EMERGENCY SEPARATION AND CLASSIFICATION IN DECISION SUPPORT SYSTEMS

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In this article, we will discuss what kind of structure should be given to the decision-making automation system in real life emergency situations, the task of which is to make the information flows manageable as a result of the collected information, to optimize the flows, filters and for the purpose of making decisions. The collected information usage in uncertainty situations brings confusion because of a lot of information. For having optimised database, it is needed to be classified, and separated by the meaning, dated, divided into levels, separated depending from the physical location and so one. Information structure decomposed by detail can bring clear image of the situation and targeted decision. In scope of this article, we look at cases of the classification model and make a choice. We will bring the systematic application of the classifications in the situations of uncertainty of disasters and the circumstances of arriving at decisions.

Keywords: Classified information flow, separated disaster, decomposed management, uncertainty, emergency situations, emergency response

Material and methods

Different forms of emergencies such as natural disasters, pandemics, and conflicts bring about many challenges that are uncertain. Responding to this kind of situation becomes an uphill battle if one cannot clearly understand what the situation is like. This is where classification comes in handy. By classifying emergencies based on factors such as severity, origin, and nature, responders can more effectively identify the unique challenges of each scenario and allocate resources efficiently for response efforts. In a Decision Support System (DSS) context, it is the "Object" not the "Subject", which are disasters. This distinction is important because it makes clear that decision-making and support revolve around disasters. The DSS serves as a tool that enables first responders to analyze and interpret disaster information, allowing them to make informed decisions (see Table 1).

Table 1.

Disasters List and Classification.

Technological Disasters	***Environmental Disasters***	***Natural Disasters***	***Biomedical Disasters***
Industrial accidents (chemical spills, nuclear incidents)	Wildfires	Earthquakes	Viral outbreaks (e.g., COVID-19)
Cyberattacks	Floods	Hurricanes/Typhoons	Influenza pandemics
Infrastructure failures	Volcanic eruptions	Tornadoes	Ebola outbreaks
		Tsunamis	

This classification highlights the diverse range of disasters, each with its unique characteristics and response requirements.

Table 2.

Classification.

By Severity	*By Nature*	*By Cause*
Catastrophic	Geophysical (earthquakes, volcanic eruptions)	Natural (earthquakes, hurricanes)
Major	Meteorological (hurricanes, floods)	Human-induced (industrial accidents, terrorism)
Moderate	Biological (pandemics, epidemics)	
Minor	Technological (industrial accidents, cyberattacks)	

We need to classify. Classification serves several purposes within the context of a DSS:

- Enhanced Understanding: Classification provides a structured framework for understanding the diverse range of disasters that may occur.
- Tailored Response: Different types of disasters require distinct response strategies. Classification enables responders to tailor their approach based on the nature and severity of the disaster.
- Resource Allocation: By classifying disasters, responders can prioritize resource allocation, ensuring that critical resources are directed to where they are most needed.
- Risk Assessment: Classification facilitates risk assessment and mitigation by identifying vulnerabilities and potential hazards associated with each type of disaster. [1,3,4]

Research results

Furthermore, any sound disaster management strategy must have necessary information gathering systems before during and after emergency situations. Historical data alongside vulnerability assessments inform preparedness plans and early warning systems before a catastrophe occurs. Real-time data, combined with surveillance, supports immediate response efforts during a crisis. Consequently, damage assessment, as well as recovery plans become vital for reconstruction purposes, as well as drawing lessons from past occurrences. Figure 1-4 shows the proposed classification model.

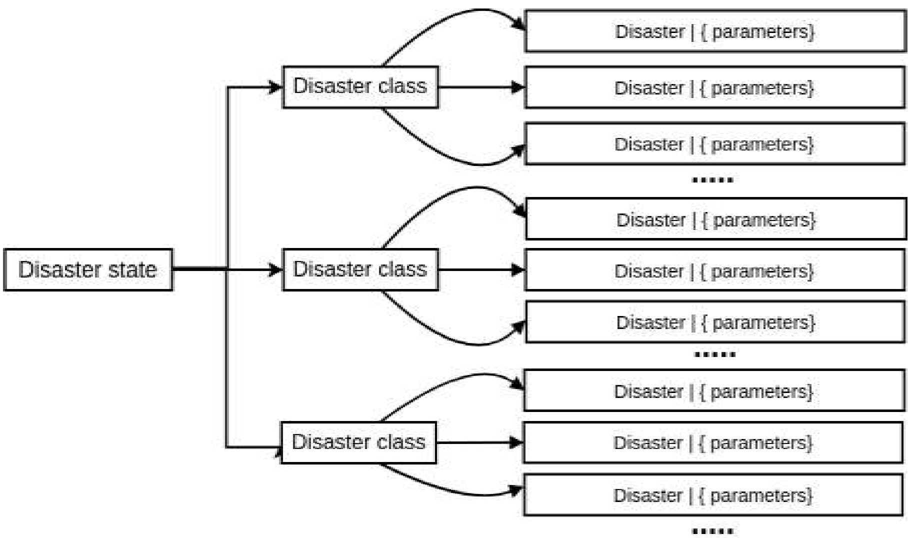

Fig. 1 Disaster classification model

This section emphasizes how information should be systematically collected during different stages of emergency response.

Let us classify this material based on disaster types and emergency stages, focusing specifically on the 'before-disaster' phase:

Below is an example of ‘Before Disaster’ case:

- Earthquakes: Past incidences; Hurricanes/Typhoons; Floods; Wildfires; Tornadoes; Tsunamis; Volcanic eruptions,
- Infrastructure/community vulnerability studies: Earthquakes, Hurricanes/Typhoons, Floods, Wildfires, Tornadoes, Tsunamis, Volcanic Eruptions,
- Earthquakes: Preparedness and mitigation plans; Hurricanes / Typhoons, Floods, Wildfires, Tornadoes, Tsunamis, Volcanic Eruptions.

Pandemics:

Historical data on past occurrences of similar disasters include viral outbreaks like COVID 19, influenza, pandemics and Ebola outbreaks. Another type of information that can be gathered from the before disaster phase is infrastructural vulnerability assessments with regard to virus outbreaks, such as COVID 19 flu pandemics and Ebola outbreak. On the preparedness and mitigation front, another example of a 'before-disaster' information source is data on viral outbreaks—such as the COVID-19 pandemic or influenza—that can be used to anticipate and manage potential health crises. The second instance is early warning systems which includes viral outbreaks such as Covid 19, influenza, pandemic, Ebola outbreak. [1,2]

Man-made Crises:

Industrial accidents (chemical spills, nuclear incidents), terrorist attacks, civil unrest, and cyber-attacks are some historical data that could be used for reference when it comes to manmade crises. Another type of information that can be obtained from the before disaster phase is vulnerability assessments with regards to industrial accidents like chemical spills, nuclear incidents, terrorist attacks and civil unrest. Another example is in the area of preparedness and mitigation where information about industrial accidents, for instance, chemical spills would be obtained. [6] An example of this is an early warning system, which can be used to monitor industrial accidents—such as chemical spills—and technological disasters like cyberattacks, among others (see Fig. 2).

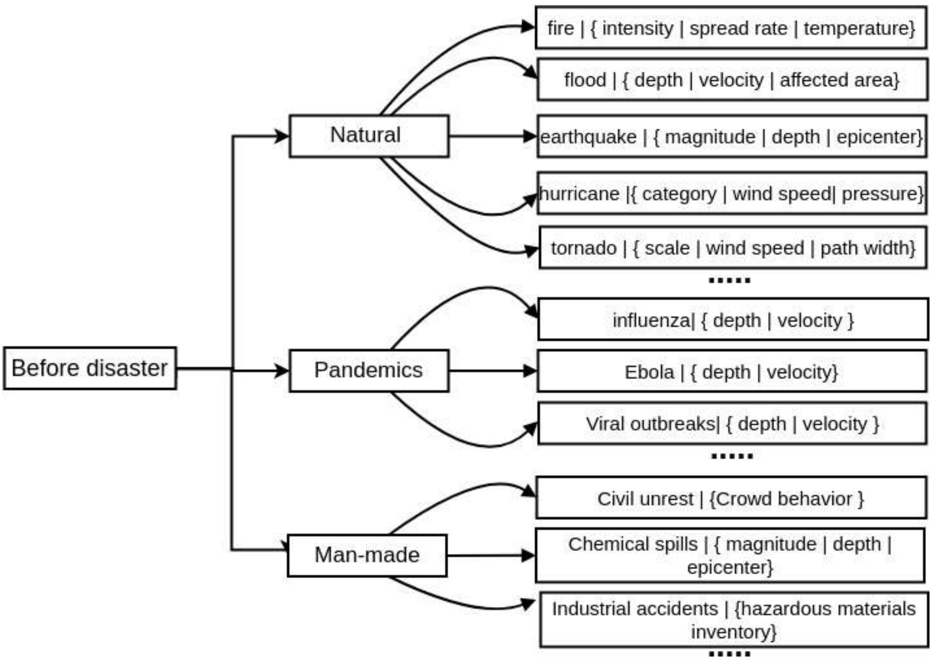

Fig. 2. Classification model for before disaster's case

Now let us consider the 'During Disaster' case:

All Kinds of Disasters:

- Real-time data on unfolding situations such as weather predictions and seismic activities,
- Surveillance videos and satellite images,
- Reports from emergency responders and eyewitnesses,
- Monitoring of social media for situational awareness.

Now let us consider the 'After Disaster' case:

All Kinds of Disasters:

- Evaluations of damages and post-event analysis,
- Health surveillance data for monitoring the spread of diseases,
- Recovery plans and reconstruction strategies,
- Lessons learned and best practices for future disaster management.

This structured breakdown highlights information types, which can be gathered before, during, and after different types of disasters. It further emphasizes that comprehensive preparedness, timely response, and effective recovery efforts are crucial in reducing impacts of emergencies.

In the context of decision theory applied to natural hazard management, decisions are made based on the evaluation of expected consequences, trade-offs between objectives, risk levels, and the expected utilities of various response strategies for different types of emergency events. Some examples illustrate the kind of decisions that can be made within this framework:

1. Resource Allocation Decisions:

   - Deciding how to distribute scarce resources such as staff, equipment, or stock among different kinds of hazards based on their seriousness or likely implications.
   - Weighing up between allocating resources toward immediate response versus longer-term recovery considerations.

2. Evacuation Planning:

   - Assessing alternative evacuation options by type(s)of disasters in relation with factors such as population density; number/condition/availability; etc..
   - Determining the risk levels related to diverse evacuation plans, as well as optimal resource allocation required for implementing them.

3. Risk Mitigation Strategies:

   - Identifying those measures that should be given priority in terms of their anticipated efficiency towards reducing both likelihoods and effects arising from risks.
   - Balancing between proactive approaches aimed at avoiding catastrophes and reactive measures targeting the amelioration of the effects.

4. Emergency Response Coordination:

   - Ensuring a unified disaster response through coordination among different players such as government agencies, emergency responders, and local community organizations.
   - Evaluating the utility values of various coordination strategies and decision-making processes in terms of their ability to manage disaster response.

5. Recovery and Reconstruction Planning:

   - Plans for post-disaster recovery or reconstruction which are based on expected impacts or possible trade-offs involved in several recovery alternatives
   - Assessing the risk levels and expected utilities of different reconstruction options with respect to restoring communities as well as infrastructure back to pre-disaster states.

Through employing decision theory principles like expected value, utility theory, and risk analysis, the policy makers can be able to make informed decisions to effectively manage disasters. Such decisions aim at minimizing negative impacts of disasters while maximizing benefits of response efforts so that they ultimately increase society's resilience against future hazards.

We can examine two distinctly different cases: one involving flooding and the other an earthquake. In both cases, we will look at the parameters before a disaster has occurred and how abrupt changes in these parameters lead to immediate response. Floods, which have this potential to destroy landscapes and societies are characterized by constant monitoring of water levels, intensities of rainfall and so on. Similarly, for earthquakes that come suddenly and without any prediction, magnitudes, depths and seismic intensities are important factors to consider when assessing an earthquake hazard. The examination of these situations emphasizes the importance of early warning systems, as well as quick decision-making processes in dealing with natural calamities.

A Real Case: Alteration in Parameters Relating to Flooding

The scenario example is

What Happened:

A severe weather system moved into the area, bringing torrential rainfall over a short period. The intensity of the downpour exceeded typical levels, leading to rapid flash flooding in local rivers and tributaries.The result was an abrupt rise in river levels and subsequent floods.

Table 3.

Real case from Flood disaster

Flood disaster		
Parameters	**Before Disaster**	**Checked Parameters**
Water level	2.5 meters	Increased to 3.8 meters
Discharge	500 cumecs	Rose to 800 cumecs
Duration	24 hours	Ongoing with forecasts predicting continued rainfall for the next 12 hours
Rainfall intensity	20 mm/hr	Surpassed 50 mm/hr
River discharge rate	300 cumecs	Jumped to 600 cumecs
Floodplain analysis	No significant flooding observed	Extensive flooding observed in previously unaffected areas
Flood recurrence intervals	100-year flood event	This event surpassed the 100-year flood threshold.

Area Size Consideration:

- Affected area expanded rapidly due to increased water levels and discharge rates. Further evacuation orders were issued for neighborhoods that faced risk of being submerged.

Prospective Analysis:

- Water levels and discharge rates were expected to continue rising due to the forecasted rainfall, combined with existing flood conditions that further worsened the situation.

Historical Archive Review:

- Similar past flood events were reviewed to gain insights into effective response strategies and to identify areas of vulnerability.

Decision-Making:

- Evacuation orders were extended to more areas at risk.
- Emergency shelters opened for those residents who had been displaced.
- Search and rescue teams dispatched for stranded individuals
- Road closures and traffic diversions implemented to ensure public safety.
- Relief supplies and resources got activated in order to support affected communities.
- Continuous monitoring of flood parameters guided ongoing response efforts based on weather forecasts.

In this scenario, changes in flood parameters triggered an emergency response involving fast measures aimed at saving lives and properties from escalating flood menace. The DSS played a vital role in monitoring the evolving situation, supporting the decision-making process, and coordinating real-time responses. [5,6]

The next scenario example is real case from Earthquake disaster

Table 4

Earthquake disaster		
Parameters	**Before Disaster**	**Checked Parameters**
Magnitude	6.0	Recorded at 7.5, indicating a major earthquake event.
Depth	10 kilometers	Shallow depth of 5 kilometers, increasing the potential for surface rupture and ground shaking.
Epicenter	50 kilometers away from populated areas	Located 20 kilometers from densely populated urban areas, increasing the likelihood of severe damage
Seismic intensity	Moderate shaking (MMI V)	Violent shaking (MMI IX) experienced in affected areas.
Ground acceleration	0.2 g	Measured at 1.0 g, indicating strong ground motion capable of causing

		structural failure.
Fault type	Strike-slip fault	Thrust faulting observed, contributing to significant vertical displacement.
Historical seismic activity	Occasional minor earthquakes	Unprecedented seismic event compared to past earthquakes in the region.

The area experienced a powerful earthquake, resulting in significant ground shaking and damage to infrastructure. The size of the earthquake exceeded normal limits so that it led to massive damages thereby posing immediate threats towards public safety.

Response Process:

Acceptable Limit Consideration:

- Acceptable limits were exceeded by these parameters and codes based on historical seismic data.
- Teams for rapid assessment were sent to evaluate damages and prioritize response.

Prospective Analysis:

- Such hazards as aftershocks, landslides and tsunamis have been considered in the ongoing response plan.
- For example, emergency response teams had prepared themselves for continuous search-and-rescue operations and medical assistance to injured people.

Decision-Making:

- Emergency evacuation orders were issued for areas at risk of further structural collapse or secondary hazards.
- Establish emergency shelters, triage centers for medical assistance to displaced persons and injured individuals.
- Assessments by engineering experts were carried out to ascertain the safety status of critical infrastructures such as bridges, dams and power plants.
- Local authorities together with international aid agencies facilitated resource mobilization in support of responding institutions, as well as recovery campaigns.

Public awareness campaigns provided guidance on safety measures, as well as available help to affected communities.

The earthquake's parameters in this case surpassed allowable limits, thus triggering a full-scale emergency response aimed at reducing the effects of the disaster and providing help to affected populations. It played a vital role in analysing the seismic event, guiding decision-making processes and coordinating multi-agency responses in real time.

Conclusion

1. I proposed an emergency separation and classification that are crucial for effective disaster management, aiding in resource allocation, risk assessment, and tailored response strategies.

2. The Decision Support System (DSS) serves as a vital tool for interpreting disaster information and facilitating informed decision-making processes for first responders.

3. The proposed classification of disasters based on severity, nature, and cause enhances understanding, enables tailored response strategies, and facilitates resource allocation and risk assessment.

4. The article introduces comprehensive disaster management strategies that encompass information gathering systems, historical data analysis, real-time monitoring, and post-event evaluation to enhance preparedness, response, and recovery efforts.

5. This decision theory principles guide decision-making processes in managing various types of emergencies, aiming to minimize negative impacts and maximize benefits of response efforts to increase society's resilience against future hazards.

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ՀԱՐՈՒԹՅՈՒՆՅԱՆ ԷԼԵՈՆՈՐ

ՀՊՏՀ տեղեկատվական տեխնոլոգիաների և կիրառական մաթեմատիկայի և ՀՊՏՀ տնտեսական ինֆորմատիկայի և տեղեկատվական համակարգերի ամբիոնի դասախոս

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Հոդվածում քննարկվում է, թե ինչ կառուցվածք պետք է ունենա իրական կյանքում արտակարգ իրավիճակներում որոշումների կայացման ավտոմատացման համակարգը, որի խնդիրն է կառավարելի դարձնել տեղեկատվական հոսքերը՝ հիմնվելով հավաքագրված տեղեկության վրա, օպտիմալացնելով հոսքերը, ֆիլտրերը որոշումների կայացման նպատակով: Հավաքագրված տեղեկատվության օգտագործումը անորոշ իրավիճակներում հանգեցնում է շփոթության՝ տեղեկատվության մեծ քանակի պատճառով: Օպտիմալացված տվյալների բազա ունենալու համար անհրաժեշտ է այն դասակարգել, առանձնացնել ըստ նշանակության, թվագրել, բաժանել մակարդակների, կազմակերպել՝ կախված ֆիզիկական դիրքից և այլն: Տեղեկատվական կառուցվածքը, որը բաժանված է մանրամասների, կարող է հստակ պատկերացում կազմել իրավիճակի մասին և նպատակային լուծում տալ: Այս հոդվածում մենք կանդրադառնանք դասակարգման մոդելի դեպքերին և ընտրություն կկատարենք: Ներկայացնենք դասակարգումների համակարգված կիրառումը աղետների անորոշության և որոշումների կայացման հանգամանքներում:

Բանալի բառեր՝ դասակարգված տեղեկատվության հոսք, տարանջատված աղետ, քայքայված կառավարում, անորոշություն, արտակարգ իրավիճակներ, արտակարգ իրավիճակների արձագանք:

АВАРИЙНОЕ РАЗДЕЛЕНИЕ И КЛАССИФИКАЦИЯ В СИСТЕМАХ ПОДДЕРЖКИ ПРИНЯТИЯ РЕШЕНИЙ

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В статье рассматривается оптимальная структура системы автоматизации принятия решений в условиях реальных чрезвычайных ситуаций, задача которой – сделать информационные потоки управляемыми в результате собранной информации, оптимизируя потоки, фильтры для целей принятия решений. Обилие неструктурированной информации в чрезвычайных ситуациях создает хаос и затрудняет принятие решений. Чтобы иметь оптимизированную базу данных, ее необходимо классифицировать, разделить по смыслу, датировать, разделить на уровни, нагнаивать в зависимости от физического местоположения и так далее. Информационная структура, разложенная по деталям, может дать четкое представление о ситуации и целенаправленное решение. В рамках статьи мы рассмотрим случаи модели классификации и сделаем выбор. Приведем систематическое применение классификаций в ситуациях неопределенности катастроф и обстоятельств принятия решений.

Ключевые слова: Засекреченный информационный поток, отдельная катастрофа, декомпозированное управление, неопределенность, чрезвычайные ситуации, чрезвычайное реагирование.

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