FINAL REPORT ON CHALLENGE #6: Drones utilisation for crop protection storage capacity

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INTRODUCTION

- Background of the challenge

  Good health and nutritional condition of crops as well as optimal physical, chemical and biological properties of soil are important features of the effects of certain environmentally friendly technologies and management efficiency in a crop production. Currently, the health's diagnosis and nutritional condition of crops are mostly made on the basis of knowledge and experience of agronomists and long-term soil-climatic information about the particular production region. At the present time, the farmers are using their subjective ratings for diagnosis of nutrition and health condition of crops, respectively advice from specialists or distributors of fertilizers and plant protection products. This diagnostic is inaccurate in many cases and leads farmers to wrong decisions with a negative impact not only to production and thus economic efficiency of the business, but a negative impact can be seen also on the environment.

- Full explanation of the challenge defining the scope of the effort.

  The (information) system to support decision-making in the field of the automated assessment of measured and collected data for the purpose of the precise application of chemicals to eliminate weeds, pests, and diseases in a crop, adding nutrients to the soil or artificial irrigation. The system for the decision support will include a mobile application which will provide the information on the precise localization for the application of chemicals/nutrients/irrigation based on created maps and GPS signals.

METHODOLOGY

- Team description + info about any coordination with other organizations, outside agencies

  The challenge is managed by Zuzana Palkova (SUA) and Miroslav Konecny (ADDSEN), which are responsible for coordination of the challenge, stakeholder engagement and communication with participants.

For technical support and development are responsible Roman Danel (database and data processing), Michal Řepka (image processing, NDVI, EVI), Tomáš Peňáz (GIS).

- Technical Background

  The proposed methodology for identifying problematic areas of a selected crop will result from the measured data, whether in an imagery form through specialized cameras (capable of scanning in the infrared, red, blue and green wavebands), or from sensors. Consequently, the vegetation indexes (Normalized Difference Vegetation Index (NDVI), Enhanced vegetation index (EVI)) which allow to identify problematic areas in the crop and then the anticipated nature, extent and cause of damage will be determined. The system determines the coordinates, suggests procedures, methods and dosage and unmanned devices apply designated substances.

- Data & Equipment list
  - LPIS data
  - Weather data
  - Data from satellites like Sentinel-2, Landsat and SPOT, which produce red and near infrared images.
  - Data from drones
  - Training data set for classification algorithms and/or real data from fields with the disease/bugs
- Detailed implementation plan

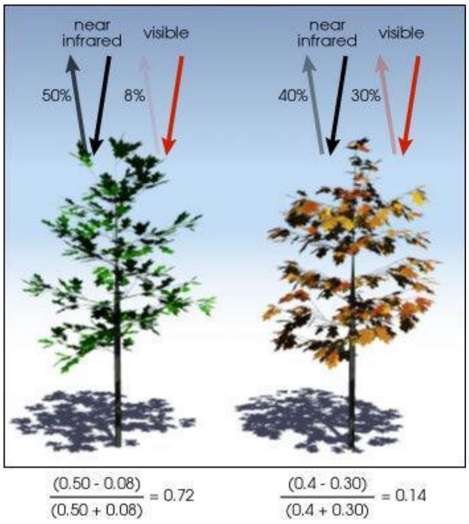
  The **normalized difference vegetation index (NDVI)** is a simple graphical indicator that can be used to analyze remote sensing measurements, often from a space platform, assessing whether or not the target being observed contains live green vegetation.

  The NDVI is computed as the difference between near-infrared (NIR) and red (RED) reflectance divided by their sum.

$$NDVI_i = \frac{NIR - RED}{NIR + RED}$$

  NDVIi represents smoothed NDVI (sNDVI) observed at time step i and their ratio yields a measure of photosynthetic activity within values between − 1 and 1. Low NDVI values indicate moisture-stressed vegetation and higher values indicate a higher density of green vegetation. It is also used for drought monitoring and famine early warning[1].

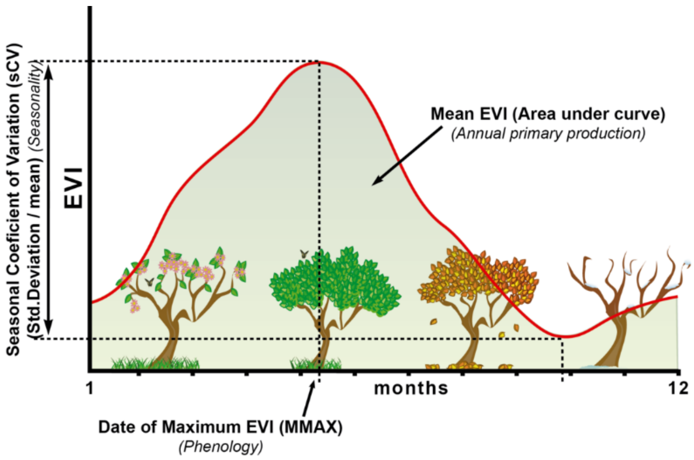
[1] Agenagnew A. Gessesse, Assefa M. Melesse, in Extreme Hydrology and Climate Variability, 2019



[2]

The **Enhanced Vegetation Index (EVI)**[3] is similar to Normalized Difference Vegetation Index (NDVI) and can be used to quantify vegetation greenness. However, EVI corrects for some atmospheric conditions and canopy background noise and is more sensitive in areas with dense vegetation. It incorporates an "L" value to adjust for canopy background, "C" values as coefficients for atmospheric resistance, and values from the blue band (B). These enhancements allow for index calculation as a ratio between the R and NIR values, while reducing the background noise, atmospheric noise, and saturation in most cases.

$$EVI = G \cdot \frac{(NIR - R)}{(NIR + C_1 \cdot R - C_2 \cdot B + L)}$$



[4]

- Analysis of needs of stakeholder groups
  The primary target groups are:

[2] https://gisgeography.com/ndvi-normalized-difference-vegetation-index/
[3] https://www.usgs.gov/landsat-missions/landsat-enhanced-vegetation-index
[4] Cabello, Javier & Alcaraz-Segura, Domingo & Lourenço, Patricia. (2012). Funcionamiento de los ecosistemas de la Red de Parques Nacionales de España: detección de impactos recientes y desarrollo de un sistema de seguimiento y alerta a partir de herramientas de teledetección.

- farmers and companies offering services for farmers and producing or selling products and/or machines for agricultural production,
- new business and economic opportunities arise directly from the production and sale of technology and indirectly in the form of service-based business opportunities - rents a technology of farmers and other stakeholders,
- new potential for further research activities for Academia + R&D institutions and Universities.

The secondary target groups represent institutions like universities, R&D companies, government bodies, which can use the outcomes for the education, research and development or controlling purposes.
Target group needs:

- Needs according to each target group e.g., Policy makers' needs:
  - AgriHub Evangelisation: the potential, utilisation, impact, awareness
  - Agrihub Technical skills/competences: Agrihub data service implementation and data processing, how to work with Agrihub data
  - Agrihub related Data science skills/competences and competences: basic geospatial data processing
  - Use cases of geospatial data for concrete end user or domain
- Experimental results

  The main aim of the activity is to develop sensing methodology, a hardware and software solution being able to determine the coordinates of each region together with its geometrical dimensions in order to provide accurate information in the form of maps of areas with insufficient moisture, weeds, pests and diseases, or areas with low nutrient concentrations, using commercially available unmanned vehicles that will include specialized sensing devices.

FINDINGS & CONCLUSION

IE6 focuses on drones' utilization for crops protection and control of their nutritional conditions. Currently, this status is controlled mostly on the basis of knowledge and experience of agronomists and long-term soil-climatic information about the particular production region.
The aim of the Innovation Experiment 6 defined for the Agrihub CZ&SK project is to develop the (information) system to support decision-making in the field of the automated assessment of measured and collected data for the purpose of the precise application of chemicals to eliminate weeds, pests, and diseases in a crop, adding nutrients to the soil or artificial irrigation.

This system should include a mobile application that will provide the information on the precise localization for the application of chemicals/nutrients/irrigation based on created maps and GPS signals.
The methodology for identifying problematic areas of a selected crop is based on the vegetation indexes (Normalized Difference Vegetation Index (NDVI) and Enhanced vegetation index (EVI)) which allow to identify of problematic areas in the crop and then the anticipated nature, extent, and cause of damage will be determined.
Possibilities for further development and implementation in agricultural practice are very wide. Important will be also the progress in hackathon challenge #6.
The IE6 opens proposals for further cooperation in the frame of triple helix principle - R&D/farmers/SMEs.
The discussions that the next INSPIRE hackathon should bring, allow to clarify some of the requirements of target consumers, primary producers, and the effect of local climate conditions.
During the preparatory activities for hackathon IE6, several questions arose from the discussions, such as:

- Are the NDVI and EVI methods optimal or building reference images databases of different health conditions of plants will be necessary?
- Is there a real interest of farmers to use drones for the health and nutritional condition of crops diagnosis, considering the limitations for using drones?
- What will be the business model for further exploitation of developed applications?

The main points for the next INSPIRE Hackathon include more precise specifications of the farmers' needs, possibilities for plants' image database development, and clarification of the business potential of drones utilization in agriculture practice.