European Union Network for the Implementation and Enforcement of Environmental Law

Project WODA: Water Over Abstraction & Illegal Abstraction Detection and Assessment

Pilot Feasibility Study Romania

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Document change log

Version	*Date*	*Comments*
1.0	08/03/16	D. Bellingeri: draw up

Summary

1 Introduction

This document describes the Pilot Feasibility Study related to Romania, in the framework of WODA project (Water Over-abstraction and illegal abstraction Detection and Assessment).

1.1 General context

1.1.1 General information about Water Management in Romania

The National Administration "Romanian Waters" is the single operator for surface water resources, natural or artificial, regardless of the holder, and for groundwater resources, regardless of their nature and related facilities.

Romanian Waters National Administration applies national strategy and policy in the field of quantitative and qualitative management of water resources, (acting for the purposes of knowledge about water resources, conservation, rational use and protection of water resources from depletion and degradation to ensure sustainable development, preventing the destructive effects of water, ecological reconstruction of water courses, providing hydrological and hydro geological supervision, implementation of legislation harmonized with EU directives in the field of sustainable management and conservation of aquatic ecosystems and wetlands.)

Water quality in Romania is monitored according to the structure and methodological principles of Integrated Monitoring System in Romania (SMIAR) in accordance with the requirements of the European Directives.

National water monitoring system comprises two types of monitoring as required by the Framework Directive 60/2000/EEC in the field of water. This creates a surveillance monitoring serving to assess the condition of all water bodies in the watershed and operational monitoring for water bodies that risk failing to meet water protection objectives (integrated in the surveillance monitoring).

The Romanian Basin Water Management Plan forms the qualitative management of water resources. It aims for the measures, actions, solutions and works to achieve and maintain environmental objectives, identification of significant anthropogenic pressures and the impact of human activities on the status of surface water and groundwater, reducing negative effects of anthropogenic pressures and reducing pollution.

1.1.2 Water issues in Romania - Bihor County

- Surface waters:

Organic pollution mainly caused by the direct or indirect emission of partially treated or untreated wastewater from agglomerations, industry and agriculture causes significant changes in the oxygen balance of surface waters and as a consequence impacts upon the composition of aquatic species/populations and therefore water status.

Nutrient pollution – particularly by nitrogen and phosphorus - can cause eutrophication of surface waters and contribute to eutrophication in the Black Sea North-Western shelf.

Hazardous substances pollution can seriously damage riverine ecology and consequently impact upon water status and affect the health of the human population

Hydrological alterations impact the status of water bodies inter alia due to alterations (increase or reductions) of flow velocities and the flow regime or alterations in quantity and flow dynamics of rivers. Water abstractions: Abstractions of water can alter the quantity and flow dynamics of rivers and therefore negatively impact water status.

- Groundwater

Groundwater is the major source of drinking water in the region and is often connected with the adjacent terrestrial ecosystems, therefore the demand on its quality is high. Pollution by nitrogen compounds (especially nitrates) from diffuse sources is the key factor affecting the chemical status of groundwater bodies in the Basin. The major sources of this diffuse pollution are the agricultural activities, non-sewered population and urban land use.

Alterations of groundwater quantity - groundwater is subject to other uses such as industry, agriculture, spa and geothermal energy. Groundwater quantity in the Basin is affected by groundwater abstraction for these uses. Furthermore, groundwater dependent terrestrial and associated aquatic ecosystems not only depend on groundwater quality but also on groundwater quantity. Therefore, groundwater use has to be appropriately balanced and should not exceed the available groundwater resource.

2 Objectives and contents of the feasibility study

The key aspects emerging from the WODA Questionnaire, and from the context analysis, taken into account in order to orientate the feasibility study, were the following:

- The area is characterized by continental climate
- Average precipitations is 841 mm/yc
- Very low irrigated surface percentage (0.04 % of the total surface dedicated to agriculture)
- From the pedological point of view, Bihor County is characterized by soils with very high potential productivity
- In Bihor County the irrigated area are very few, basically due to damage and the clogging of irrigation canals, as well as deterioration or lack pumping equipment

This particular situation causes strong differences between actual and potential irrigation requirements in the area.

The main focus of the feasibility study is on water uses in agriculture, and about the use of multitemporal optical EO data, primarily in order to derive crop maps, and for the monitoring of potentially irrigated parcels.

The essential steps followed were:

- Multitemporal Landsat8 data selection and analysis
- Simplified crop map classification
- Detection of potentially irrigated parcels

In the second part of the feasibility study, further qualitative focuses were made about water permits for specific agricultural land use (greenhouses).

2.1 Test area definition

The overall test area is Bihor County in Romania, and particularly in the Marghita area.

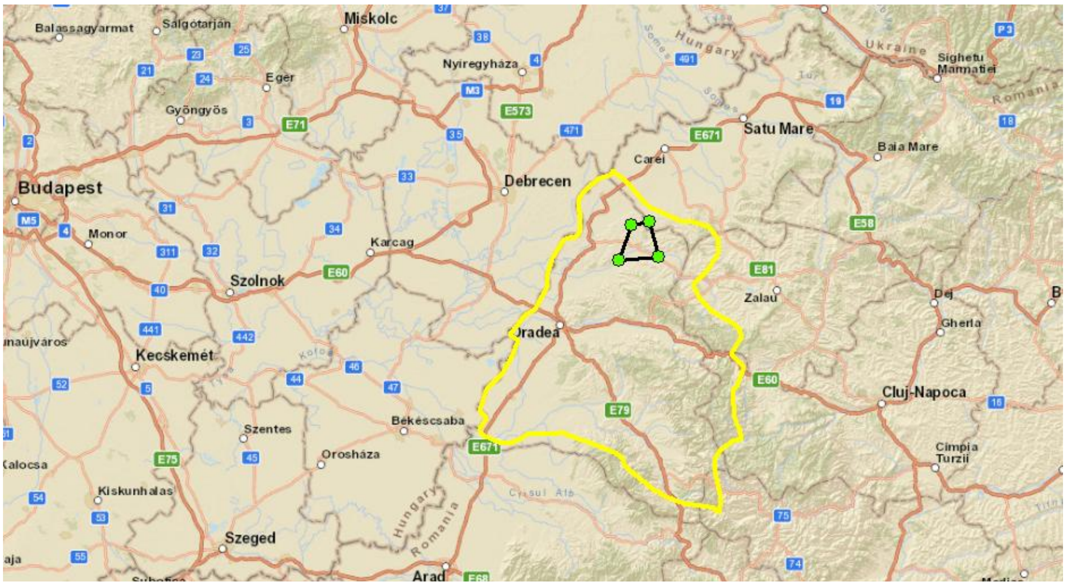

Figure 1: Bihor County, Romania (yellow polygon), and location of Marghita test area (black)

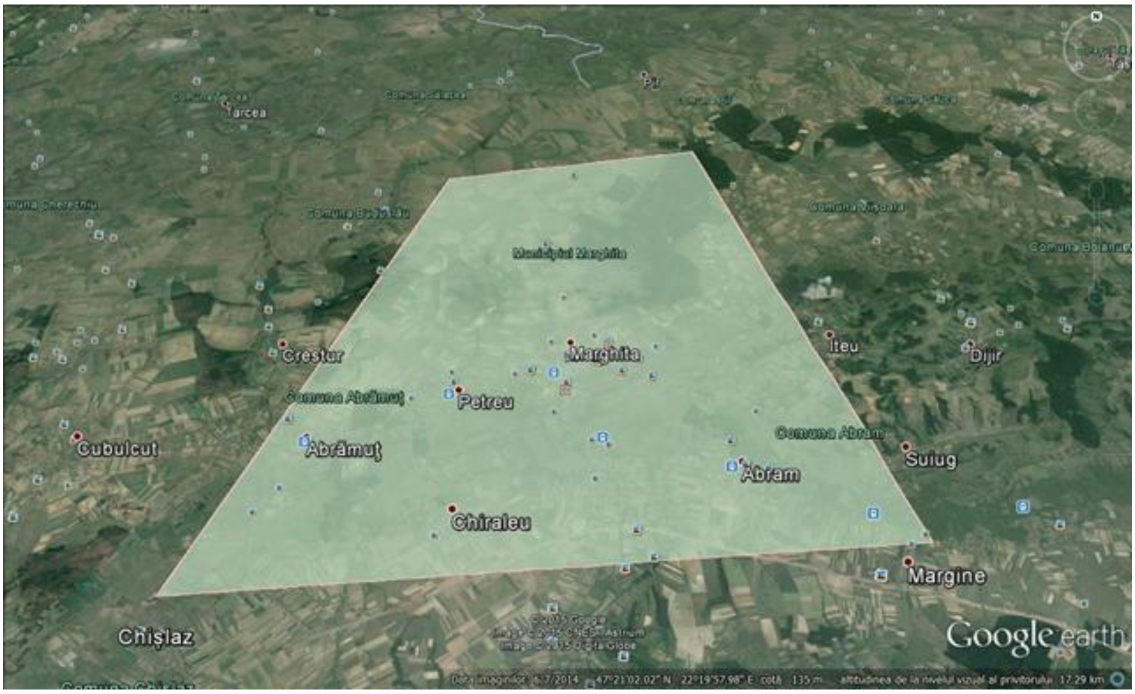

Figure 2: Focus on Marghita test area, Bihor County, Romania

2.2 Auxiliary data availability

2.2.1 Water permits

The total known amounts of permitted water in the test area are:

- 0,06 thousands m^3 /year for administrative headquarters
- 1908,59 thousands m^3 /year for Marghita municipality water supply
- 65,80 thousands m^3/year for agricultural use (irrigation)

In the test area there is a total of 17 water permits (some with multiple abstraction points), and some known but non-authorized abstraction points.

Water abstraction points in the test area are for the following multiple uses:

- Geothermal water abstraction
- Civil use
- Oil industry
- Car was activities
- Agriculture (1)
- Fishery ponds
- Concrete manifacturing
- IPPC (pig farming)
- Wood processing

Most of the abstraction points are situated in the deeper aquifer.

In Bihor County the irrigated areas are very few, due to damage and the clogging of irrigation canals, as well as deterioration or lack pumping equipment.

2.2.2 Landuse maps, agricultural parcels

Unfortunately, no local land use maps were available; for basic applications, the European CORINE LandCover database was exploited in this feasibility study.

Moreover, no agricultural parcels in the test area were available.

2.2.3 Pedology and crop statistics

Bihor County is generally characterized by soils with very high potential productivity (chernozems, brown soils, etc..), see Figure 3 for reference.

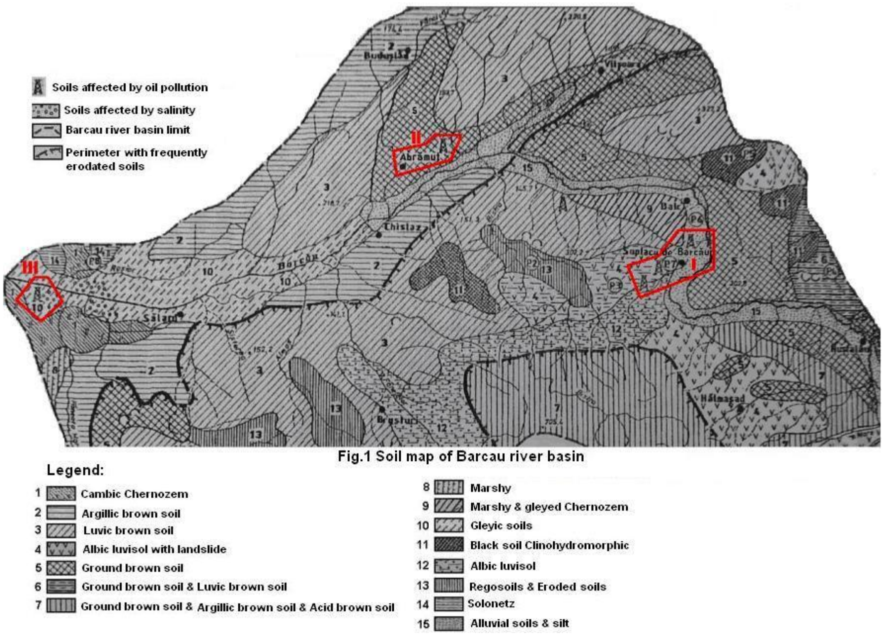

Figure 3: Extract of Pedological map for Bihor County

Main crop statistics for the test area were provided (see Figure 4).

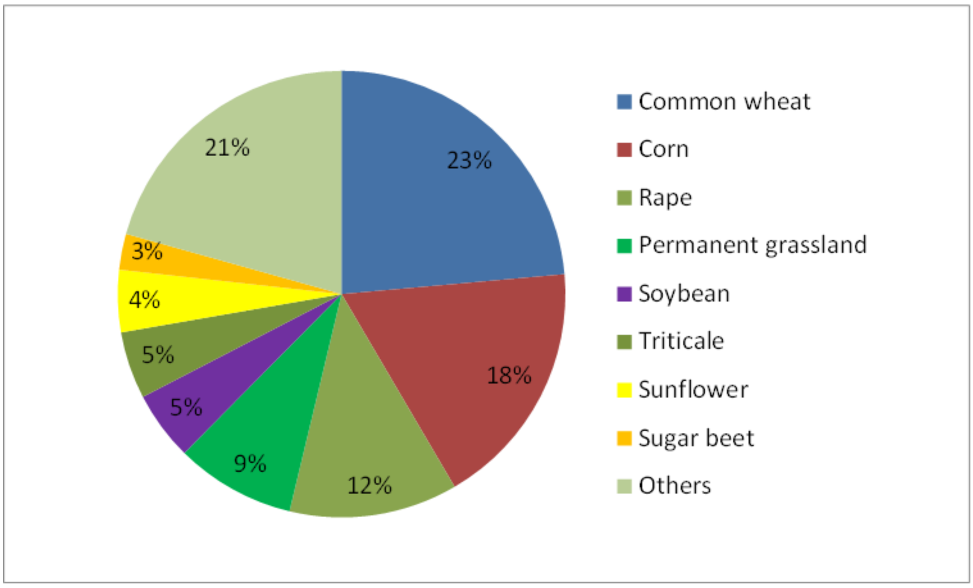

Figure 4: Basic statistic of crop type % in the test area.

The area is characterized by a wide type of crops, and by a significant percentage of potentially irrigated, and water demanding, crops (in particular in continental climates).

2.3 EO data – state of the art and data availability

The basic optical EO data used in this feasibility study are a multitemporal data set of Landsat8 data, referred to 2014 and 2015.

Bihor County is covered by 2 different scenes of the Landsat8 coverages, and in particular by the scene 186/027.

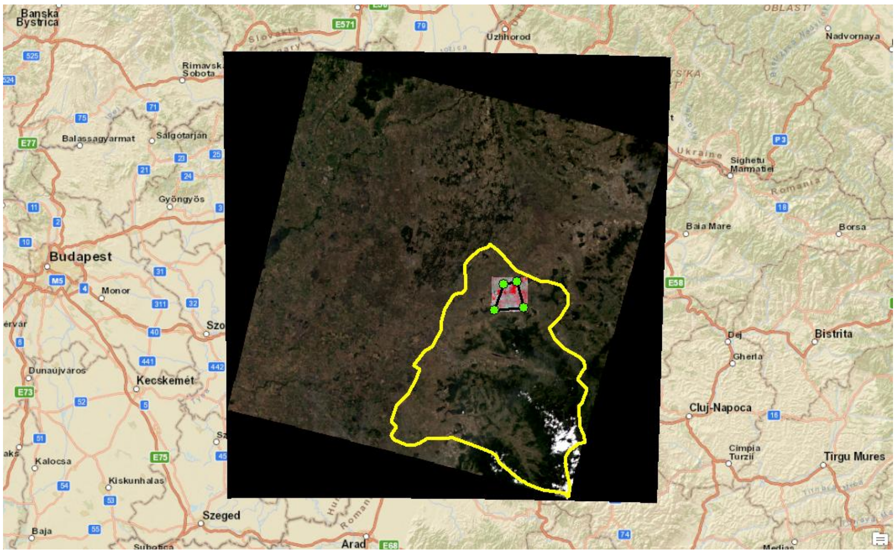

Figure 5: Landsat8 scene 186/027 coverage over Bihor County

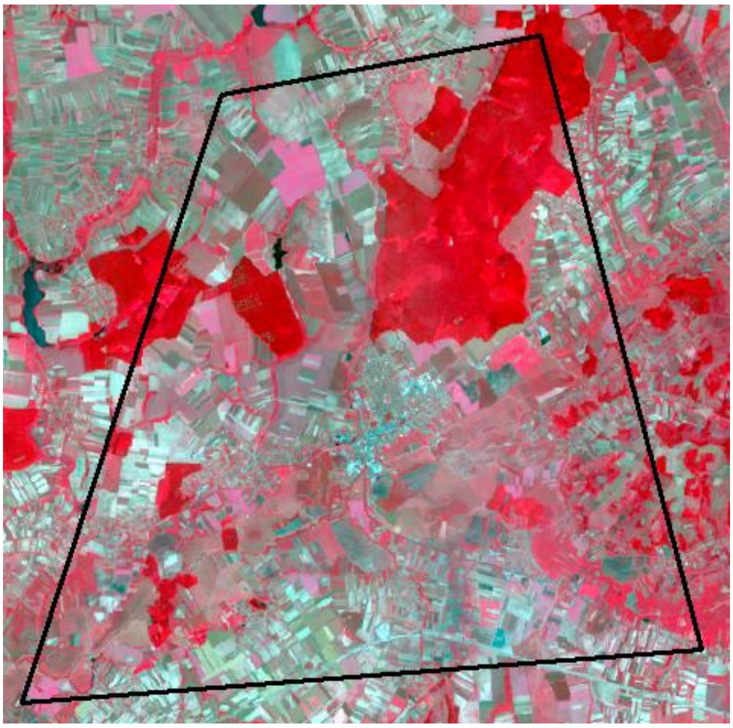

Figure 6: Focus of a Landsat8 image (6/6/2014) over Marghita test area - Infrared false color composite (IRFC)

The temporal resolution of Landsat8 data (frequency of acquisition over a single scene) is 16 days; cloud cover in the context of Romania is in general a strong limiting factor, and in 2014 and 2015 no more than 4-5 cloud free Landsat8 images were available in the most significant periods (at least enough to characterize the phenology of the main crops and detect the main crop types).

Otherwise, the spatial resolution of Landsat8 data (30x30 meters resolution) isn't in general a strong limiting factor, considering the average agricultural parcel size in Romania.

The future availability of Sentinel2 data (10x10 meters pixel size, at least 10 days of temporal resolution, wider scenes) will be for sure a strong improvement in monitoring capabilities.

3 EO data analysis

3.1 Crop maps classifications

The available Landsat8 multitemporal cloud free data over the test area for 2014 and 2015 were classified in order to derive simplified crop type maps.
Focusing for example for the 2014 case, 4 Landsat8 images were available in significant phenological periods (21 march, 6 june, 12 august, 29 september).
This multitemporal Landsat8 data set was used to derived multitemporal vegetation index (NDVI), and then used to classify the area defined in the CORINE Land Cover database as arable land, pastures or permanent crops.

The general concept and part of the processing is summarized in the following figures.

In Figure 7, for example, in a), b), c), d) the four multitemporal Landsat8 available data are visualized in IRFC false color composite, where red hues refer to vegetation (21/3, 6/6, 12/8, 29/9 respectively). In e), there is the plot of the temporal variation of NDVI over the four date for the a specific pixel (red dot). In this case, the high NDVI index all over the period, from march to september, is typical of pastures. This particular temporal path is exploited in order to classify all the pixel in the image with similar temporal behavior (visualized in green in f) window).

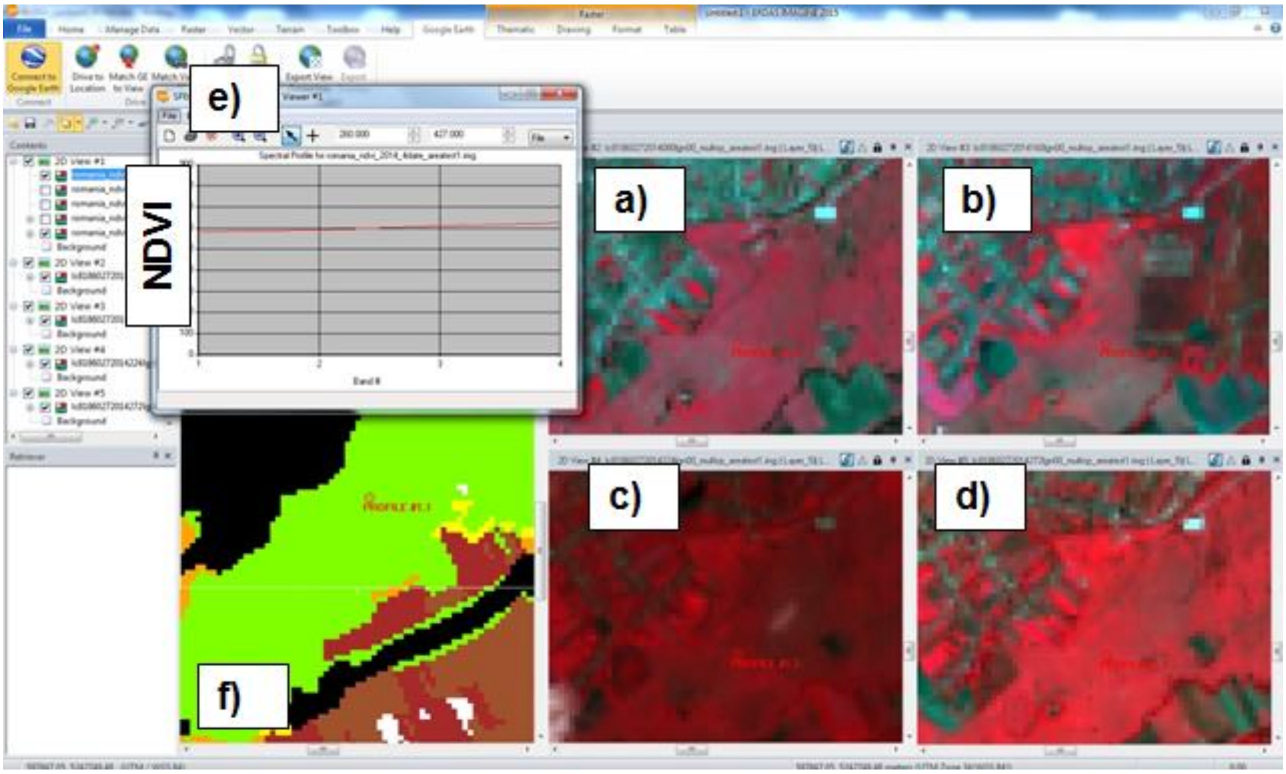

Figure 7: Landsat8 multitemporal data set analysis – pasture areas (see text for details).

Figure 8 is similar, but relative to a different crop type: as above, in a), b), c), d) the four multitemporal Landsat8 available data are visualized (21/3, 6/6, 12/8, 29/9 respectively). In e), there is the plot of the temporal variation of NDVI over the four date for the a specific pixel (red dot). In this case, the NDVI index is very high (vegetated) in march, lower in june and then very low (not vegetated) in august and september. This temporal path, typical of a winter crop, is exploited in order to classify all the pixel in the image with similar temporal behavior (visualized in orange in f) window).

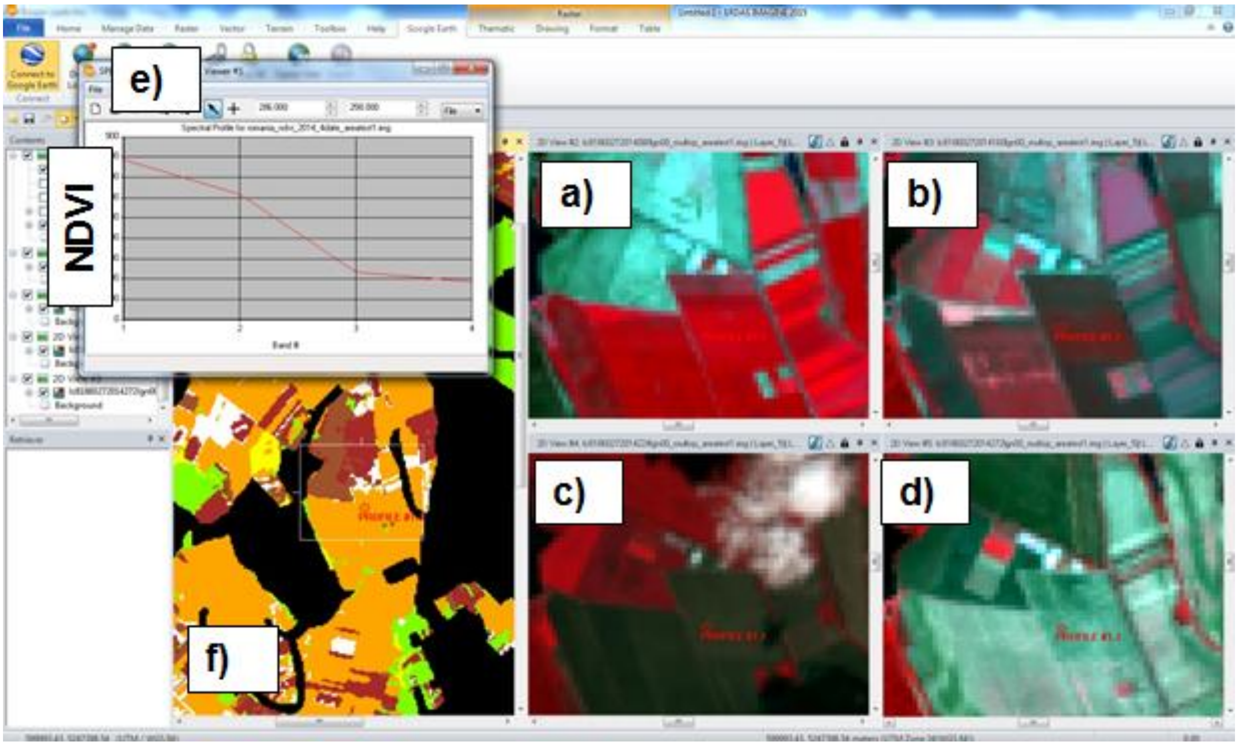

Figure 8: Landsat8 multitemporal data set analysis – winter crops areas (see text for details).

Figure 9 is similar, but relative to a different crop type: in this case, the NDVI index is very low (not vegetated) in march, then NDVI raises in june and in august (maximum of biomass) and then strongly decreases in september. This temporal NDVI path could be related to a summer crop, and is exploited in order to classify all the pixel in the image with similar temporal behavior (visualized in brown in f) window).

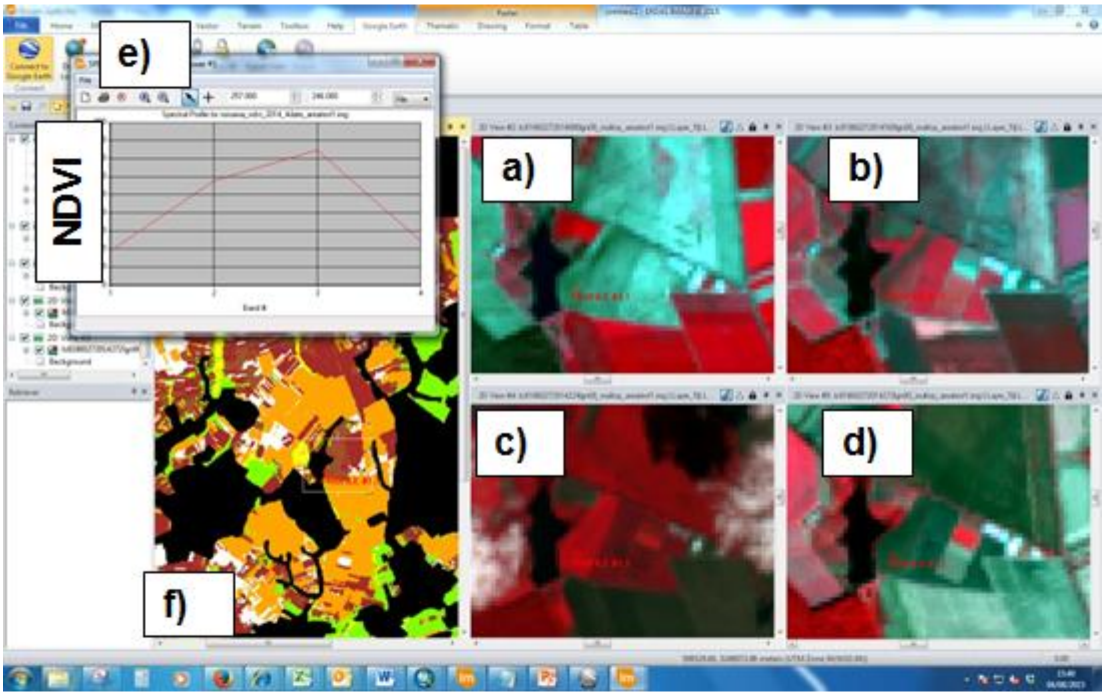

Figure 9: Landsat8 multitemporal data set analysis – summer crops (type A) (see text for details).

Also Figure 10 and Figure 11 are similar, but relative to different summer crop types (type B and type C): in both cases, the NDVI index is very low (not vegetated) in march, but there are differences in the duration of the vegetated period of the two summer crops. As above, these temporal NDVI paths are exploited in order to classify all the pixel in the image with similar temporal behaviors.

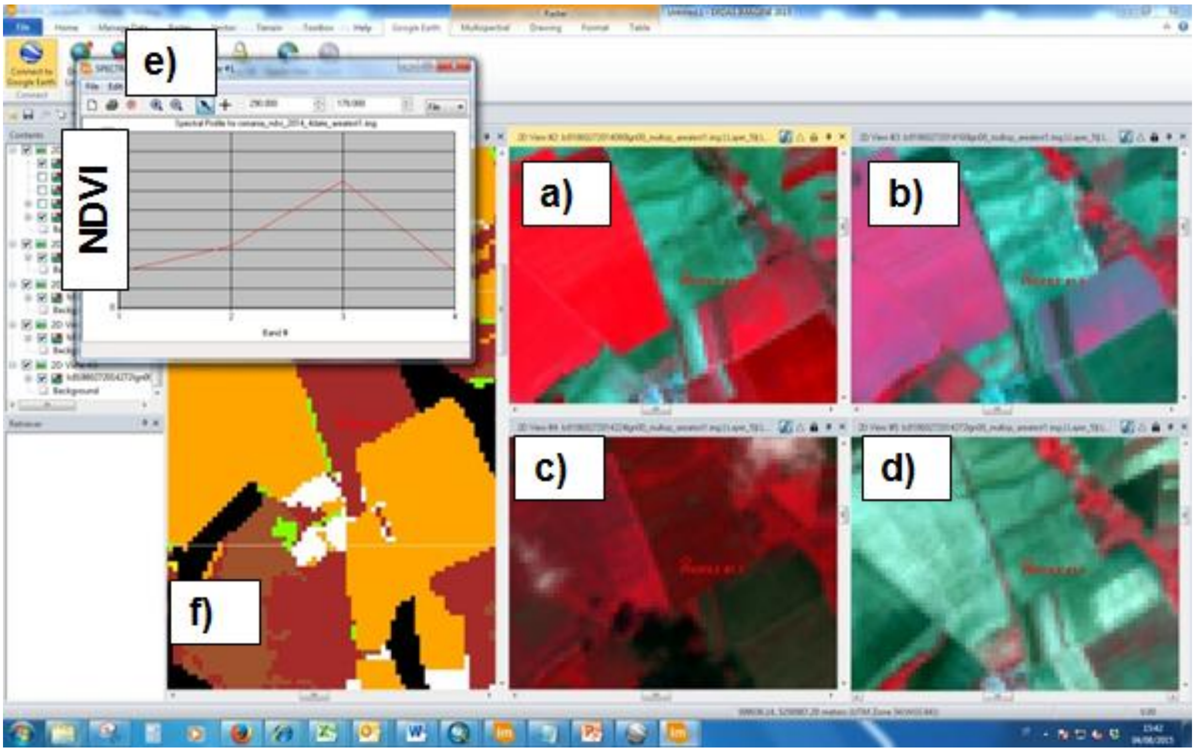

Figure 10: Landsat8 multitemporal data set analysis – summer crops (type B) (see text for details).

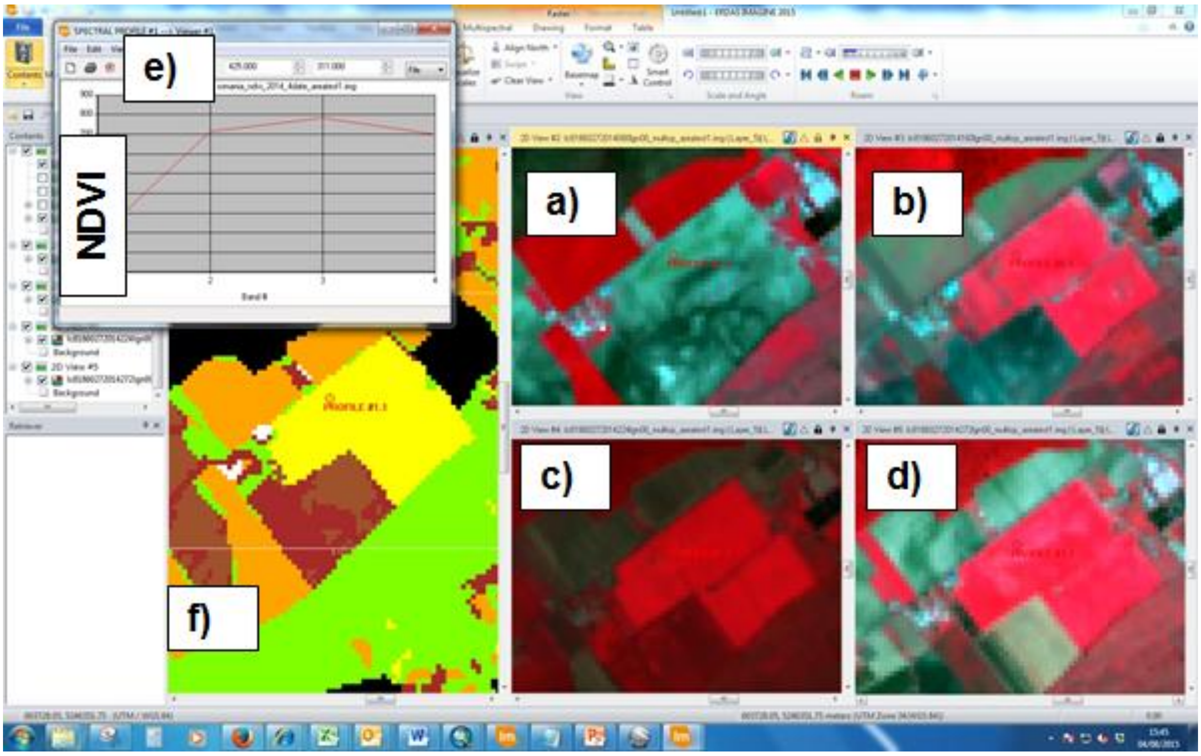

Figure 11: Landsat8 multitemporal data set analysis – summer crops (type C) (see text for details).

This type of basic crop classifications were performed automatically and without any ground truth available, so these are only preliminary classifications in order to characterize the main crops type and extract the potentially irrigated and water demanding crops.

The mean NDVI temporal paths of the different classified crop class area summarized in Figure 12.

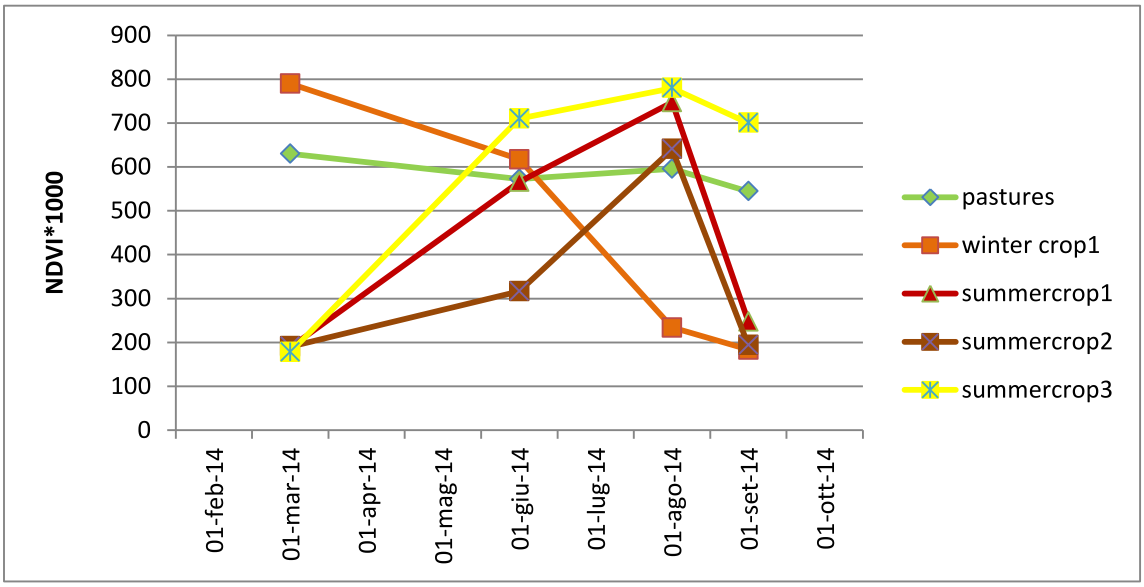

Figure 12: Mean NDVI temporal paths of the main crop class in the test area

Actually there are no other auxiliary informations in order to improve the characterization of the classified crops (and in particular to differentiate the different “summer crop” classes (type A B and C); these summer crops are those with an higher probability of being water demanding and potentially requiring irrigation. For example, from local checks, also with Google Earth and StreetView softwares, these summer crop type A and type B are in most cases referred to potentially irrigated summer crops like those in Figure 13 (corn, sunflower, ..)

Figure 13: Images, from StreetView, near area classified as summer crop A and B

3.2 Further focuses in Bihor County area – water permits for greenhouses

In the second part of the feasibility study further qualitative focuses were made about water permits for specific agricultural land use (greenhouses), not only in Marghita test area but in general in Bihor County, and after a specific check of water permits in agriculture.

For example, in Arpasel Village there is a single 100 m deep drilling used for the irrigation (drip and manual irrigation system) of flower and vegetable greenhouses with an area of 4,500 square meters. For this drill there is a single Water Permit.
Checking the high resolution satellite images available in public softwares like Google Earth, in this single small village, for example, the is a huge quantity of active greenhouses (see Figure 14).

Figure 14: Arpasel village, and zoom over the main active greenhouses

In the conclusion of these type of verifications carried out in Bihor county it was found that all the greenhouses in the county, except for three, are actually operating illegally (without Water Permit), as there is no database with quantitative informations on water abstractions.

Locally, the amount and density of greenhouse is very high (see for example Figure 15, relative to Mihai Bravu village in Bihor County).

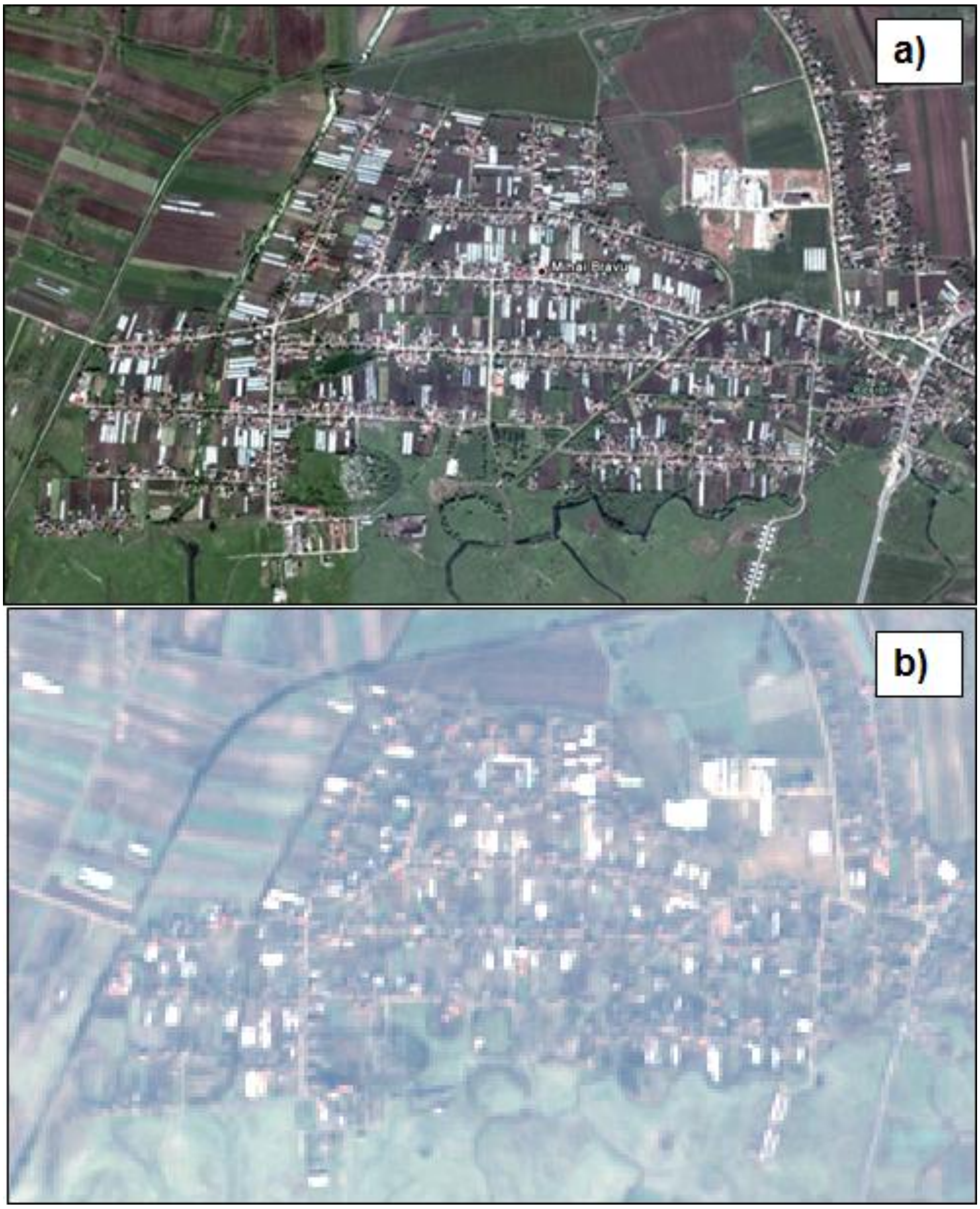

Figure 15: Mihau Bravu area, Bihor County. Comparison between high resolution satellite image available in GoogleEarth (a) and a very recent Sentinel2 image (1 january 2016) at 10 meters resolution (b).

In this example, it’s quite evident the potential application of greenhouse detection and mapping from high resolution satellite images, like those available in public softwares like GoogleEarth. Moreover, exploiting also lower spatial resolution, but higher temporal revisit satellite data, like Sentinel2 for instance, it could be possible to updated the maps and check periodically the temporal evolution of greenhouses (number, extension, ..), over a wide area.

In conclusion, EO data could provide for the future a potential benefit in order to map and monitor the number and the temporal evolution of greenhouses, and provide potential benefits for their controls and compliance assurance assessment.

4 Conclusions and outlooks

The main crop map classification provided in this feasibility study is an example of a possible first output, useful to detect the potentially water demanding agricultural areas and their evolution over time.

From the EO-data point of view, with Sentinel-2 data there will be a strong improvement in monitoring capabilities.

If relevant, the mapping of greenhouses is technically feasible (with high resolution data and/or Sentinel-2); EO data could provide for the future a potential benefit in order to map and monitor the number and the temporal evolution of greenhouses, and provide potential benefits for controls and compliance assurance assessment.

For all the other non-agricultural water uses, the only EO method to detect groundwater over-abstraction is SAR Interferometry: this approach is potentially technically feasible in alluvial plains.

Major efforts for possible evolution in the future are related to the improvements in auxiliary data availability, and related to all the “non-technical” issues (i.e. improvements of relationships and communication with other authorities, data exchange protocols, technical capacity building, etc…).