Prospective Study on the Potential Use of Satellite Data for Disaster Prevention, Preparedness, and Mitigation in Poland

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Abbreviations:
ACK CYFRONET AGH: Academic Computer Centre CYFRONET of the University of Science and Technology
IT: information technology
LGU: local government unit

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Abstract

Considering climate change, the risk of natural disasters requires a comprehensive approach on the part of all entities dealing with crisis management. Despite the advanced technologies available to predict weather phenomena, it is often unmanageable to take remedial measures, and the best solution is to suitably prepare for, and efficiently operate after, the occurrence of any given crisis. Nevertheless, it is imperative to implement the latest techniques and solutions which will allow for better preparation and responsiveness in the event of natural disasters. This manuscript presents results of initial analysis concerning the currently tested project, which is aimed at, among other things, improving safety in the event of natural disasters in Poland. There were two reasons for creating the manuscript. First, to present the potential of the system currently being built in Poland, which aims to reduce the risks associated with natural disasters and minimize the problems related to crisis management in Poland. And second, to open discussions and create grounds for information exchange between countries implementing similar solutions, especially neighboring countries, with which joint actions could be taken in the event of disasters in border areas.

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Introduction/Report

Remote sensing techniques provide significant, effective, and rapid monitoring of flooded areas, assist in planning current rescue operations, and in estimating flood damage. Both optical and radar imaging can be used in the analysis of the disaster as it is happening.[1] Floods are relatively short-lived and are usually accompanied by adverse weather conditions. When imaging the weather causing floods, the optical or visual range is severely limited by clouds.[2,3] At the same time, a high-frequency of optically-driven revisions is required over any given disaster area by some current systems using optical sensors alone to assess and monitor the impact. Radar imaging uses microwaves that penetrate the cloud covering and optimizes the ability to record both day and night, making this imaging an ideal source for performing the required analysis. The use of modern technologies in counteracting the effects of crises arising as a result of floods (also droughts, large-scale fires, or other weather anomalies) is an operational requirement for the 21st century.[4]

Currently, the Sat4Envi system is being implemented in Poland, engaging three key institutions: The Institute of Meteorology and Water Management – National Research Institute (IMGW-PIB; Warsaw, Poland); the Academic Computer Centre CYFRONET of the University of Science and Technology (ACK CYFRONET AGH; Kraków, Poland); and The Crisis Information Centre (CIK) – part of Earth Observation Group in the Space Research Centre of the Polish Academy of Sciences (Warszawa, Poland) where the Polish Space Agency (Gdansk, Poland) prepares an education and training program for public administration employees in the use of satellite data.[5] The Sat4Envi Project is the operating system for gathering, sharing, and promotion of digital information about the environment. The main goal of the Sat4Envi is to freely disseminate satellite images (as public information).[5] The obtained satellite data can support the work of public administration on each of its three levels (commune, district, and voivodship [an area administered by a Governor in several countries of central and Eastern Europe]). To achieve this goal, a preparatory process was identified which consists of three components: resources, organization, and mentality.

The first component includes the information technology (IT) potential of entities legally involved in crisis management in Poland.

The second component, organization, involves the process of interacting between the center (where satellite data are collected) and recipients in the field (most often local government units [LGUs]).

The third component, mentality, covers the most challenging element of any system and concerns the knowledge, competence, and skills of official decision makers. This last component also requires the greatest outlay of LGU resources, including financial, as neglect in this area may quickly lead to the marginalization of the Sat4Envi program.

The key initiative of the Sat4Envi project is to share satellite data with the largest group of interested parties in the shortest possible time. To reach a broad group of recipients, a comprehensive system needs to be built which will ensure the acquisition of data from satellites, their collection in a user-friendly database, and the possibility of rapid data processing that leads to beneficial decision making.[6] Primarily, the database should be accessible not only for public administration, including crisis management, but also for the scientific community, enterprises, and regular citizens. It is worth noting that citizens possess very diverse needs within recognized citizen advocacy associations or foundations, which must be taken into account;[7] these include concerns that directly impact mortality and morbidity outcomes at the local level.

In the context of the first component, resources, digital data obtained from Copernicus satellites (Europe), or other cooperating artificial satellites, will be stored centrally in the designated "satellite data warehouses" located in the ACK CYFRONET AGH.[8,9] Servers with archive data and handling queries from the customer portal will also be located at CYFRONET. Every new data archive will require significant expenditure on servers and their modernization to handle any queries. These data may be managed by the inhabitants of Poland or from abroad. Whereas they may refer to the current and archival status, they may also cover problems from agriculture through hydrology, to broadly understood spatial planning (eg, geodesy or the science of accurately measuring and understanding its impact on the geometric space occupied by the flood). Therefore, system support was proposed as a division of two categories: satellite images and files (databases).

With the second component, the organization, the main task includes the provision of information as soon as possible in a manner that allows correct reception (analysis and forecasting). Therefore, these data must be transmitted in the highest resolution and in a publicly available format (preferably pdf or jpg). The organization of data transferal must also be based on an intuitive customer portal, so that any person, even untrained, can obtain the necessary data. In Poland, as in other European Union countries, a rotation is maintained in public administration positions. Hence, the interface of the customer portal, at least at the primary level, should be manageable to the untrained population.[10] Indeed, there will be situations, especially in the private sector (the so-called third sector), when someone will require, for the first time, to correctly generate processed data in a short time. As such, the data presentation must be useful to those interested and be universal enough to be further processed (modified) on other software. It should be compatible with commonly used extensions, as useless data sent remains useless, no matter how swiftly it is sent. In crisis management, which constitutes a vital component of the sense of security in Polish society, the information obtained through Sat4Envi requires instantaneous implementation into locally used systems. If not, anticipating crises or forecasting fluctuations in already existing threats (eg, natural disasters) will become problematic. As a result, the system which doesn't meet expectations will be marginalized.[11]

The last component, mentality, is responsible for the systematic training of employees dedicated to the Sat4Envi system. It should be an obligation to continually improve the digital competences of users from communes, districts, and voivodships to ensure operational efficiency for crisis management and rescue. As such, one of the project tasks is to create a center for analyzing and developing satellite information in the field of its use, and the popularization of modern technologies. The system's successes will create demand for additional services. In the private sector, there will be many phone applications employing and disseminating the benefits of Sat4Envi.[5,12]

Limitations

The Sat4Envi project has been underway since the autumn of 2017. The main difficulty appears to be the lack of compatibility between potential data recipients. This generates problems requiring compliance in the decisions of many entities, which are often independent and are looking differently at crisis management itself.[13] Consequently, the time remaining for implementation (autumn 2020) may not be sufficient. This is not due to the first and second components (resources and organization), but because of the third – *mentality*.

About resources on the current phase of "data warehouse satellite" construction, it is capable of operating in selected areas. The proposed thematic platforms include hydrology, agriculture, meteorology, and spatial planning.[5,14] They are all widely required at every level of public administration in Poland.[15] However, as part of the inclusive consultation taking place, new proposals for mapping are emerging. Even smog issues are now highlighted.[16] The map of smog in Poland is built on uncertified stations, most often on private sensors distributed inconsistently with regards to recommendations, which partially distorts the reading of air conditions. This example supports that centralization under specific conditions does deliver results.[17]

Similarly, to support the proposal for a central server (ACK CYFRONET AGH), any self-governing local government could create a diverse, and certainly in this case, a less-efficient system. The local authorities would not generate the necessary funds; not for the purchase and maintenance of servers, nor for coverage of archival costs at the expected level. Currently, it seems sufficient and efficient for local governments to maintain hardware performance according to the requirements of the Sat4Envi system.[18]

In terms of organization (the second component), it will be possible to create a portal that will shorten the time required to access these satellite data (from registration to the possibility of mass transfer). At this point, attention needs to be placed on the reception of the platform, as it should be intuitive. Similarly, internal communication and data transmission (compatibility) must not hinder operation, especially when taking into account the time deficit, which is omnipresent in crises. Unfortunately, there is a lack of centralization in crisis management in Poland, similar to the services and inspections.[19] Competency problems are not a major problem, but they do occur in the supervision

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over implementing changes. In Poland, crisis management is mainly assigned to the district, commune, and voivodship self-government, these being self-governing under the Constitution.[12] There are no obligations for specific modernization of LGUs, and the lack of obligations will increase this risk. The probable outcome for local governments is to lower the level of administration, resulting in less knowledge, skills, and competences in the case of the Sat4Envi. Unfortunately, there is a lack of viable solutions currently implemented in the most developed countries, such as the Federal Emergency Management Agency (FEMA; Washington, DC USA) in the USA.[20,21]

However, concerted efforts should be directed primarily at changing the mentality (third component) of public administration employees, and more precisely, at adapting their perception and thinking towards the possibilities offered by the Sat4Envi system.[12] Forming positive perception requires, above all, training on a wide-scale, starting from the voivodship level, through the district level, and the commune level. Pilot training for a selected (representative) public sector group is already underway, but it is only in the form of a lecture presentation with limited infrastructure support.[22] Mainly, the training familiarizes participants with the historical foundations of the program and the possibilities of using satellite data in spatial management, agriculture, environmental protection, and water management. In this way, knowledge concerning possibilities offered by the Sat4Envi system is articulated if only in the context of the use of data in current Polish legal conditions. The culmination of promoting the Sat4Envi program comes during the period covering the end of 2019 and the beginning of 2020.[5] It is worth noting that it is proposed that at a later date, training should be conducted as part of the practical use of the system so that public administration employees will acquire skills and competencies designed to increase the quality of crisis management.[23] Finally, it should be emphasized that the organization of training is tailored to the needs of specific entities, to levels of administration, and to the tasks specified by the legislator, as evidenced by the survey conducted among crisis management institutions.

Implementation

The implementation of the Sat4Evi system will undoubtedly increase the institutional potential as part of crisis management and rescue in Poland. Remote sensing provides the ability to image a significant area in a short time, which is crucial in crises.[24,25] However, the implementation process requires multilateral coordination and significant financial expenditures, which remains complicated in the current Polish administrative environment.[26]

Benefits and Potential for the Future

The vast majority of public administration is prepared (especially in terms of technology) for the use of Sat4Envi, but employees are concerned for the lack of intuitiveness of the portal and the lack of software compatibility, which will generate adjustment costs. Second, in the lower levels of local government, the greater the chance of training (implementation) difficulties. Third, there is skepticism in the administration towards Sat4Envi as a free, compatible, and universal system. Fourth, universal access raises concerns among officials, particularly in the context of the protection of personal data and privacy in general. Fifth, the use of the system in crisis management will mainly be used for forecasting and reconstruction (after a crisis event). Lastly, it is arduous to react in real-time when the satellite constructs images every five days. As such, the authors provide a comprehensive listing of areas requiring further discussion, debate, and implementation before any satellite IT system can be successfully deployed within Poland and its neighbors.

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