

# Analysis of the Potential of IT System Support in Early Warning Systems: Mitigating Flood Risk in Poland

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## Abbreviations:

ISOK: IT System for Poland's Protection Against Extreme Hazards  
IT: Information Technology

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## Abstract

Nowadays, extreme weather and atmospheric conditions are becoming more frequent and more intense. It seems obvious that together with climate change, the vulnerability of the public and of individual regions to the risks of various types of natural hazards also increases. This would increase the importance of organization concerning potential measures to protect against these extraordinary events, and to prepare for reducing their ramifications.

One such initiative is the creation of an early warning system for inhabitants of a given area of a country, to help guard against the extraordinary threat associated with a natural disaster; especially floods. The creation of such a system is aimed at increasing public safety and limiting losses caused by the occurrence of natural, technological, and synergistic hazards. Particular emphasis during the construction of a current system is placed on supporting flood risk management, which is aimed at increasing the safety of citizens and reducing losses caused by the occurrence of flooding in Poland. This would be possible by the identification of areas threatened by flooding throughout the country, and then limiting economic expansion in these areas.

Ultimately, the project aims to consolidate information regarding hazardous events and gather them in a professional Information Technology (IT) system, using an integrated database and a modern module for disseminating information to end users. The system is to provide access to this information for both the administration and the individual citizen. This article presents the potential of a so called "IT System for the Country's Protection Against Extreme Hazards," which is currently being developed in Poland, with particular emphasis on reducing the risks related to natural disasters and minimizing the problems of crisis management in Poland. This article is also aimed at opening discussions and creating a basis for the exchange of information from countries implementing similar solutions, especially neighboring countries, with which joint action could be undertaken.

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## Introduction

Ensuring an effective system for protecting a country against hazardous events is particularly important due to the growing number of such events, as well as the increasing scale of both economic and social impact which they cause. Correspondingly, the improvement of the effectiveness of flood risk management has become a more important issue.

Prior endeavors aimed at constructing more and more complex and expensive systems of technical flood protection have not brought satisfying outcomes. In fact, the construction of new protections can actually increase the risk of losses. This is because areas protected with this security system are often densely populated, and consequently, a possible failure of this system, resulting in these areas being flooded, would generate enormous losses.

This is why it is so important to identify the areas at-risk of flooding. This will allow, if necessary, to make informed decisions regarding the location of the investment.<sup>1,2</sup>

Every year, millions from the special reserve of the Poland state budget are spent on disaster relief. One of the biggest floods in Polish history occurred in 1997, causing material damage estimated to be worth US\$3.2 billion, while also resulting in 55 fatalities. And in 2010, a flood caused losses of US\$3.7 billion.<sup>3,4</sup> Taking into account the scale of losses caused by natural disasters in Poland, the scope of the proposed system is to include

in the first instance hazards related to extraordinary atmospheric, hydrological, and technological phenomena.

Additional problems are that the existing Information Technology (IT) systems used in Poland to cover the population and the economy are scattered and inconsistent, based on different technical solutions, and use different data.<sup>2</sup> This does not provide a sufficient guarantee of effective notification for alerting populations and institutions concerning hazardous weather conditions.

### IT System for the Country's Protection Against Extreme Hazards

Due to the lack of tools to ensure the effective functioning of crisis management in Poland, an initiative was born to consolidate information concerning hazardous events and place them in a professional IT system. The "IT System for the Country's Protection Against Extreme Hazards" (polish ISOK) is planned as a module for disseminating information to end users, providing access for both the administration and individual citizens. It also aims to contribute to the resolution or minimization of a number of issues related to crisis resource management in Poland, with a special focus on flood risks.

The project is mainly focused on the public. Anyone with a device which has access to the internet will be able to check if the area they are in is at-risk of flooding, and if so, how big of a threat there is.<sup>5-8</sup>

In addition to individual recipients, project stakeholders are also to be responsible for spatial planning and flood protection planning. This mainly concerns the regional water management boards responsible for protecting areas at-risk of flooding before they are populated in a way which hinders protection.<sup>9,10</sup>

The ISOK also means to address institutions responsible for preventing crisis situations. In particular, this applies to voivodeship (the area administered by a voivode "Governor" in several countries of central and eastern Europe; voivodeship is the highest-level administrative sub-division of Poland, corresponding to a "province" in many other countries) crisis resource management centers and other government and self-government administration units, at the national, regional, and local level, dealing with issues of flood protection and other threats and crisis response. Thus, IT solutions are to significantly improve the flood and crisis management capabilities.<sup>6,7,11</sup>

The main objective of the project is to create a new system which will significantly improve public safety, as well as safeguard the economy and the environment, from the impact of floods and other hazardous events. This goal is planned to be achieved by developing a flood hazard map, flood risk maps, maps of meteorological threats, maps of other hazards, and a map of Poland's hydrographic distribution. These products are to support crisis management in the event of a flood, as well as in any other emergency situation, to the extent that the IT system will allow. It is planned that the ISOK IT system will be an open system, one which can be expanded with new functions or ranges of data, depending on new needs formulated in the future.<sup>6,12,13</sup>

Flood hazard maps are intended to primarily present an area which will be flooded if an overbank flow pours through a river. This will be the case for areas where there are no embankments. Where embankments are built, the overbank flow should be located between flood embankments. Nevertheless, due to possible damage or failure of the embankments, it is necessary to determine what areas would be flooded. Such information is to be included in the flood hazard maps.<sup>6,14,15</sup>

### Benefits and Potential for the Future

The most significant planned social benefits to be achieved thanks to the ISOK system are: (1) a reduction of losses caused by the occurrence of flood hazards, by identifying the danger areas for the public; (2) enabling proper spatial planning, especially in the context of flood hazards occurring in river valleys, including those which could arise as a result of failure of water facilities, especially river embankments, allowing conscious making of investment decisions regarding their location in areas exposed to the danger of flooding; (3) increasing the sense of safety for the public; (4) limiting the number of those impacted by the presence of elements, in particular floods; and (5) improving the functioning of crisis management systems at all levels.<sup>6</sup>

These benefits are to be achieved as a result of: (1) construction of the ISOK IT system, by the use of which other products created in the project will be made available, such as flood hazard maps, flood risk maps, maps of meteorological threats (ie, storms, heavy rainfall, and others) and maps of other hazards (eg, maps of threatened water intakes and risk of industrial failures), as well as a hydrographic map of Poland; (2) obtaining a numerical model of land relief and numerical model of land cover and digital orthophoto map; (3) obtaining a digital topographic map, known as the topographic database professionally; (4) performing new hydrological calculations for all rivers covered by the project, according to a uniform methodology, and for a single historical period; (5) implementation of mathematical-hydraulic modelling of flood surges and dike failure, for all rivers covered by the project; (6) creating a preliminary flood risk assessment and making flood hazard maps, as well as maps of meteorological threats and maps of other threats; and (7) inventory of available IT resources and communication resources between cooperating institutions in the field of crisis management.<sup>6</sup>

The implementation of the ISOK system will place Poland among countries which manage the safety of their societies and economy in a modern way, and effectively minimize the risks and losses caused by the occurrence of catastrophic natural phenomena.<sup>6-8</sup>

### Limitations

In the case of any new proposals, especially those which involve a large section of the population, concerns have arisen in regards to their limitations. This is understandable, and what has been proposed here is only the first step leading to a wider system implementation potential. As stated, the system must show how it takes into account and mitigates the risk for the entire population, including those most vulnerable.

At the beginning of November 2018, the National Water Management Authority (Warsaw, Poland) concluded a contract with an external company to complete the construction of the ISOK. Earlier work was concluded by terminating the contract due to the significant delay of the previous contractor. At the moment of writing this report, it is planned for the system to be put into service by the end of February 2019.

The main goal of the project is to create a system to improve public safety, as well as safeguarding the economy and environment against extraordinary hazards, by creating an electronic IT platform with necessary reference registers, which will constitute a tool for crisis management.

In order to create flood hazard maps, it is also necessary to use a mathematical-hydraulic model which can calculate such a scenario. To implement these calculations, the model needs geodetic

data – numerical terrain model, numerical terrain coverage model, orthophoto map, topographic data (topographic objects database), and cross-sections of “wet” riverbed – such data will be obtained from ISOK. The model also needs hydrological data with a probable flow rate of  $p = 1\%$  (once every hundred years). With ISOK, it will be possible to calculate these values for all mapped rivers. As it is currently in the construction phase, it is difficult to consider the practical implementations, and even more so to evaluate the proper performance of the system.

It is also worth noting that it will be the responsibility of the regional authorities to take into account the project results (flood risk maps and flood hazard maps) in the spatial development plans of individual regions.

The authors believe that this proposal is only the first step towards alleviating the consequences, which must also weigh in on the immediate debate between citizens and governments to ensure universal and equal opportunities to cover all traditional and newly exposed “vulnerable” societies.

The authors suggest that the IT system will eventually need to have the capacity and capability to “think” outside the flood itself and be tailored, when possible, as a multidisciplinary and transdisciplinary tool. The potential of this IT will not stand still, but it will need to adapt as sudden-onset natural disasters increase

in proportion to inherent climate changes, which is already quite evident in traditional natural flooding at-risk areas.

### Conclusions

The ISOK project is primarily a project for the public. The created system is to have a major impact upon:

- Reducing losses caused by dangerous phenomena, in particular floods, in terms of human lives and human health, the environment and cultural heritage, as well as economic activity;
- Improving the operation of public administration units in the field of crisis management and flood risk management;
- Increasing the sense of safety within society; and
- Enabling conscious investment decisions regarding location.

The IT system currently deals with increasing flood risks, but will need, in the future, to coordinate the system to issues that increase both risk and recovery to any floods, such as increasing population densities and urbanization; biodiversity losses that will prevent or limit recovery and rehabilitation of flooded areas; and stresses on food production, water quality, and energy resources. So far, no countries have yet developed multidisciplinary monitoring systems, but will need to in the future.<sup>16,17</sup>

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