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KNOWLEDGE EXTRACTION FOR DISASTER MITIGATION AND RAPID DEPLOYMENT THROUGH INDICATORS

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Abstract:- **Disaster mitigation demands for rapid deployment of resources in a systematic manner. This needs an immediate assessment of the situation and effective actions plans to limit the fatal-chaining-effects of the adversity. In this work, new categorisation of Disaster is thus proposed. This approach of classification can lead to an altogether different paradigm, to handle the Disasters in a more effective and efficient manner by proper interpretations of the risk and its impact. This paper presents a methodology for utilising the first hand information and GIS to categorise the hazardous situation in a comprehensive manner for proper knowledge extraction. Thus proving it time effective and accurate in deploying the resources involving a disaster mitigation knowledge base**.

Keywords:- **Indicators, GIS, Vulnerability Mapping, Disaster Mitigation, Knowledge Extraction, Knowledge Management, Resource Plan.**

I. INTRODUCTION

The major challenge in disaster mitigation is of rapid deployment of the Resources in an effective manner. This signifies the need to understand the Disaster itself on a wider perspective, so that a comprehensive DM approach could be realized. Because different approaches have used related data and information in their own manner, and therefore there is a need for a common abstraction method related to the Disasters, to overcome the limitations induced by the lack of clear standards and definitions of Hazards and Disasters [1]; which leads to inconsistent reliability and poor interoperability. It has been observed that each of these databases has its own specificity; resulting in classifying the same Disaster in different classes.

The past Disaster related data, records and information about Hazard, Vulnerability, Disasters' impact etc., are very important to make an effective DM plan [2]. However, it has been observed that in the earlier work the Disasters are categorised by their causes; like earthquake, tsunami, wildfire etc., and the DM plans are built taking these into consideration [14].

It may be further noted that the occurrence of one type of Disaster may induce a chain of different type of Disasters [49]. The existing DM plans take the lead with the plan relevant to the first cause and are not holistic so far as cascading of Disasters is concerned [50]. This work also argues that no two Disasters are alike, even occurred due to the same cause and as such they would need different approaches to handle. In this work, it is thus proposed that the Disasters should not be classified or categorised by the cause of the Hazards but on the contrary it should be categorised by the existing and probable effects of the Hazards.

This approach of classification can lead to an altogether different paradigm, to handle the Disasters in a more effective and efficient manner by proper interpretations of the risk and its impact. The following section elaborates such paradigm.

II. DISASTER INDICATORS

This research work proposes to measure the risk and Vulnerability due to the Hazard using a weighted set of 'indicators' [6]. The objective is to classify the Disaster and provide this information to the control centre. In turn to access the knowledge that is required to precisely identify and propose adequate Disaster risk management actions and plans. The proposed system of indicators based classification thus allows for the identification of comprehensive Resource management plan that is required immediately after the Hazard, without any delay [60].

In order to exemplify the effectiveness and easiness to use this methodology, this research work has included a set of aggregate indicators, and are not limited ; thus may further be modified to make the system more dependable.

The Knowledge-Base (KB) for categorisation of Disaster and subsequent Resource Plan generation, in this work, allow a holistic, relative, flexible and comparatively better analysis of Disaster and its management.

At this point, this research is also motivated to foresee the development of a system which gives a way to make the planning and execution activities measureable based on these indicators [62]. It may be noted that all other methodologies have complexity of what is to be measured and what can be achieved, and pose limitations of obtaining a measurement model.

This system of risk indicators enables managing the current Vulnerability and risk situations in a more trusted way. In this work, the indicators have been selected to represent the main elements of the Vulnerability and threat.

The system of indicators covers different key areas of the Disaster risk issues, such as:

- Population at risk;
- Potential damages & infrastructure losses;
- Time of occurrence, that make particular regions more sensitive;
- Location and area of coverage;
- Climatic conditions of the region;
- Utilities at risk;
- Hazard severity of the area etc.

The Vulnerability and Hazard maps are obtainable from GIS [30] and play a very important role in this system of indicators, related to provide information like population and infrastructure at risk etc. Serious efforts are being put to develop the Vulnerability and Hazard mapping and zoning throughout the globe [31]. Researchers are also emphasising the standardization and interoperability of these data and information [14].

III. GIS AND VULNERABILITY MAPPING

A Vulnerability map gives the precise location of sites where the peoples, environment or properties are at risk due to a potentially catastrophic event that could result in death, injury, pollution or other destruction. Such maps are being developed in conjunction with information about different types of risks [32]. A Vulnerability map typically can show the housing areas that are vulnerable to a chemical spill at a nearly factory. Vulnerability maps are created using ICT, like geographic information systems (GIS), digital land survey equipment etc. The maps also include different classes with their attributes and weight values.

Vulnerability mapping can allow improved information about threats and its risks. It allows for a better visual representation and understanding of Vulnerabilities, so that decision -makers can see where and when Resources are needed for protection of these areas [33]. The Vulnerability maps will allow to decide about the mitigation measures to prevent or reduce loss of life, injury and other consequences like damage to environment, property etc. before a Disaster occurs. This has two advantages like: firstly, future planning in the area under consideration can be done with appropriate care and secondly, during an Adversity, proper prior planning could be done.

It means Vulnerability maps can be of use in all the phases of Disaster Management: preparedness, prevention, mitigation, operations, relief, recovery and most importantly the lessons-learned, which could continuously help improve all these functions.

In the prevention stage the planners can use Vulnerability maps to avoid high risk zones while developing areas for housing, commercial or industrial use; Fire departments can well plan for a rescue operation; multiple Disasters can be envisaged and rescue operations could be planned accordingly; and can also be used to plan evacuation routes and moving special groups such as senior citizens, children and handicaps. The operation officers can be updated about the Disaster situation, and the need for and the location of sensitive areas. The Vulnerability maps can also include evacuation routes to examine their effectiveness for saving lives.

Even after the Disaster, the Vulnerability map and a new intermittent map showing the extent of the damage can assist in assessing how well the emergency was managed. During a Post-Disaster review, the consequences of the Disaster can be easily assessed with the help of field data. The evaluators can see whether an accurate assessment of vulnerable areas was made.

IV. KNOWLEDGE MANAGEMENT SYSTEM

In the discussions above it has been found that a lot of relevant information is available in the form of GIS for use in Disaster Mitigation and planning, however in an unmanaged manner, and could be further worked on to make it more effective over time. This leads us to conceive a system which could be developed on better formal grounds. This motivates us to explore and propose use of the technologies like Knowledge Management (KM) and Data Mining instead of conventional approaches of scheduling and searching, which are proved to be time consuming.

According to [40] a Knowledge Management System (KMS) is the ‘IT (Information Technology)-based system developed to support and enhance the DM team in knowledge creation, storage/retrieval, transfer, and application’. Maier [42] extended the concept of the KMS by integrating it with an ICT (Information and Communication Technology) system which can support and enhance the functions of knowledge identification, collection, transformation, structuring, appraisal, validation, sharing, preservation, progression, collaboration and deployment. KMS uses a variety of technologies designed to enhance knowledge storage and knowledge communication/transfer.

KM success has been defined as reusing knowledge to improve DM effectiveness by providing the appropriate knowledge to those who need it [41], [44]. KM is expected to have a positive impact on the DM, as it improves DM efficiency and effectiveness using the dimensions of impact on mitigation process, strategy, leadership and organizational culture.

V. KNOWLEDGE MANAGEMENT FOR DISASTER MITIGATION

This work also argues that the Knowledge Management, KM, in the domain of DM, is the methodology of selectively applying knowledge from previous experiences of decision-making in Disaster situations, to the current and future decision making activities, with the purpose of improving the Disaster Management effectiveness.

In IT arena, KM is a discipline of IT which leads to an actionable paradigm; knowledge needs to be used and applied for proper actions required in DM to have an impact. IT is a proven tool which could enable communication between knowledge creators and/or possessors and Knowledge users.

This research work has chosen to use knowledge in two ways; by linking concerned knowledge of the past DM experience to those performing the present DM task, and by supporting knowledge sharing and collaboration between knowledge users and experts. Thus a Knowledge Management so conceived for DM, is the system to aid DM team in identifying, sharing, retrieving, and using knowledge they need.

The Knowledge related to Disaster is never absolute, it is rather more judgemental and thus fuzzy in nature; where certain variables cannot be expressed numerically, and would need qualitative ranking appropriate to take Hazard Mitigation decisions. For example, this work introduces terms such as: 'high', 'moderate' and 'low' to assess a hazardous event.

The indicators used in this work are chosen through an extensive review of the risk management literatures [6], [60] assessment of available data, and broad-based feedback, consultation and analysis. These indicators get populated further while monitoring the events over time, in terms of risks and their causes.

The main advantage of a DM system lies in its ability to act on the Disaster by identifying factors that would lead immediate risk management actions, while measuring the effectiveness of those actions. The main objective is to facilitate the development of a Pre-Disaster plan which could be acted upon as per the need at the time of a Hazard. In other words, a Disaster Mitigation plan would be ready before hand to avoid any delays.

The prevalent Vulnerability map; which highlights the Vulnerability in a three dimensional space, should form part of a system of indicators that allows the implementation of effective prevention, mitigation, preparedness and risk transfer measures to reduce the risk [33].

VI. KNOWLEDGE-BASE AND RESOURCE PLAN

After the categorisation of the Disaster the task is to understand the overall Resource requirement for complete mitigation. A little delay in Resource allocation and mobilization may result into increased fatality and infrastructure losses, so the utmost priority is to get the Resource Plan as soon as the Disaster information is received; including the precedence of these Resources, in order to deliver their responsibility effectively.

In this research, it is proposed to have first-hand Disaster information from the Actor/Source (referred as Initial Disaster Information - IDI in this work) and may be authenticated by the Resources in action deployed at the site later on (referred as Resource-authenticated Initial Disaster Information - RIDI in this work). This information will be comprised of direct (which will be utilised as it is) as well as indirect indicators. Information of indirect indicators is derived from the GIS & Vulnerability maps. These consolidated indicators will lead to define the category of the Disaster. It is already mentioned that this research work has taken these indicators on the fuzzy scale as 'low', 'medium' and 'high'.

The Fig. 1 explains the knowledge extraction. This comprises of various database artefacts and components as shown. The format of the first-hand information (IDI) could be in a tabular form and typical android application can be developed to enable and prompt Actors to reply. This will also include the details of the latitude and longitude of the location from where the information is sent.

This detail will act as an input for the proposed GIS system. The GIS system along with Vulnerability map will be able to extract other indicators like population at risk, climatic conditions etc. These indirectly derived indicators along with the direct indicators will now act as an input for the next stage to conclude for the category of the present Disaster. The Disaster category is a comprehensive table having indicators' degrees/values in rows for the corresponding Disaster category mentioned in the columns [60].

The Disaster category information will now be an input for the next stage of the system which will generate the Resource Plan. This research work hereby proposes to break-up the entire Disaster Management plan in the suitable time periods or cycles so that entire mitigation plan can be understood transparently. The Resource Plan will give the details of all the Resources required on each time cycle as shown in the Fig. 4.1, providing the chronological order of all the Resources required to mitigate the Disaster [60].

This table will also generate their corresponding precedence, as without this management plan will not be effective. In this table the Resource sequencing details are displayed in the rows for entire time cycles as shown in the columns. This Resource scheduling will then be utilised by the Control Centre for the verification and the availability of the Resources at that particular moment to finally execute the management operations.

The experience gained in handling each Disaster is very vital and should be used to update the knowledge source so that it becomes more and more matured over time to take any future challenge in another Disaster situation [43].

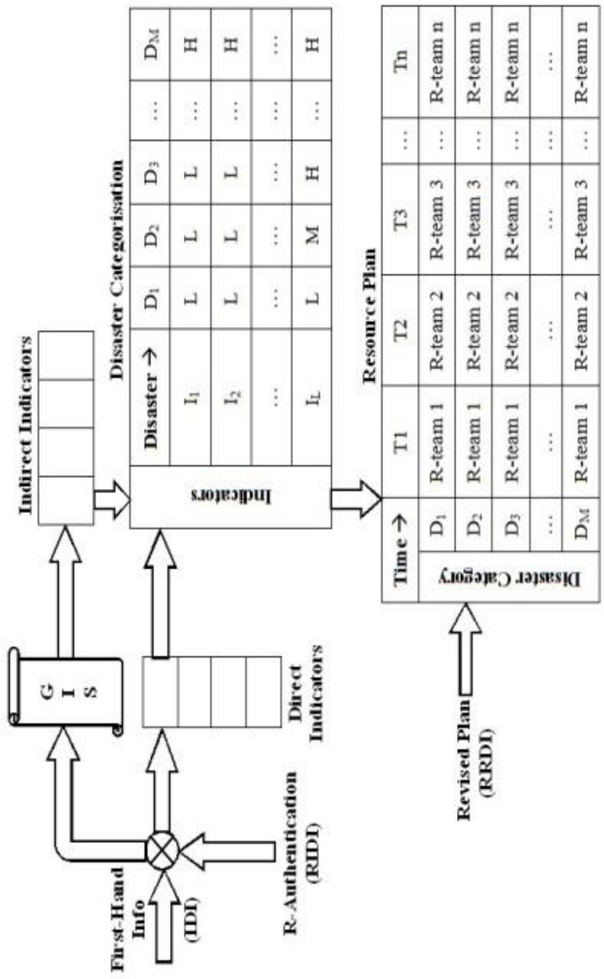

Fig. 1. Knowledge Extraction Process in DM

VII. CONCLUSION

Early and appropriate information / perspective about occurrence of a disaster to the control centre can play a vital role in limiting the spread of the disaster. Proper planning of actions there on can further help coordinate the teams in a right manner.

Having identified this important need in the DM, new system maturity functionality is introduced in this research work, whereby the Knowledge-Base can attain higher maturity over time. Fig. 1 depicts this process. Here the DM strategy obtained from the Resource plan is utilized by the Resource teams first on the site; the teams may take some decisions depending upon the needs to mitigate the situation. Following which the team needs to review the actions taken and suggest a new improved Resource Plan (referred as Redefine Resource-authenticated Disaster Information - RRDI) and will be adopted by the KB administrator at the Control Centre.

The authors also propose to use this mapped information in further work for its use in a flexible resource planning, scheduling and deployment for a comprehensive DM system.

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