EUROGEO 2020 Conference
April 22-23rd 2021, Madrid, Spain
SUSTAINABLE DEVELOPMENT GOALS FOR ALL

The technological concept of the Green Cadastre for the needs of sustainable agricultural policy in Poland

Agnieszka Dawidowicz [1], Marcin Kulawiak [2], Elżbieta Zysk [3]
agnieszka.dawidowicz@uwm.edu.pl [1] (corresponding author), Marcin.Kulawiak@eti.pg.edu.pl [2] elzbieta.zysk@uwm.edu.pl [3]
[1,3] Institute of Spatial Management and Geography, Faculty of Geoengineering, University of Warmia and Mazury in Olsztyn, Poland
[2] Department of Geoinformatics, Faculty of Electronics, Telecommunication and Informatics, Gdansk University of Technology, Poland

Abstract
In an era of globalization, increasing world population, progressing urbanization, and decreasing availability of cultivable land for food production, securing food production is an important issue. It is not easy in the face of so many natural disasters. Sustainable agricultural production requires, above all, access to current and accurate data on space and dynamic atmospheric phenomena, the occurrence of extreme weather events, erosions, epidemiological threats, parasites or pests. Early warnings can prevent possible losses. Hence, it is particularly important for national governments to create information systems for both sustainable agricultural policy and directly sustainable agricultural production. Considering the Green Cadastre (GC) concept created in Poland, which is a sub-module of the national Land Administration System, a technological solution was proposed for obtaining spatial data of this GC sub-module based on available sensors. The simulations carried out showed the usefulness of the data obtained for the needs of GC.

The Spatial Data Infrastructure in Poland
Assuming that the GC would be a uniform system deployed at the country (European Member State) level, it should directly interface with the national Land Administration System (LAS). LAS is the backbone of the national infrastructure for the implementation of sustainable land policies and land management strategies. It enables comprehensive access to information about geographical objects as well as land tenure rights, land use restrictions and land-owner responsibilities (Dawidowicz and Źróbek, 2018). LAS created in different countries guarantee the harmonization of global data in line with the Land Administration Domain Model (LADM) and ISO standard 19152 (Lemmen et al.2015). In Poland, the LAS concept is being implemented in the form of the Integrated Real Estate Information System (IREIS) on the basis of the Regulation of the Council of Ministers of 17 January 2013 on the Integrated Real Estate Information System. The various elements of IREIS, including databases and services, are being implemented in phases (Fig.1).

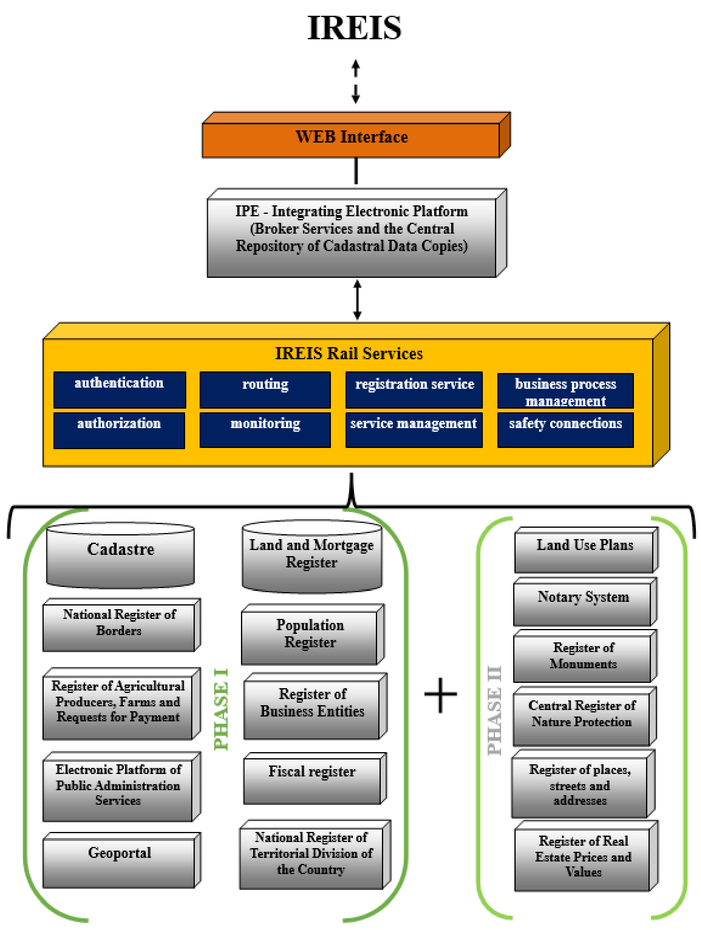

Figure 1. Functional architecture of the IREIS. Source: Own elaboration.

Integrated Real Estate Information System (IREIS)
The IREIS aims to integrate the databases of many public registers, including cadastre, land register, tax register and land-use plans, for the purpose of providing effective support for other systems and economic processes. Access to the system is available to both authorities as well as citizens (albeit the latter cannot access the full system functionality). While IREIS provides a wide array of capabilities, as far as green cadastre information is concerned it is currently limited by the available tools and data sources. In this context, in order to reduce feature redundancy, the developed Green Cadastre should directly interface with the IREIS framework and act as an extension of the existing functionality.

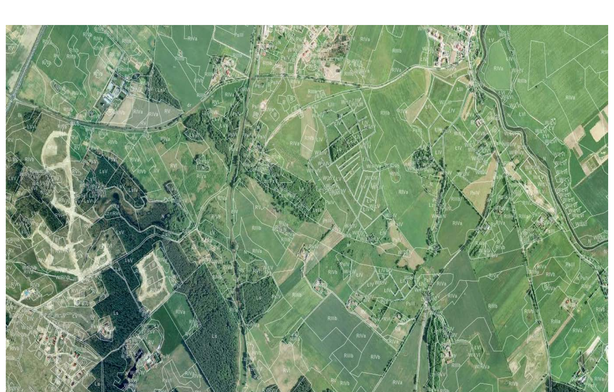

Figure 5. An image from the Land Information System of Stawiguda, Poland, depicting land use parcels overlaid on an orthophotomap of the area.

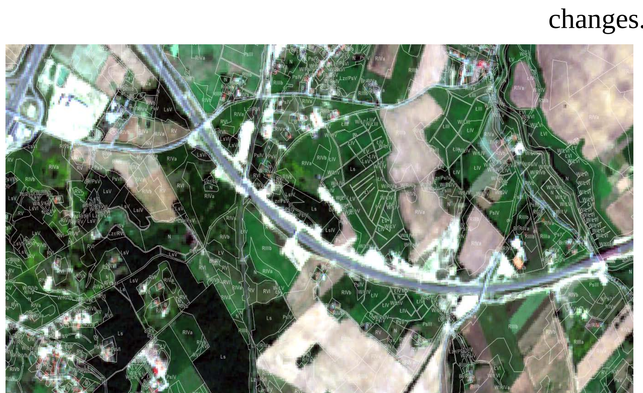

Figure 6. The Stawiguda land use parcels overlaid on an image obtained from a Sentinel-2 satellite on 26.08.2019. The new road and other recent investment activities are properly represented.

Required functionalities of the Green Cadastre

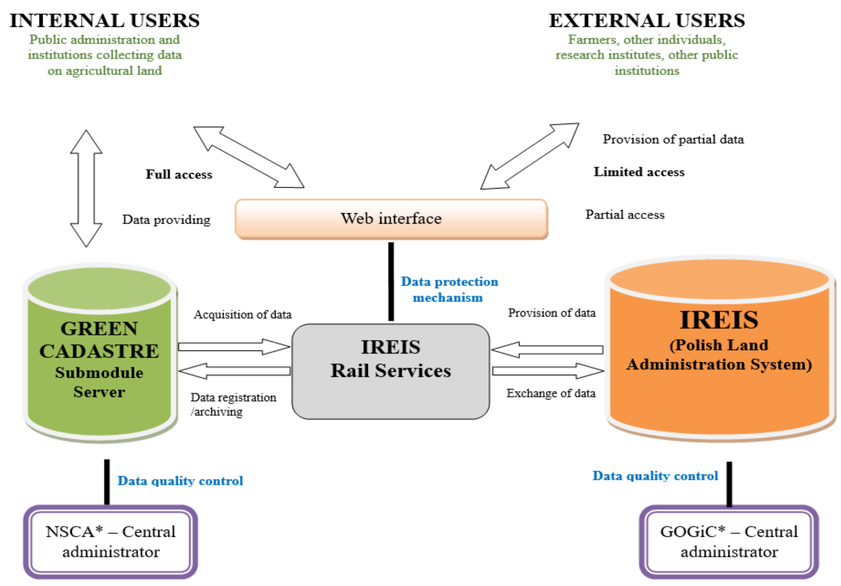

Figure 2. Functional architecture and data flow in the Green Cadastre. Source: Zysk et al. 2020.

The proposed architecture of Green Cadastre

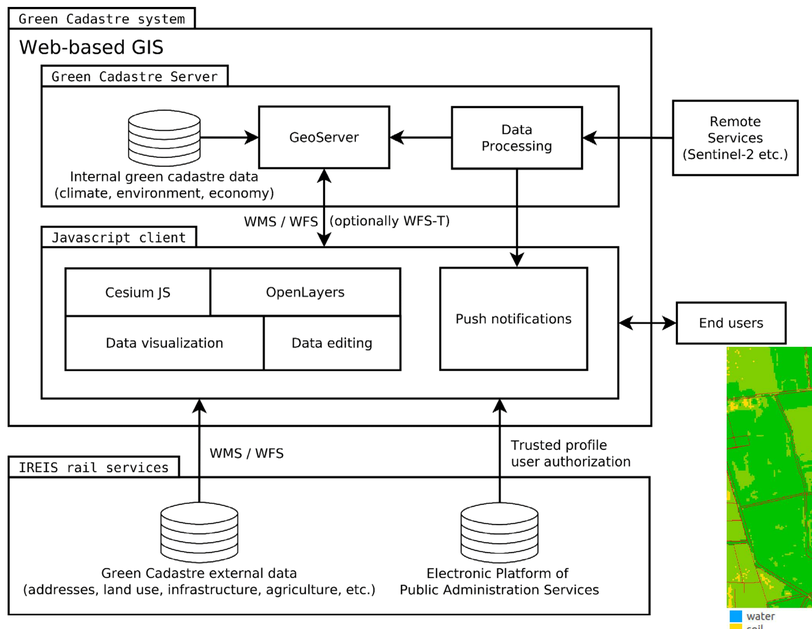

Figure 3. Proposed architecture of the Green Cadastre system.

The architectural solution for the GC was founded on the general GC concept (Zysk et al. 2020), which stated that the proposed system should be based on the existing data registers and technologies to eliminate redundancy, save time and minimize costs. Moreover, when designing the databases and general system architecture, the authors took into account the fact that technology is constantly evolving, with new software and hardware solutions cyclically replacing existing ones. Therefore, the presented architecture is based solely on open standards and well-established and dynamically developing Open Source technologies, which should ensure its long-term sustainability. Moreover, an architecture based on open standards and technologies should be more easily adaptable to the needs of different stakeholders in a flexible and inclusive way. This is particularly important because the proposed system should provide compatibility with solutions and technologies already implemented in the national Integrated Real Estate Information System. As a consequence, the proposed design of the GC system around open technologies enables it to interface with the IREIS and act as a dedicated submodule (Fig.2).

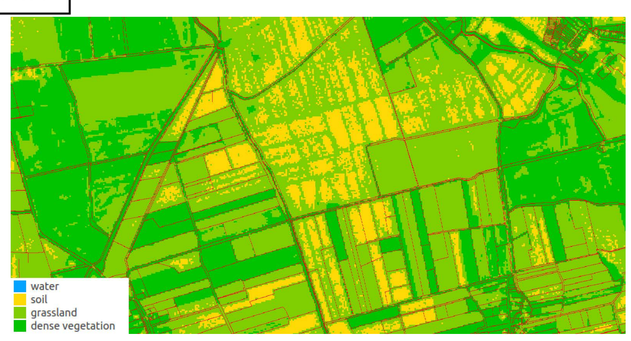

Figure 4. NDVI-based local climate analysis with overlaid land use parcels produced from Sentinel-2 satellite image of agricultural area in Nowy Dwor Gdanski, Poland, captured on 13.09.2016. Source: own study.

The GC and its elements has been designed to support the following system functionalities:
- the GC should provide capability for data processing and analysis, data visualization, data exchange, generation of reports, generation of information materials, predictions, warnings, and alerts;
- the GC should be an integral part of the national SDI, directly interfacing with the IREIS;
- core GC functionality should be made available to the public to support social participation and promote the development of a spatially enabled society;
- authorized users should be able to report invalid or missing data;
- the GC should be accessible through a web application compliant with Desktop computers as well as mobile devices such as smartphones and tablets;
- contents of the GC database should be made available through protocols conforming to Open Geospatial Consortium (OGC) standards, so that they may be accessed through any compatible software;
- data should be visualized in layers with a clear legend to generate maps with customized content for different purposes;
- the solution should be built using open technologies, so that it may be easily adopted to suit any newly introduced changes.

Conclusions
The paper presents a novel concept of an INSPIRE-compliant Green Cadastre architecture, dedicated primarily for deployment in EU countries. The concept has been designed for the EU Member State of Poland via an interdisciplinary approach which combined geographical, agricultural and IT knowledge to develop a fully tailored solution.

Figure 7. Sample visualization of the slope and aspect of land use parcels in Nowy Dwor Gdanski, Poland, in the Cesium Web-GIS client, using the Cesium Ion dataset for illustrative purposes.

The proposed system is designated to act as an element of the existing land administration framework, and thus it interacts with presently available data and services through open standards such as OGC WMS and WFS. The proposed architecture of the GC system allows for integration and processing of data from external sources, such as Copernicus Open Access Hub, for the purpose of providing users with up-to-date information regarding climate characteristics such as temperature, precipitation and state of vegetation at every land use parcel. This design aims to encourage individual farmers as well as their organized groups to integrate the provided GC data streams as part of their own solutions for precise agriculture.