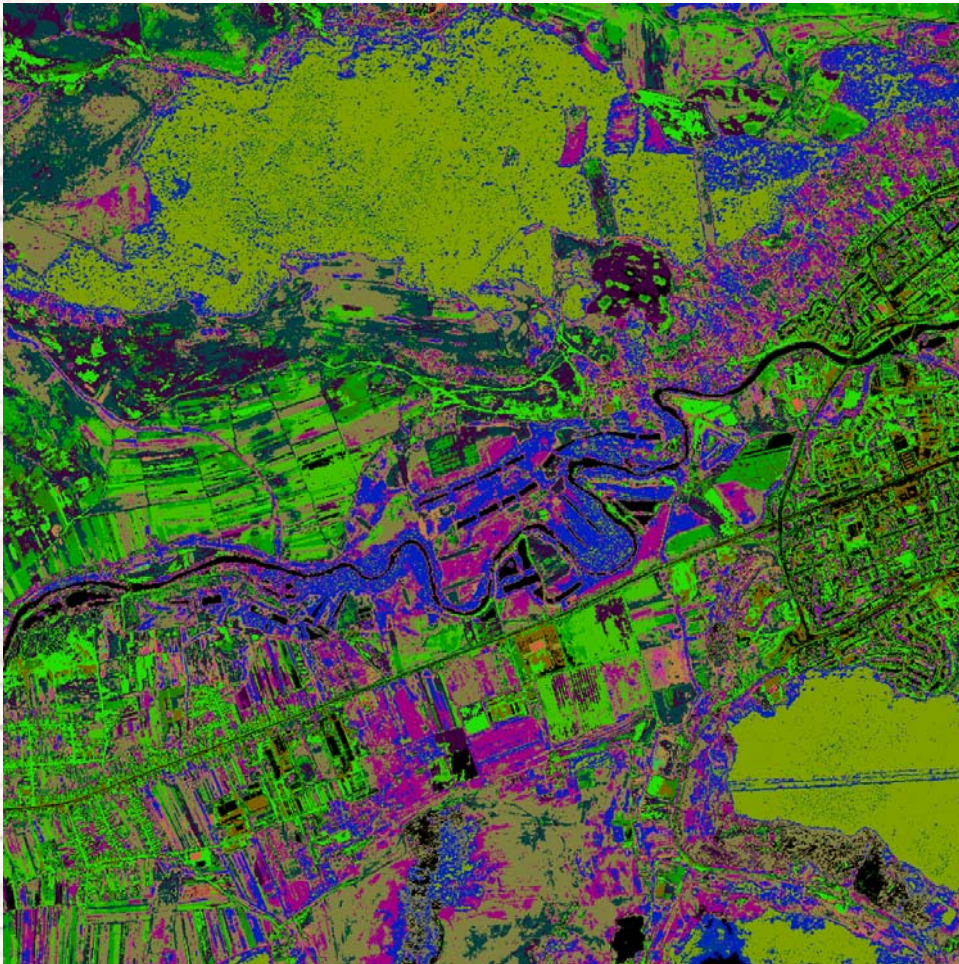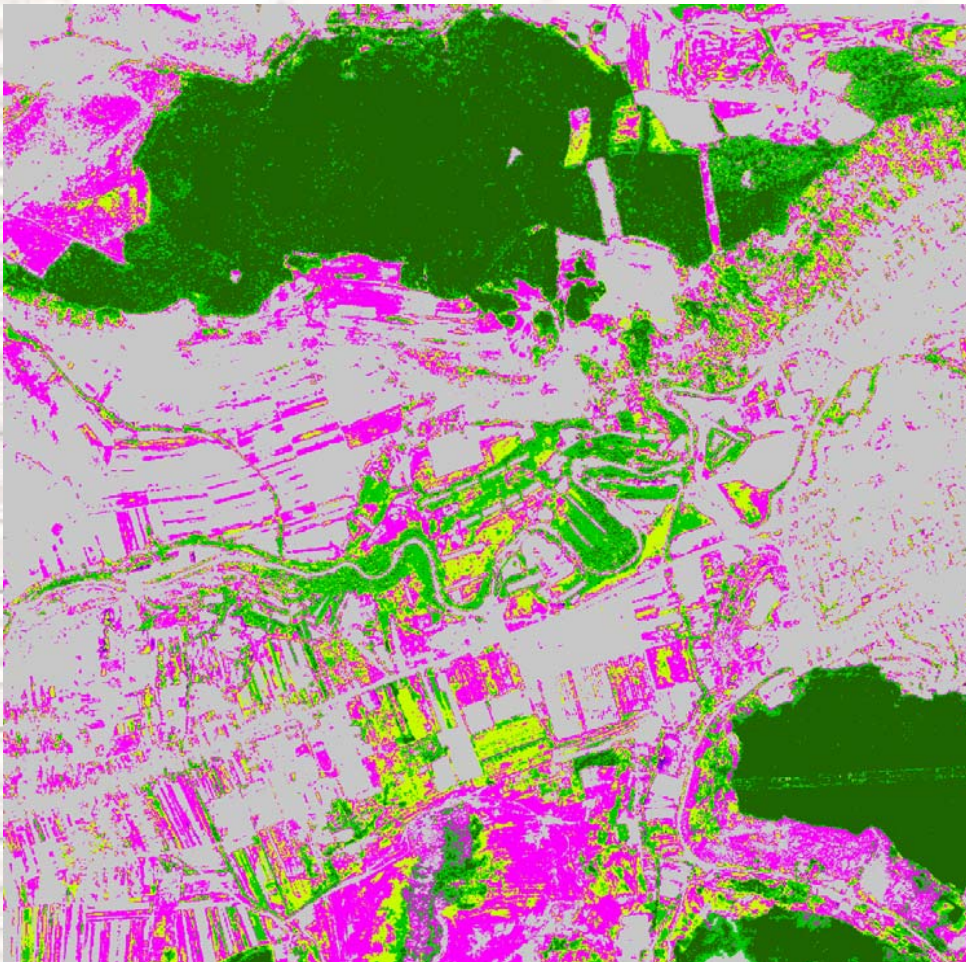

RVI (ratio vegetation index) based classification algorithm

$$RVI = NIR / Red$$

- The RVI classification algorithm calculates the ratio of bands four and three for each pixel in the image.

- By scaling, the values obtained are positive numbers (corresponding to color nuances), and the extremely wide range of values (0, 255) does not allow a rigorous segmentation.

Vegetation indices – Experiments

NDVI (normalized difference vegetation index)
based classification algorithm

$$NDVI = (NIR - Red)/(NIR + Red)$$

• Both RVI and NDVI measure the slope of the line between the origin of the red-NIR space and the red-NIR value of the image pixel.

• The only difference between RVI and NDVI consists of the values of the two indices.

• The values from -1.0 to 1.0 for NDVI are easier to use than the infinite RVI values.

• NDVI can also be considered as an improvement of RVI that eliminates the effects of red-NIR reflectance in the broad band by normalization.

Vegetation indices – Experiments
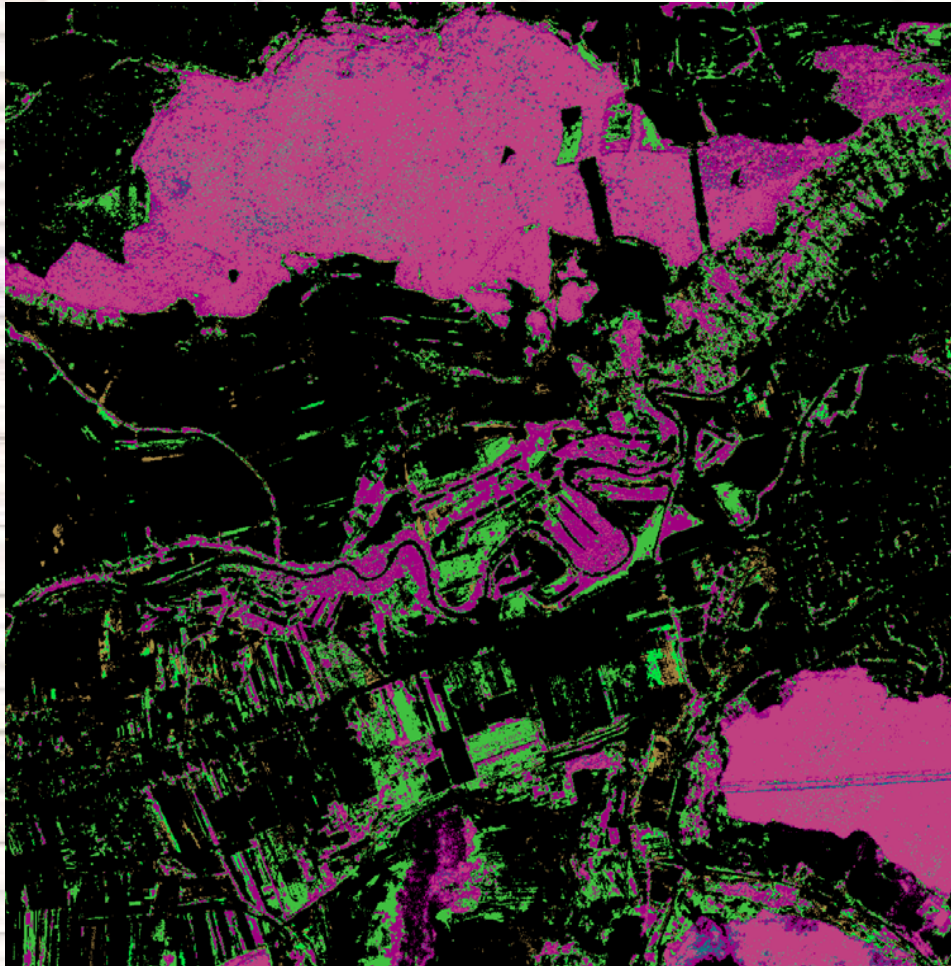
SNDVI (scaled vegetation index) based classification algorithm

$$SNDVI = 100*(NDVI + 1)$$

• By scaling of the results obtained by the NDVI classification algorithm, correspondences are obtained in the color spectrum for each detected class of vegetation.

• As in the case of any algorithm based on scaled indices, Scaled NDVI allows to obtain more vegetation classes than NDVI, but without a good identification of each class.

• Vegetation areas are treated equally by this algorithm, which does not differentiate water, desert, cement or other non-vegetation areas.

Vegetation indices – Experiments

GEMI (global environmental monitoring index) based classification algorithm

$$GEMI = \eta*(1-0.25*\eta)-(Red-0.125)/(1-Red)$$

Where,

$$\eta = [2*(NIR - Red)+1.5*NIR+0.5*Red]/(nir+red+0.5)$$

• Following the application of the GEMI classification algorithm, the global environmental monitoring index was shown to be extremely sensitive to soil noise therefore its performance in the study of areas covered with low vegetation is drastically reduced.

• This algorithm has the advantage of allowing a better segmentation of non-vegetation areas compared to NDVI.

• Still GEMI is not sufficiently accurate in segmenting vegetation areas.

Vegetation indices – Experiments
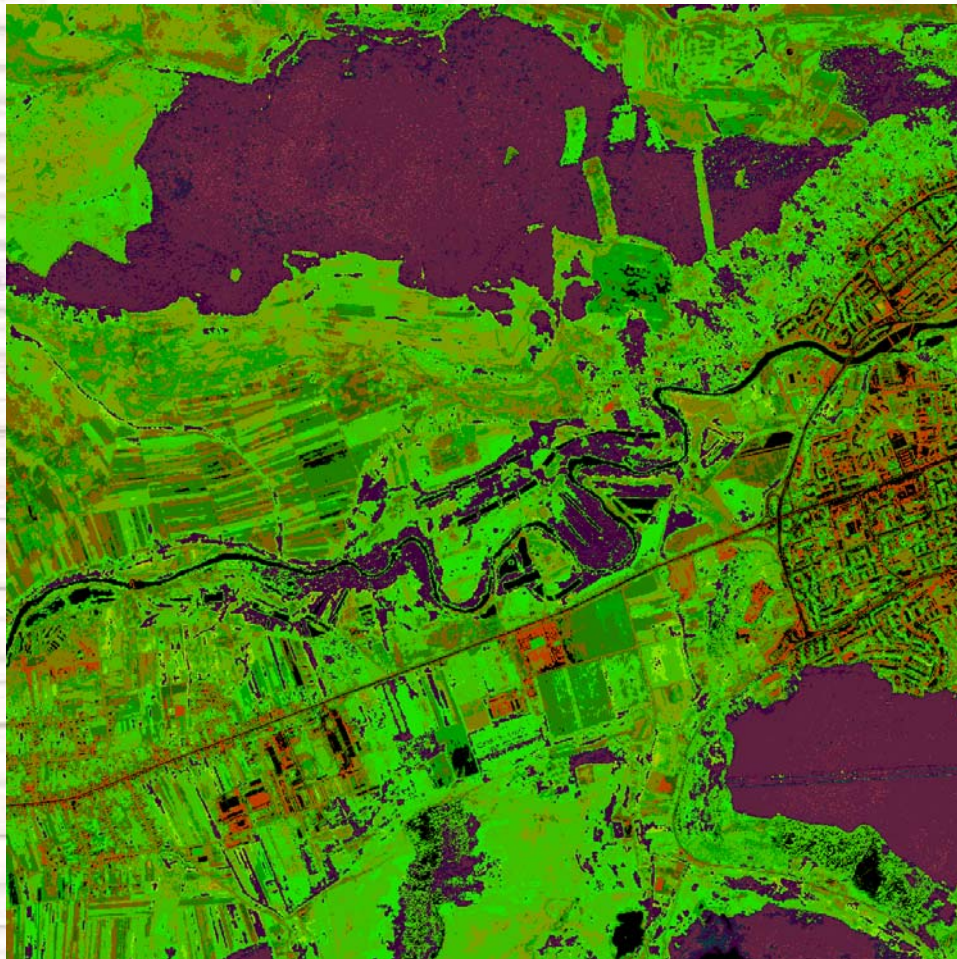
IPVI based classification algorithm

$$IPVI = NIR / (NIR+Red)$$

• The classification algorithm based on IPVI demonstrates that the red radiation subtraction in the numerator of NDVI is irrelevant.

• IPVI is functionally equivalent to NDVI and RVI, but its values only range between 0.0-1.0.

• It also eliminates one mathematical operation per image pixel, which is important for the rapid processing of a large number of data.

•In addition, IPVI has the advantages of GEMI in the segmentation of non-vegetation areas.

Vegetation indices – Experiments
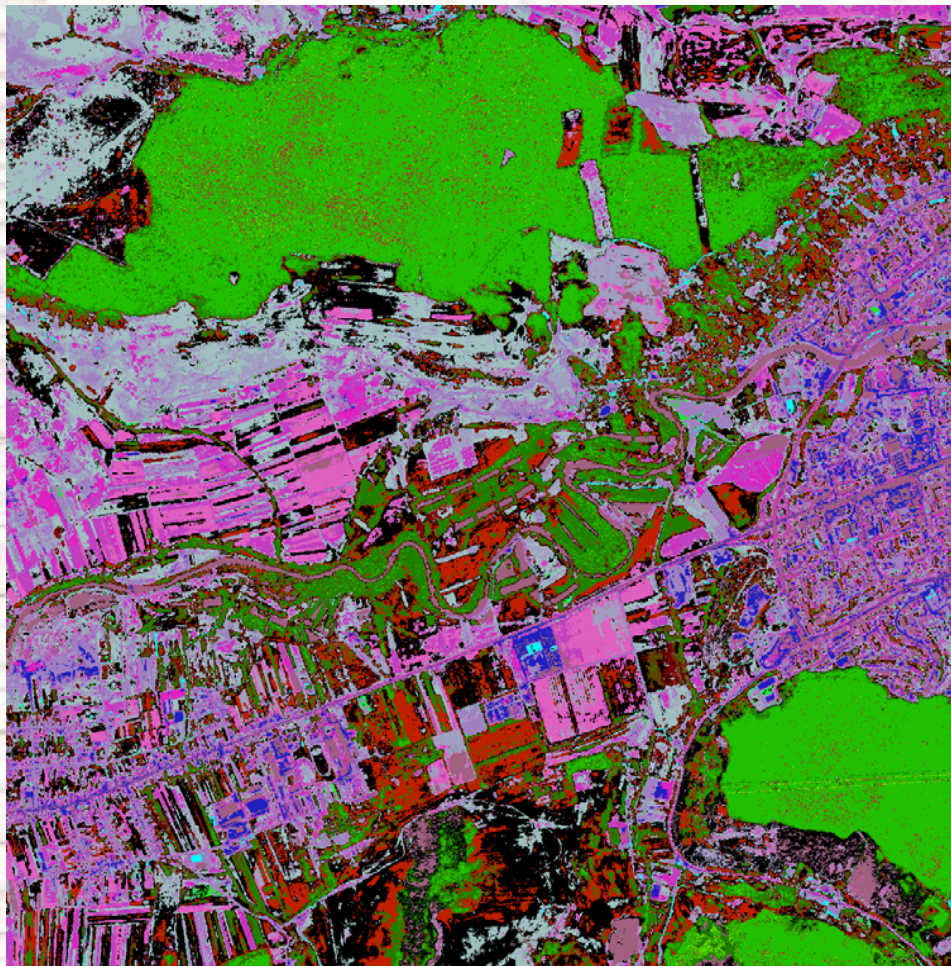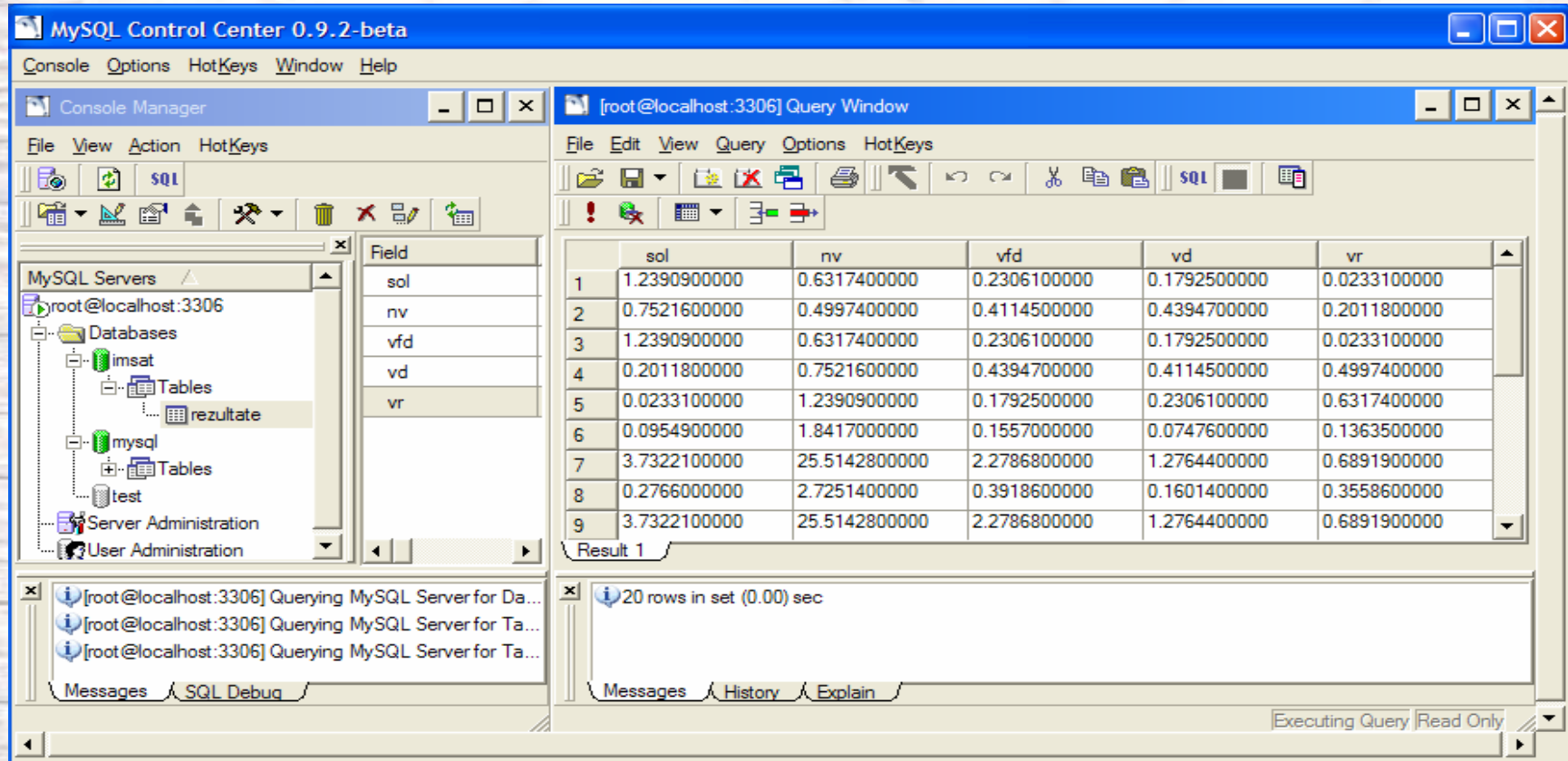
OSAVI
based classification algorithm

$$OSAVI = (NIR - Red) / (NIR + Red + 0.16)$$

- The algorithm based on OSAVI is superior to the previous indices, the adjustment of vegetation to soil allowing to significantly eliminate sensitivity to soil.

- OSAVI refines the previous algorithms, obtaining a very good segmentation in the case of all tested images.

GeoDatabase

Conclusions

- The slightly differentiated work techniques used aimed to show certain characteristics of vegetation and, at the same time, to define the most adequate of these in the extraction and processing of information. The results obtained confirmed the accuracy of the work hypotheses and the possibilities of using satellite images.

- The tests were performed on approximately 40 Landsat, Spot, Ikonos and QuickBird images (different areas of the globe).

- The results obtained can be immediately applicable to both scientific research and the monitoring of ecosystems and the development of vegetation areas, especially of forests.

- The importance of such concerns is completely justified and attractive, considering the dynamics in the evolution of more effective records that could hardly be imagined a decade ago.

Future works

PIMS can take the following directions of development:

- integration of the decodification of scientific satellite image formats in the application, mainly HDF;

- obtaining of information on vegetation health;

- complete georeferencing;

- PIMS' integration in existing GeoDatabase structures;

- populating the Imsat database with satellite images from Romania and their corresponding metadata.

Thanks

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