VÉDELEM TUDOMÁNY
KATASZTRÓFAVÉDELMI ONLINE TUDOMÁNYOS FOLYÓIRAT

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DESCRIPTION AND INVESTIGATION OF IT SYSTEMS USED IN DISASTER MANAGEMENT

Abstract

Countries at risk of natural disasters need to have resources in place commensurate with the type and extent of disaster risks identified through appropriate risk analysis procedures. Assessing the extent of the vulnerability and reviewing it regularly is a very complex task. This is especially true in the midst of the changes brought about by current climate change. Thus, it is an increasing challenge for professionals to assess the factors that determine the development of disasters effectively. Thus, it is inevitable that this multivariate system will rely heavily on state-of-the-art IT solutions offered by the 21st century to prevent, reduce, and manage threats. In this research, various IT solutions are presented, which can serve as a modern background for reducing hazards and damages caused by disasters.

Keywords: disaster, IT systems, emergency, artificial intelligence, big data

KATASZTRÓFÁK ELLENI VÉDEKEZÉS INFORMATIKAI TÁMOGATÁSÁNAK EGYES KÉRDÉSEI

Absztrakt

A katasztrófáktól fenyegetett országok megfelelő kockázatelemző eljárásokkal feltárt katasztrófakockázatok típusához és mértékéhez igazodó erőforrásokat kell, hogy készenlétben tartsanak. A veszélyezettség mértékének megítélése és annak rendszeres felülvizsgálata igen összetett feladat. Különösen igaz ez a környezeti tényezők jelen éghajlati elemek jelen változásai közepette. Egyre nagyobb kihívás tehát a szakemberek számára a katasztrófák kialakulását meghatározó tényezők eredményes megítélése. Így elkerülhetetlen, hogy ebben a sokváltozós rendszerben erőteljesen támaszkodjanak a 21. század kínálta legkorszerűbb informatikai megoldásokra a veszélyek megelőzése, csökkentése és kezelése során. E tanulmányban bemutatásra kerülnek, azok a különféle informatikai megoldások, melyek korszerű háttérként megalapozhatják a katasztrófák jelentette veszélyek és károk csökkentését.

Kulcsszavak: katasztrófa, informatikai rendszerek, veszélyhelyzet, mesterséges intelligencia, big data, IoT

1. INTRODUCTION

Disasters that affect humanity from time to time can take many forms, from natural, through civilization to economic or technological types. Techniques and tools have been developed by people for centuries to predict and prevent these. The continuous development of industry and information technology gives us more opportunities to forecast and prevent these threats accurately. In the 21st century, where huge data sets are being processed by companies and artificial intelligence is constantly evolving, a combination of these must be used in forecasting and prevention. Thus, IT systems and technologies play a major role before, during, and after these events.

1.1. Types of disasters and hazards

Disasters can be divided according to their origin into two main categories, such as those caused by **natural** and **civilizational** threats. The grouping of disasters in our natural environment can be based on well-separable environmental factors, among which we can identify disasters of geological, hydrological, meteorological, and ecological origin. While civilization disasters include human (social, biological, etc.), technological (nuclear, chemical, etc.) and infrastructure-mediated disasters provide primary differentiation opportunities. [1]

A catastrophe of civilian origin can often be triggered by pollution caused by the release and uncontrolled spread of hazardous substances or waste, which poses a serious threat to human life, health, and our very life and the environment. In this field, following the Tisza's cyanide pollution in Hungary in 2000 and the red mud disasters that occurred in 2010, the Hungarian population has already received serious lessons from these.

However, humanity has been threatened by other threats, such as devastating epidemics, for centuries. Most of these, including occasional seasonal influenza pandemics, are relatively easy to overcome thanks to increasingly high levels of public health systems. On the other hand, we are much less armed against the Covid-19 epidemic, which has not yet been sufficiently "mapped" by our immune system in the evolutionary race. This is currently spreading dangerously in the world. [2]

2. DISASTERS WORLDWIDE

Natural disasters have been documented by humanity since before our time, but statistics have only been compiled since the 19th century. ***Figure 1*** shows that the number of disasters has increased exponentially over the past 118 years, averaging 111 per year between 1900 and 2018. [3] This is also because the population is constantly growing, expanding, thus using the Earth's resources and engaging in highly polluting behavior. Humanity has grown from 1.65 billion to 4.67 times to 7.7 billion in nearly 120 years. A highlighted continent is Asia, where, according to a 2017 survey, the population density per location can be up to 1,252 people per square kilometer, such as in Bangladesh. [4]

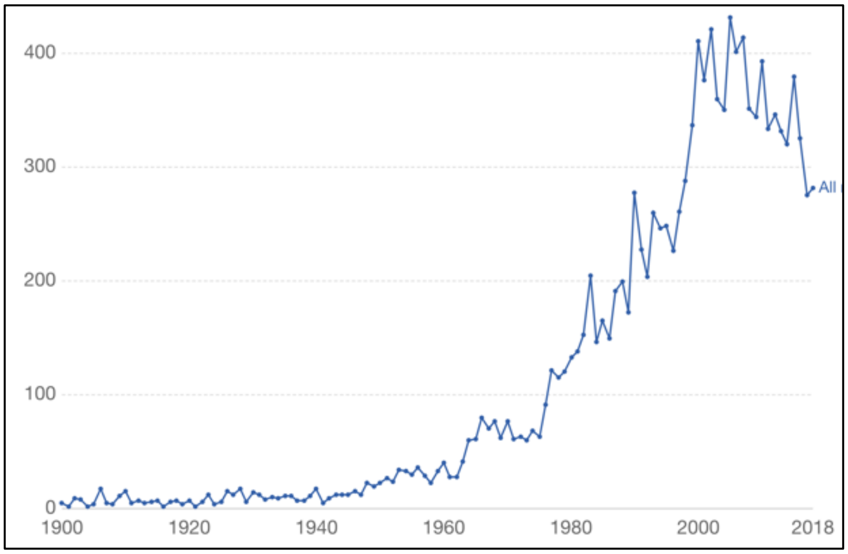

Figure 1. - Number of disasters between 1900-2018 [3]

Figure 2 ***shows the 9 most common natural disasters between 1970 and 2018, of which floods and extreme weather are prominent, followed by earthquakes, extreme temperatures, and droughts***. [3]

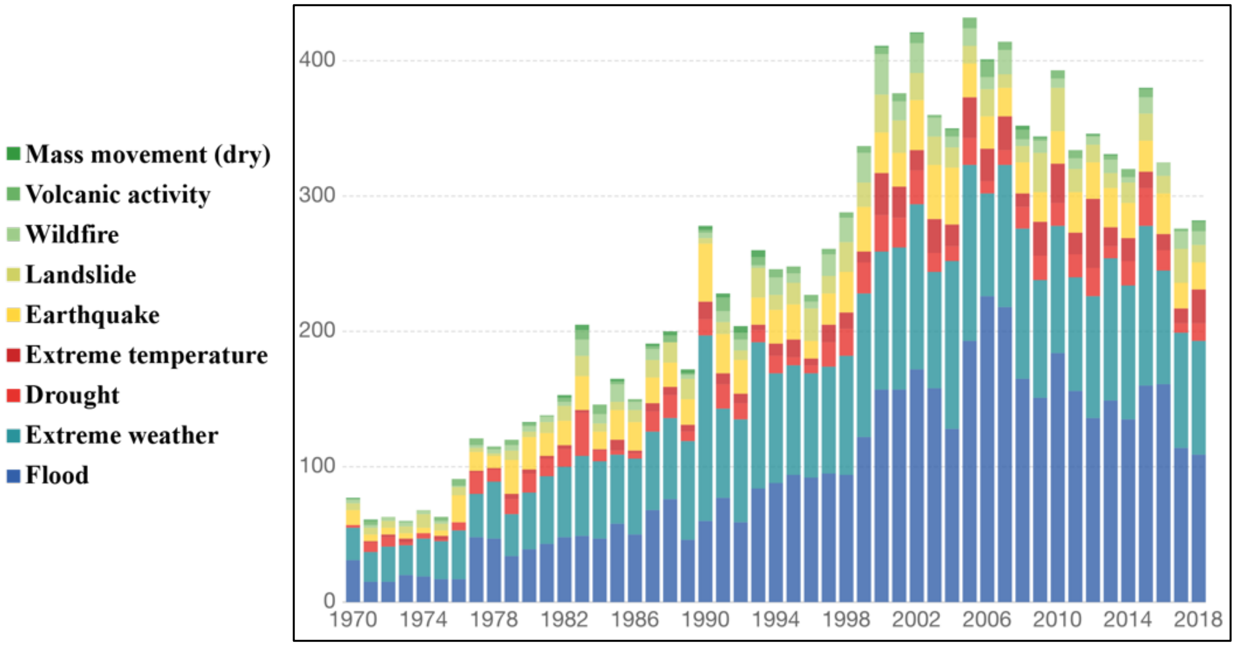

Figure 2. ***- Distribution of disasters between 1970 and 2018*** [3]

Analyzing the figure shows that between 2005 and 2007, a record number of 212 floods per year was registered worldwide. According to a study examining the relationship between natural disasters and migration, this period covers the inability of people to live in a constantly flooded region, forcing them to move, which can be global to move between countries and continents, thanks to the constantly evolving transport. [5] In Thailand, the largest-ever flood in 2005 was measured between 29 September and 2 October in Chiang Mai, caused by Typhoon Damrey, with 867 m^3 / s. ***Figure 3*** shows that a precipitation level of 200 mm was measured on 29 September, which can be considered a record amount.[6] As a result of the rain, the soil structure changed in the areas that have been submerged for a longer period of time and started increasing of soil erosion.

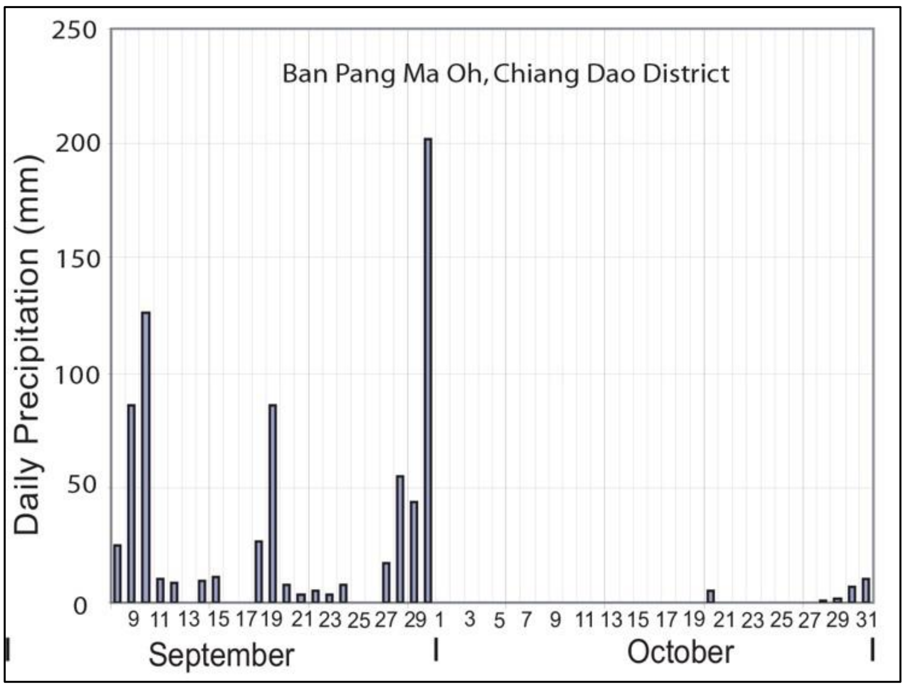

Figure 3. - ***Daily precipitation around Chiang Dao***, 2005 [6]

The risk of high hydrological disasters in Hungary. On the one hand, this means the recurrence of inland water damage, and on the other hand, the flood waves on our surface watercourses have posed a threat. Floods in surface waters are threatening more and more severe floods as a result of human activity in the global environment. [7]

Climate researchers predict drier weather on a global scale for the coming decades. In some regions of the earth, groundwater recedes into deeper layers, which also affects drinking water supply. Thus, the people living there are forced to provide adequate drinking water from other sources, which may in some cases involve the installation of water treatment equipment, as has become necessary in connection with the arsenic removal of water bases in the regions of south-eastern Hungary. While elsewhere, as in Hungary, they warn of the increasing hectic nature of weather phenomena.

In addition to water damage, fire damage is also significant on an annual basis. Unfortunately, we can already see that in more than one case the result of deliberate arson is the appearance of extensive forest fires. [8]

In this area, special attention should be paid to Hungary in the early spring period, when the forest can become inflamed due to meadows and stubble burns. Furthermore, the prolonged rainfall-free, hot weather that arrives during the summer also significantly increases the chances of forest fires fed by dehydrated biomass. [9]

3. DISASTER PREVENTION AND PROTECTION

Article 53 of The Fundamental Law of Hungary deals with the emergency, with its definition, roles, and responsibilities according to which.

„(1) In the event of a natural disaster or industrial accident endangering life and property, or in order to mitigate its consequences, the Government shall declare a state of danger, and may introduce extraordinary measures laid down in a cardinal Act.

(2) In a state of danger, the Government may adopt decrees by means of which it may, as provided for by a cardinal Act, suspend the application of certain Acts, derogate from the provisions of Acts and take other extraordinary measures.

(3) The decrees of the Government referred to in paragraph (2) shall remain in force for fifteen days, unless the Government, on the basis of authorisation by the National Assembly, extends those decrees.

(4) Upon the termination of the state of danger, such decrees of the Government shall cease to have effect." [10]

In the event of disasters, law enforcement agencies and citizens have 3 main chronological tasks.

- Preparing for danger;
- Save, repair;
- Restoration, reconstruction.

With regard to possible future events that may occur in connection with a suspected disaster situation, the risk analysis prior to the above-mentioned preparation is essential, which is a professional task of high importance in the current system of tasks of a professional disaster management organization. Although the methodology is different from the methodology used in a professional disaster management organization, the standard ISO 31000: 2018 Risk Management and Guidelines also deals with risk management. Among other things, the standard sets out principles and processes for companies to prevent, manage and recover from a potential emergency. [11]

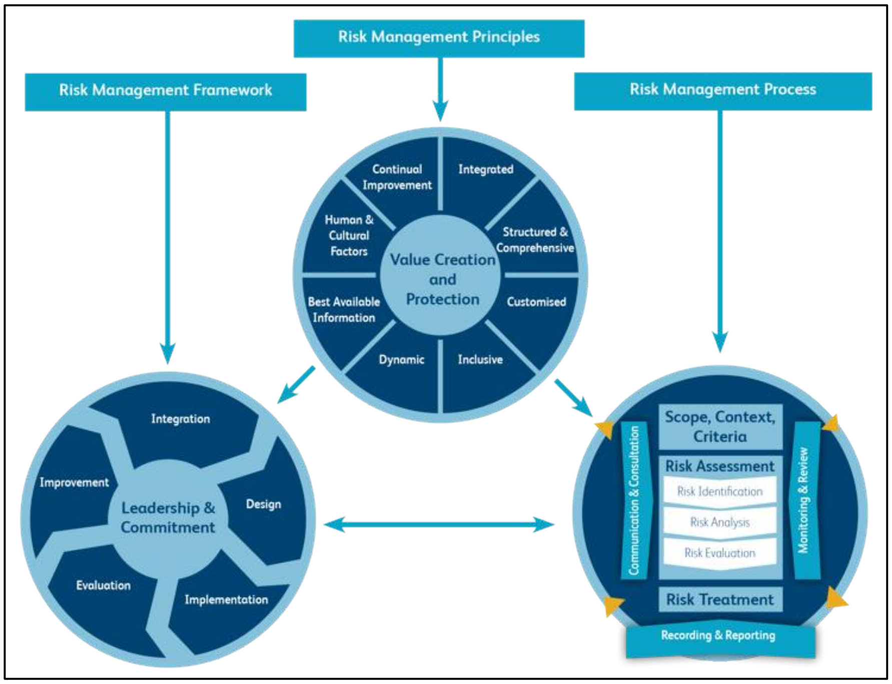

Figure 4. - ***Principles and processes according to ISO 31000*** [11]

The 234/2011. (XI. 10.) of the Government Decree, disaster protection classes have been defined, which classify the hazards based on the occurrence frequency and impact. ***(Table 3)***

Table 1. **- Disaster management classification** [12]

Impact	**Occurrence frequency**			
	Rare	**Infrequent**	**Frequent**	**Very frequent**
Very serious	II. class	II. class	I. class	I. class
Serious	III. class	II. class	II. class	I. class
Not severe	III. class	III. class	II. class	II. class
Low	III. class	III. class	III. class	III. class

According to the frequency and statistical probability of occurrence, the following categories are distinguished:

- **rare**: it is unlikely to occur in the next few years (10 years),
- **infrequent**: may occur but is unlikely to occur within a few (5) years,
- **frequent**: likely to occur within a few (3) years,
- **very frequent**: it is very likely to occur at least once or several times in a year.

Level of hazardous impact:

- **very serious**: an event involving fatalities or irreversible damage to the environment or serious financial consequences,
- **severe**: an event causing serious injury or reversible environmental damage, as well as material damage,
- **non-serious**: an event that causes minor injuries, does not cause environmental damage or does not cause significant material damage,
- **low**: it does not cause an injury that requires medical attention, nor does it have any financial consequences. [12]

4. APPLICATION OF IT SYSTEMS IN DISASTER PREVENTION

In 2015, the IT system of Disaster Management was renewed in Hungary. A centralized, efficient management system was set up, based on the 2010 red mud disaster, as information could not reach stakeholders slowly when the disaster occurred. Furthermore, the number of sites increased to 200, so an IT expansion and modernization was necessary. 1247/2011 contributed to this. (VII. 18.) Government Decree, in which the Electronic Public Administration Operational Program 2011-2013. "Increasing the decision support role and security of disaster management IT systems" was a priority in its 2007 Action Plan. called construction.

The investment covered 4 priority areas:

- Info communication technology;
- IT infrastructure;
- Complex GIS system and application developments;
- Fixed and mobile driving points, training room.

In addition to the modernization of the networks, the endpoint, monitoring and detection systems were also renovated, amounting to approximately HUF 1.5 billion. Also, great emphasis was placed on education and training, resulting in a training center for system operators and users.

New deployment management and registration system have been developed, and state-of-the-art micro-UAV devices have been introduced to help identify a dangerous area quickly and efficiently. [13]

Analyzing the international market, there are different systems for forecasting, preventing, and monitoring each disaster type. Japanese researchers have developed a system for predicting tsunamis after a subsea crustal movement that induces a subsequent flood. Figure 5 shows that they are working with live data, running the data on a simulation system when the earthquake, which evaluates the incoming data, models the possible consequences, damage, and the extent of the tsunami, and then notifies the authorities and the public. [14]

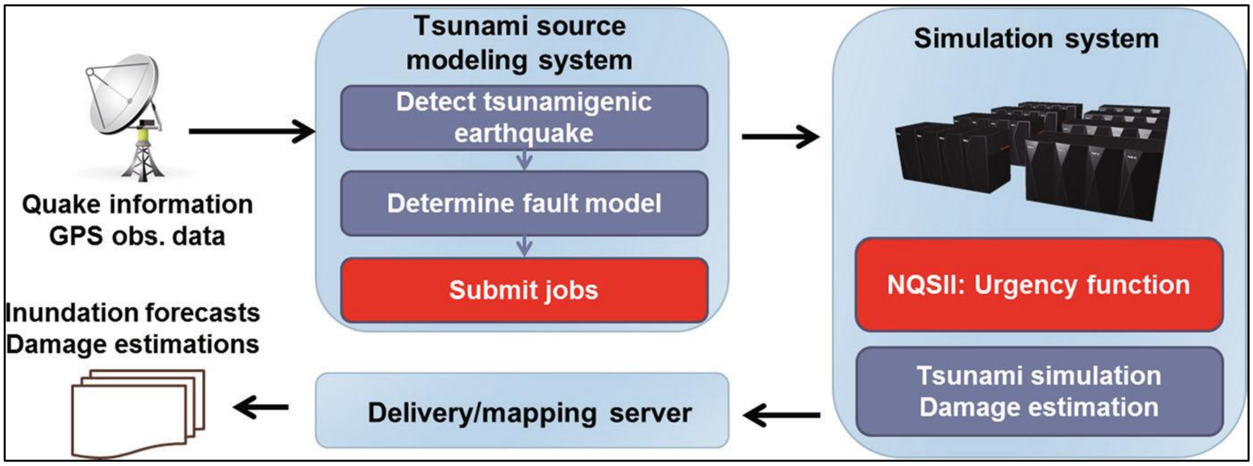

Figure 5. - ***Live flood modeling flowchart*** [14]

Thailand is significantly affected during the hurricane season when vast amounts of rainfall and landslides hit the country. One study is concerned with using a wireless sensor network to detect and monitor the landscape during this period. The Portrait-based Disaster Alerting System (PDAS) or image-based disaster forecasting system uses live images of the area supported by data from additional sensor sensors and then together with GPS coordinates on a wireless network (GSM, GPRS, IEEE802). 11x) transmitted to the center. At the center, the measured result is compared with the default values, then the simulation is performed with the help of MATLAB, the risk is analyzed, and then the data is transmitted. Thus, continuous observation in critical areas and timely prevention of a possible further catastrophe of civilization. ***Figure 6*** illustrates the analytical model and processes that researchers work with. [15]

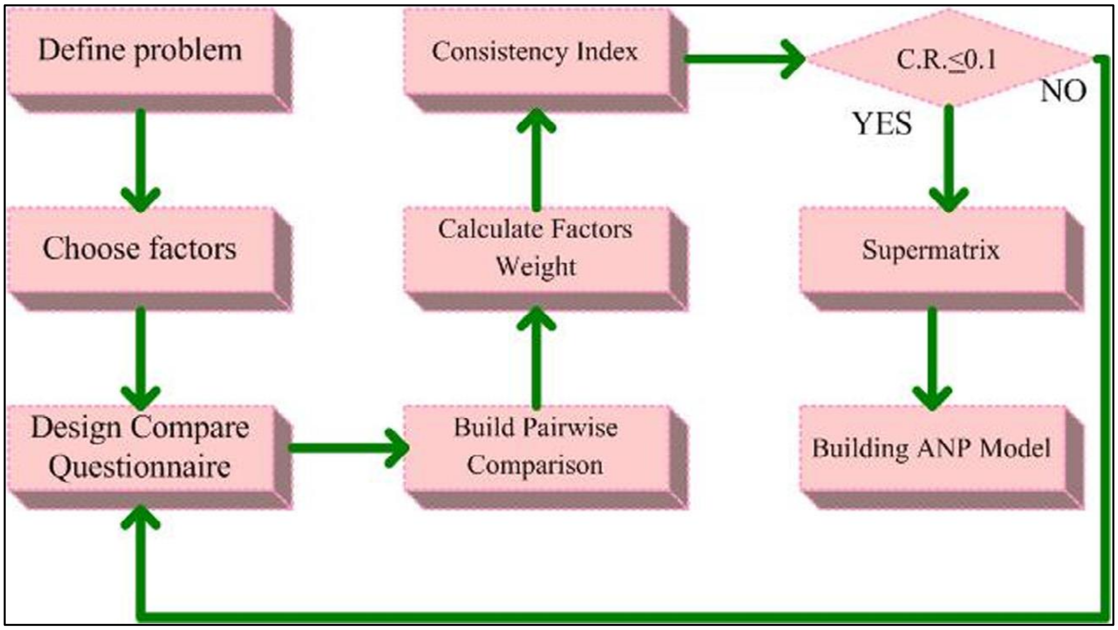

Figure 6. - ***Network analysis model*** [14]

In China, disaster protection is a significant challenge for the government and the population, causing enormous social and economic damage annually. Most existing systems operate passively, so it is not possible to make 100% use of resources. One study addresses a specifically event-focused mechanism that can use the Integrated Disaster Information Service System (IDISS) to predict threats more effectively and accurately. The element of his system here is also a visualization sensor system, but it is further supplemented with data processing units and a notification chain. ***(Figure 7)*** [16]

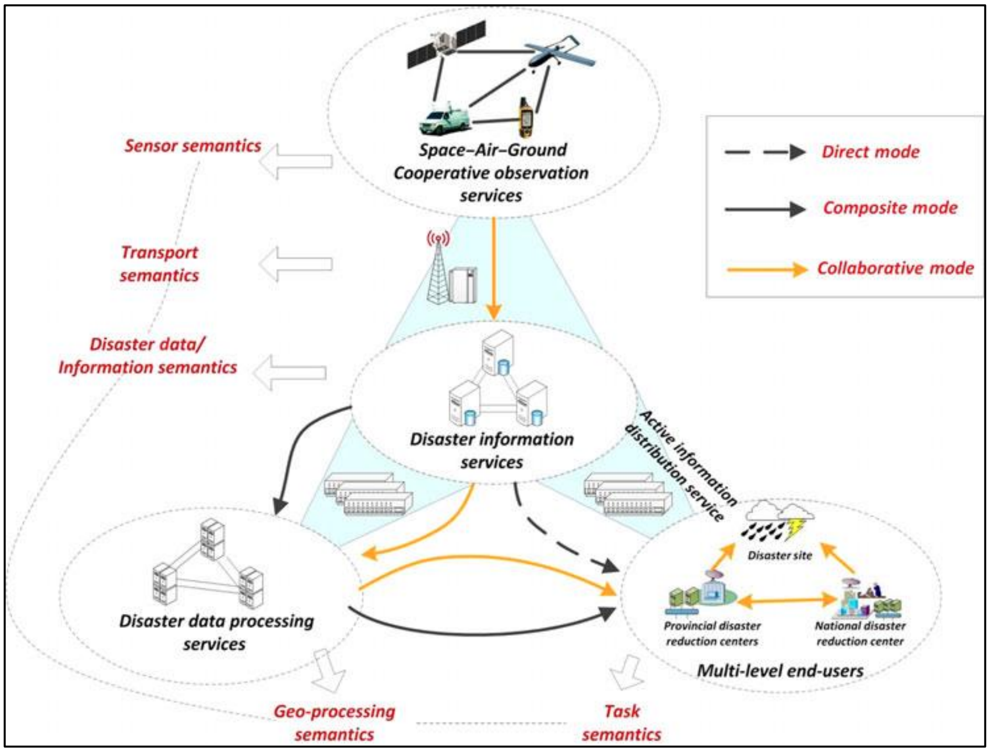

Figure 7. – ***Remote control model*** [16]

5. FUTURE IN THE DISASTER PROTECTION AND THE ARTIFICIAL INTELLIGENCE (AI)

Over the past decade, the flow of information and technological advances have reached unprecedented proportions and are steadily accelerating. Networks capable of 5G communication were launched in 2019. New wireless standards will be introduced in the 2.4 and 5 GHz range, outstanding research results in the field of artificial intelligence will be achieved and successfully applied by companies and big data professionals and technologies in the data processing. They are continually evolving.

In addition to industry, these technologies are continuously being taken over by law enforcement agencies. State-of-the-art measuring instruments, computer equipment, specialists, and technologies are needed when a disaster occurs or is prevented. In collaboration with the authorities, researchers and professionals are continually processing the measurement data so that a possible natural disaster, such as a flood or drought, can be predicted more and more accurately.

One of the most useful data analysis methods is artificial intelligence (AI), which is essentially a vast, continuously learning database model, where professionals in real-time perform correlations and event correlations. For this purpose, a system (UrbanFlood) has been developed, predicting and modeling a possible flood based on the received data, previous measurements, and trends. To do this, a module has been developed that can be accessed and managed via a web interface. Figure 8 shows a flow chart of the MI module of UrbanFlood, which is responsible for the measurement, analysis, and display processes. [17]

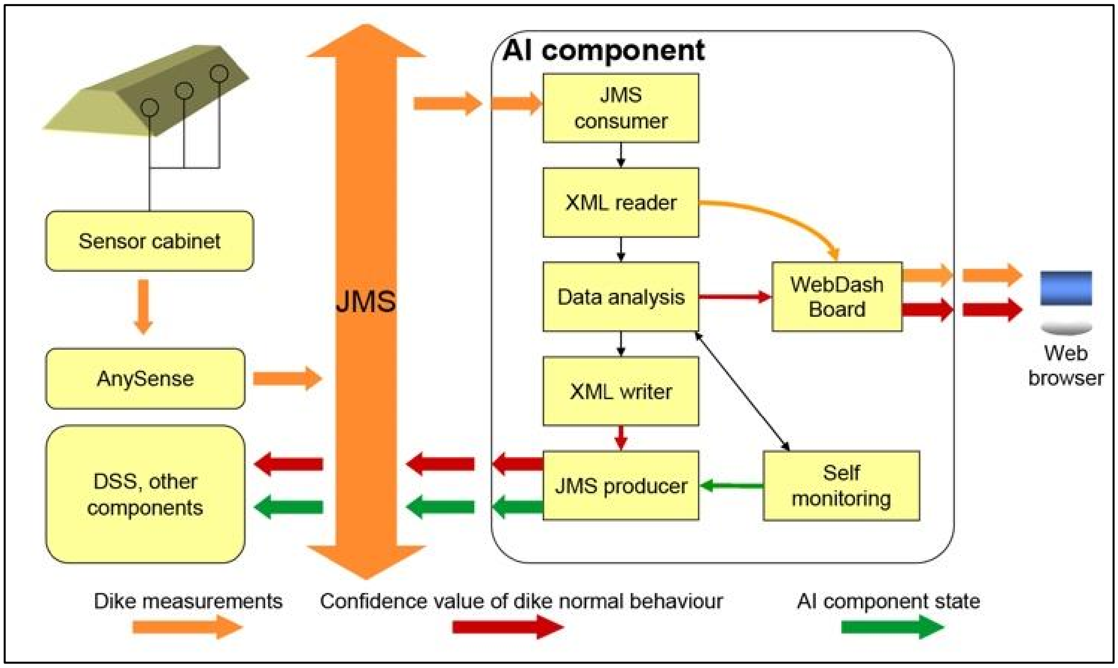

Figure 8. – AI component of a notification system [17]

6. CONCLUSION

Disaster prevention and management always requires IT support. The continuous development of information technology greatly contributes to the prevention of future disasters and the minimization of damage. The use of artificial intelligence is essential to process, manage, and understand the ever-growing data set provided by the expanding sensor base and data from our devices. Thus, it is likely that in the future we will encounter more and more of these technologies in conjunction with quantum computers, such as the Q System One launched by IBM in 2019. [18]

Thanks to constant international cooperation and knowledge sharing, defense agencies are constantly evolving and acquiring new techniques for defending against threats. Thus, even together, they can curb a global natural disaster or mitigate its damage.

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