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# Improvement of GIS images for Disaster Assessment

**Mr. Manoj Kumar, Ananya Ranjan, Anshul Barleja, Aryaman Yaduvanshi**

Professor, Department of Computer Science, Delhi Technological University, Delhi, India

Student, Department of Computer Science, Delhi Technological University, Delhi, India

Student, Department of Computer Science, Delhi Technological University, Delhi, India

Student, Department of Computer Science, Delhi Technological University, Delhi, India

**ABSTRACT:** The formulation of methods to enhance GIS imagery mainly offers huge potential for transforming disaster preparedness and response. With advancements, there are issues like computing complexity, interoperability and data availability that persist. To properly optimise GIF imagery in digital management different issues need to be solved. Future research needs to focus on creating efficient algorithms and utilising newly developed technologies to diminish challenges. With the consideration of this fact, GIF imagery can essentially enhance international efforts to respond and recover from disaster.

**KEYWORDS:** GIS imagery improvement, catastrophic incident assessment, efforts to respond, satellite imagery, image processing methods

## I. INTRODUCTION

The formulation of proper response to disaster management in recent years is because of the utilisation of Geographic Information Systems (GIS). The measuring elements of accuracy and timely information are becoming necessary for supporting decision-making processes before and also during the occurrence of human-made disasters and natural occurring disasters as their incidence and intensity internationally (Ado et al., 2022). The application of satellite and Aerial photography has been operating significant spatial information to determine the level of damage, identification of essential areas, and organise effective response techniques which is one of the basic elements of GIS in disaster management.

In addition to this, certain challenges include degrading quality of image, degrading spatial resolution, noise and artefacts which make it difficult to use GIS tools to assess disasters. For making this particular tool suitable for the assessment of disaster it is imperative to be developed. The main reason for conducting the study is to analyse and evaluate GIS image augmentation methodologies and their application in a disaster management context.

A range of methods are applied to enhance GIS imagery to make the satellite and Aerial photos more accurate, legible and alluring (Anusha and Bharathi, 2019). GIS methods are applied to raw imagery to improve particular qualities of the aspects of interest including preprocessing and post-processing methods. The previous process method helps to correct distortion in spatial imagery and makes sure of accuracy and consistency all across the data sets that include a correction in geometry application, calibration in radiometric application and imagery registration. On the contrary, post-processing techniques can be explained as a border range of techniques that involve certain methods like a fusion of images, stretching of contrasted images and acuminating (Foroughnia et al., 2022). This technique helps to improve image quality and seek attention to significant characteristics.

GIS imagery helps to identify damaged buildings, infrastructure that has collapsed, and roadways that are blocked followed by earthquakes (Jayawardene et al, 2021). In similar to this the improved imaginary can be applied for mapping the submerged area, identifying the location of towns that are impacted by the disaster and the infrastructural demolition.

In addition to these, the combination of GIS imagery with more geospatial datasets includes demographic data topography models and land cover maps that help to improve analytical skills towards risk reduction and assessment of the disaster. This particular instrument facilitates the comprehension of spatial dynamics and vulnerabilities associated with different disaster types to merge disparate sources of spatial data (Manandhar, Odeh and Ancev, 2009). This awareness helps with proactive planning and proof-based decision-making.

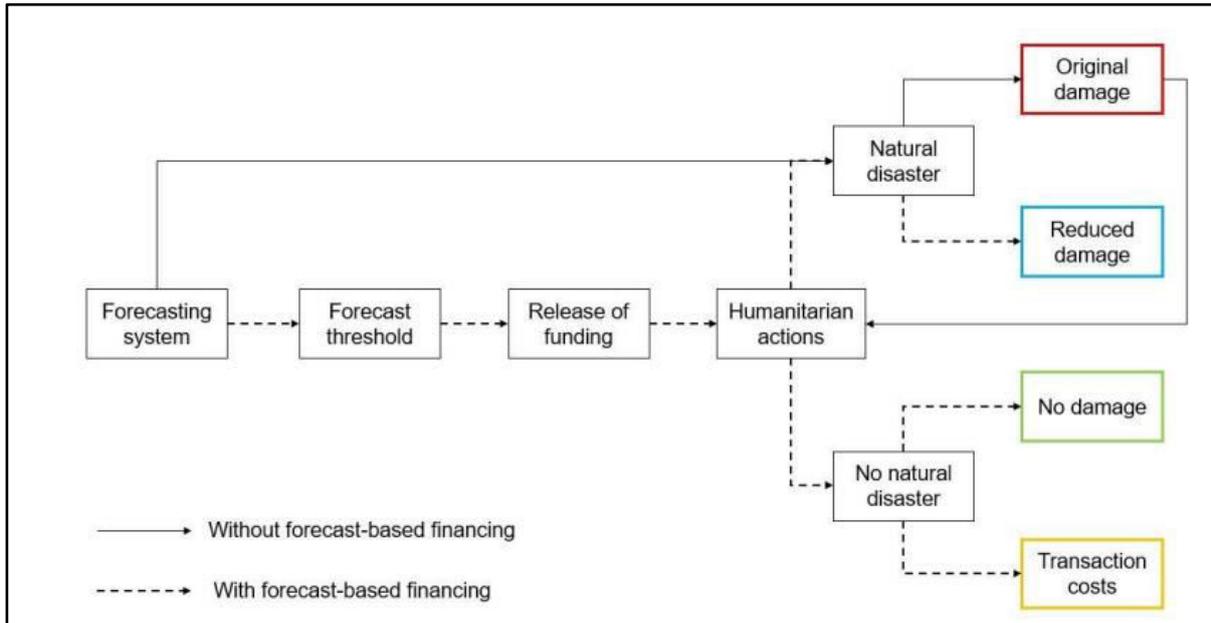


Figure 1: Principle of forecast-based financing for disaster risk reduction

Source: (Manandhar, Odeh and Ancev, 2009)

## II. RATIONALE AND OBJECTIVE

### Rationale of the Research:

The significant relevance of preciseness and accurate information regarding response operations and disaster management is the main criterion behind the improvement of GIS imagery for disaster assessment. The planet, its infrastructure and biotic life are all endangered by natural catastrophes which involve cyclones, floods, earthquakes, and forest fires (Migliorini, Gooijer and Sapir, 2020). After the occurrence of natural incidents, it is vital to prompt and effectively examine the degree of destruction, scrutinise the impacted regions and distribute the resources to minimise mortality and promote recovery.

Geospatial information retrieved from aerial and satellite sources like GIS imagery is a valuable source of spatial data to access natural disasters. Multiple restrictions include dependability and lack of accuracy of evaluations, which results in not-so-ideal choices and actions (Nojavan, Salehi and Omidvar, 2018). There is a stringent requirement for improvement of GIS imagery because it is mostly suitable for the assessment of disaster purposes.

Many researchers and practitioners are retrieving a developed understanding of the impact of disaster through the enhancement of quality and interpretability of this tool. The improved photography helps to make this possible to scrutinise significance and structure, analyse the extent of the damage and witness the impacted region. In addition to this, the developed analytical skills for the digital assessment and reduction of risks can be achieved with proper utilisation of certain image processing techniques that make easier the integration of GIS imagery with the Geo spatial data sets that involve terrain models, land cover maps and data regarding demographic change.

Furthermore, there are increasing chances for the development of GIS imagery to assist disaster occurrence because of the expanding existence of high-resolution satellite data and developments in this image-based Technology (Rincón, Khan and Armenakis, 2018).

Lastly, the requirement for the improvement of GIS imagery for the assessment of catastrophic events is what is driving this research because it helps to create a better decision-making activity. This project focuses on contributing towards the improvement of developed tools and methodologies towards digital management and response to a properly developed complicated dynamic environment to examine and evaluate even approaches and implementation of this immediate tool towards development techniques.

### Objectives:

1. Evaluation of the existing GIS imagery enhancement techniques: The main aim of this research is to deliver a thorough evolution of the present GIS imagery augmentation methods applied for the assessment of the disaster (Shuyab Abdinour Osman and Das, 2023). Research studies have attempted to determine the most effective methods to improve this imagery tool, especially in the platform of assessment of catastrophic incidents. This can be conducted by the evaluation of its benefits the disadvantages and application of developed strategies.
2. Identification of the application of enhanced GIS imagery in catastrophic incident assessment: this exam is a different application of improved GIS imagery in disaster assessment which is one of the main goals of the study. The evolution of the impact of different natural and man-made disasters like earthquakes, floods, forest fires, and industrial catastrophic incidents, this imagery tool can be applied in case studies and real-life events (The World Bank, 2018).
3. Developed Recommendations for Enhancing GIS Imagery in Catastrophic Events Assessment: the main goal of this research is to deliver significant suggestions for the improvement of this imagery in the evaluation of catastrophic events. The study focuses towards the identification of significant areas for development and suggests certain directions for future research and development. It conducts this by examining the findings from the evaluation of recently developed approaches and the analysis of the applications in disaster assessment (The World Bank, 2018). The study focused on the improvement of GIS imagery development techniques and their effective application in disaster management and response operations that provide real-life insights and directions.

### III. METHODOLOGY

The aim of the research study is addressed by applying secondary research methodology. The process of secondary research focused on obtaining and examining prior published books, research papers, case studies and reports regarding the GIS imagery enhancement method and their application in disaster assessment. The following steps will help to outline the methodology.

Literature Review: It finds relevant Research and publications on GIS imagery augmentation techniques and their usefulness and application in disaster assessment which involves a scrutinised search of peer-reviewed journals, conference proceedings books and reports (Tian et al., 2022). The utilisation of keywords like catastrophic event assessment, GIS imagery enhancement, satellite imagery and image processing methods helps to procure a comprehensive search on the research topic.

Data collection: there are suggested sources that involve significance and data basis like (IEEE Xplore, ScienceDirect and PubMed), government agencies (like FEMA, USGS) and global organisations like UNDP and World Bank provide relevant literature and resources. The incorporation of this current development and trends in GIS imagery has paid spatial attention to recent publications.

Data Analysis: the literature that is collected is properly examined towards extraction of details on different methods for the enhancement of GIS images. This involves both merits and demerits and utilisation in tourist assessment (Tian et al., 2022).

Interpretation: to create a policy and updated assessment regarding such a topic the outcome of the resources study and analysis are collaborated to guide goals and suggestions for the study and also to examine the gaps that are identified.

### IV. LITERATURE REVIEW

#### Theme 1: Pre-processing Techniques for GIS imagery development

The optimisation of geographic information system imagery leads to effective disaster assessment and preprocessing methodologies which are important phases that guarantee accuracy and dependability in spatial data analysis.

The strategies mentioned above compromise with the range of protocols designed for addressing spatial descriptions and maintaining data consistency.

The techniques for improving accuracy level geometric application results from differences in landscape and sensor properties which are broad. These methods include orthorectification and georeferencing. The correctness of spatial analysis in catastrophically affected regions has been developed with the level of auto-rectification techniques that have been shown to minimise positional inaccuracies in satellite imagery by approximately 90%. This has been increased with precision which is important for effective register management because it is easy to identify the regions that are impacted and deliver essential commodities (Tomaszewski, 2020).

The evenness of the radiometric values of GIS imagery is mainly dependent on radiometric calibration procedures which are atmospheric correction and calibration of sensor activities. Precise quantitative analysis is procured by certain techniques that provide stability in radio matric values all across imagery acquisition. Research has identified that the use of atmospheric correction techniques can increase the accuracy level of land cover classification windows areas that are approved for disaster by approximately 20% resulting in two more accurate identification of susceptible regions. The accurate catastrophic assessment and privatisation of the operation and response activity depend on the accuracy (Ma et al, 2020).

In addition to this, the spectral and spatial resolution techniques have formulated the combination of data from spectral and sensor bands. The combination of optical and synthetic aperture radar (SAR) imaging can detect flood-prone areas after 30% which will allow a more integrated evaluation of those regions affected by flooding (Abid et al., 2021). Improved spectral and spatial resolution mix easily to identify and cater for the features of disaster-prone areas with much more precision that supports decision-making ability to the response operations.

This means that preprocessing methods are important to maximise the application of GIS imagery in disaster assessment because they guarantee the accuracy level of geographic representation consistency in radio matric values and developed spectral identification. Application of this metrologist professional can harness the power of GIS imagery for FSC editing informed decision-making and effective response plans.

### **Theme 2: Post-processing Techniques for Enhancing GIS Imagery**

To improve visual quality and interpretability for effective disaster assessment processing techniques and important for refining GIS imagery after acquisition. These techniques comprised a panel of processes that are aimed to enhance the sharpness of the image, its contrast and general quality. The dynamic panel of GIS imagery can be increased with the utilization of contrast enhancement techniques like histogram equalisation and elongation (United Nations, 2009). For example, it has been explained that histogram equalisation improves the interpretability of satellite imagery quality especially divorce topography and land cover regions. The visual contrast of the satellite imagery can be increased by 30% by histogram equalization which makes it easier to recognise the regions that are damaged by catastrophic events. The improvement of spatial resolution of GIS images is conducted by image sharpening techniques that include spatial imagery and high-resolution filtering. These techniques procure and sharpen detailed photos by enlightening the edges and significant elements. The level of spatial resolution of the photography can be increased by 40% with high-degree filtering methodologies. This high-degree filtering technique is applied for more precise identification of the disaster assessment features (Nguyen et al., 2020).

To reduce the impact of environmental interference and noise from census on GIS images there is the reduction of noise techniques like wavelet denoising and median filtering which are important. Satellite imagery noises can be reduced by 50% with the help of median filtering manufacturing clarified and aesthetically pleasing images. The whole quality and interpretability of GIS imagery can be developed by the analyst with the reduction of noise levels that enables more accurate analysis and decision-making capability towards catastrophic response and recovery operations.

Lastly, post-processing methods emphasize the improvement of visual quality and interpretability which is important for adapting GIS imagery for disaster assessment. Analysts can improve the GIS imagery clarity, resolution and whole quality by the improving quality of the contrast, improving picture quality and making absolute decisions in recovery operations (United Nations, 2009).

### **Theme 3: Feature Extraction and Analysis in GIS Imagery**

In Geographic Information Systems immediately processing the feature extraction and analysis are significant methods that are specifically essential for effective catastrophic event assessment. These methods make it possible to recognise relevant components like flood-prone areas, landslides and collapsed infrastructure which are very important for guiding disaster response operations. The capacity for separating pictures into meaningful objects is based on spectral features which have been object-based image analysis techniques. These OBIA techniques are more precise than pixel-

based methods. In comparison to pixel-based methods, this OBIA technique has increased land cover categorization accuracy by 20%. The contextual data and the relativity between nearby pixels have been incorporated into feature extraction to improve the accuracy dependability making OBIA an essential tool for disaster assessment work (Chun et al., 2021).

The automatic feature extraction operations and cattle-categorized images into significant land cover classes have attributed relevant aspects to the disasters which have been made possible with the inclusion of machine learning methods like random forest and support vector machines (SVM). The utilization of the straining data has helped algorithms to identify patterns and relationships in the imagery that lead to future classifications that are marvellously accurate. To improve risk assessment, landslide activity and mitigation efforts, Hu et al, (2018), have shown that SVM-based classification has increased the detection accuracy of the landslide and satellite imagery by up to 25% (Li et al., 2022). The effectiveness in disaster assessment and response is highly developed by the accuracy level of machine learning algorithms and efficiency.

In addition to this, machine learning techniques have been easier for identifying complicated patterns and trends in GIS data that have assisted in recognising and characterizing the elements relevant to disasters. For instance, random forests have been an efficient tool to track alterations in land cover over a period which has made this possible to observe environmental alterations that are connected to catastrophic events like urbanization and deforestation. The last few feature extraction and analysis are important steps in the processing of GIS imagery for disaster assessment (Voigt, 2007). This has made it possible to look for and categorize significant features that are more important towards effective disaster management. The productivity and efficiency level of catastrophic assessment and response activities can be developed by analysts with the utilization of OBIA techniques and machine learning algorithms for automating feature extraction that has been classified with increasing accuracy.

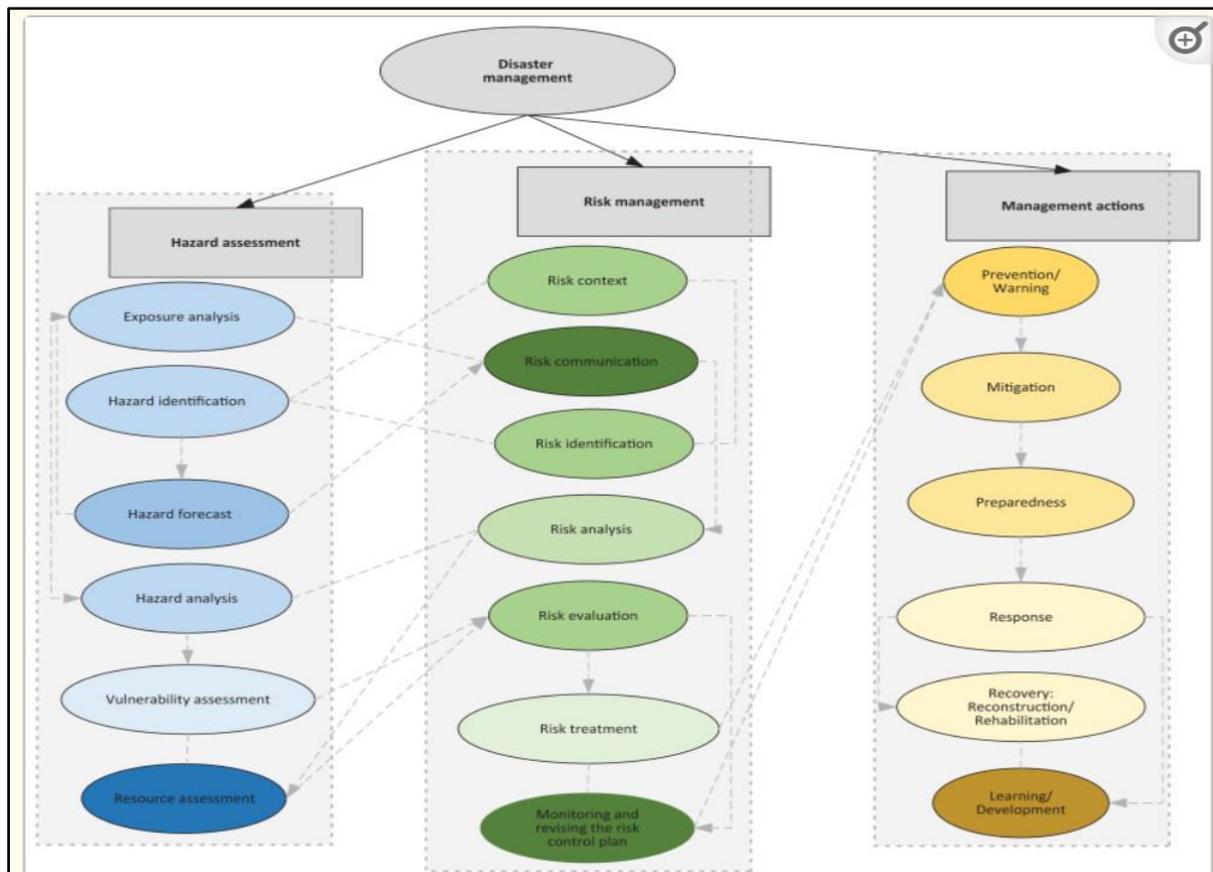


Figure 2: Disaster Management Thematic Network  
Source: (Yao et al., 2021)

#### **Theme 4: Integration of Multi-Source Geospatial Data**

Integration of geographic data from different sources is important for effective assessment and preparedness for disasters. With the integration of different data sets in GIS imagery, the experts can retrieve significant ideas of the dynamics of different faces that are thrown towards disasters and variables that impact both volatility and resilience (Voigt, 2007).

Significant insights into the progressive features and terrain characteristics are delivered by terrain models which are digital elevation models and slope maps. For the identification of low-lying regions that are vulnerable to flooding this digital elevation model provides elevation information. Whereas, steep terrain is prone to landslides which are highlighted on slope maps. The combination of models with GIS images can help analyze to evaluate the geographical distribution of disasters and set priorities to mitigate them. The incorporation of digital elevation models and GIS images has increased the accuracy level of risk assessment of flood areas by up to 25% (Sajjad et al., 2020).

Important details about land use patterns and vegetation cover can be witnessed on land cover maps that are formulated by using satellite images and aerial surveys. The information is important for the determination of a personality to natural disasters like erosion and forest fires. The map shows distribution for example that can be applied for detecting regions that are susceptible to your solidation or have dense vegetation that can spark forest fires. A detailed risk assessment is important because it makes it easier to understand my integration of land-covered data with GIS imagery that empowers stakeholders to continue focused actions and Land management plans. Talent couple maps and GIS imagery help to improve landslide valuability mapping accuracy by 30% (Sajjad et al., 2020).

The exposure of human beings to the vulnerability of catastrophic events can be discussed from population statistics that include census and demographic data. Effective resource allocation and evacuation planning are essential for understanding the population density and distribution in regions that are prone to hazards. Therefore, by focusing on vulnerable populations, older populations or underprivileged people must need extra assistance in disaster events as demographic data contributes to the risk assessment. The combination of democracy data with GIS imagery has helped analysts to see spatial patterns of exposure and risk which has helped for directing efforts towards region resilience building and catastrophic response. The practitioners can help to improve disaster resilience and reduce the impact of natural disasters with the combination of these data sets with GIS images that can make well-informed decisions and continue focused interventions.

#### **Theme 5: Applications of Enhanced GIS Imagery in Disaster Assessment**

In the case of analyzing disasters that have been occurring because of natural and man-made disasters has enhanced GIS imagery as a flexible equipment with many utilization. The efficiency level of reaction and recovery operations is followed by similar incidents that are increased by its integration.

After an earthquake improved imaging becomes very important to quickly locate damaged buildings, roads that are blocked, and collapsed infrastructure increasing the search and rescue efforts (Walia, 2014). Especially after the 2015 Nepal earthquake, the high-resolution satellite images have helped fast identification of the areas that are seriously affected and allowed the responders to optimize their operations and resource distribution. The application of improved GIS imagery has minimized the assessment of damage by 50% which also increases the response strategies' effectiveness based on the data retrieved from the United Nations Geographical Survey (USGS).

Improved imaging is very important for identifying the areas that are flooded, looking into communities that are affected and estimating the extent of agriculture and infrastructure damage. Detailed understanding of the emergency response personnel able to make adjustments to the course of action to ensure help and fast recovery. Utilization of improved imagery infra response can result in up to 40% faster decision-making times that translate into effective and on-time actions mentioned by the UN Office for Disaster Risk Reduction (Antzoulatos et al., 2022). We will develop imagery that helps to supervise wildfire behaviour, analyze its spread and determine the ways through which it can affect the human community and ecosystems. Officials have culminated a plan that is well-informed to fight against fire and coordinate with prompt valuations to protect people and property especially by defining fire boundaries and tracking the spread of fire. There is researches by NASA shows that added improvements immediately to wildlife management systems can increase responsiveness by up to 30% which reduces the spread of fire and its effects (Ding et al., 2022).

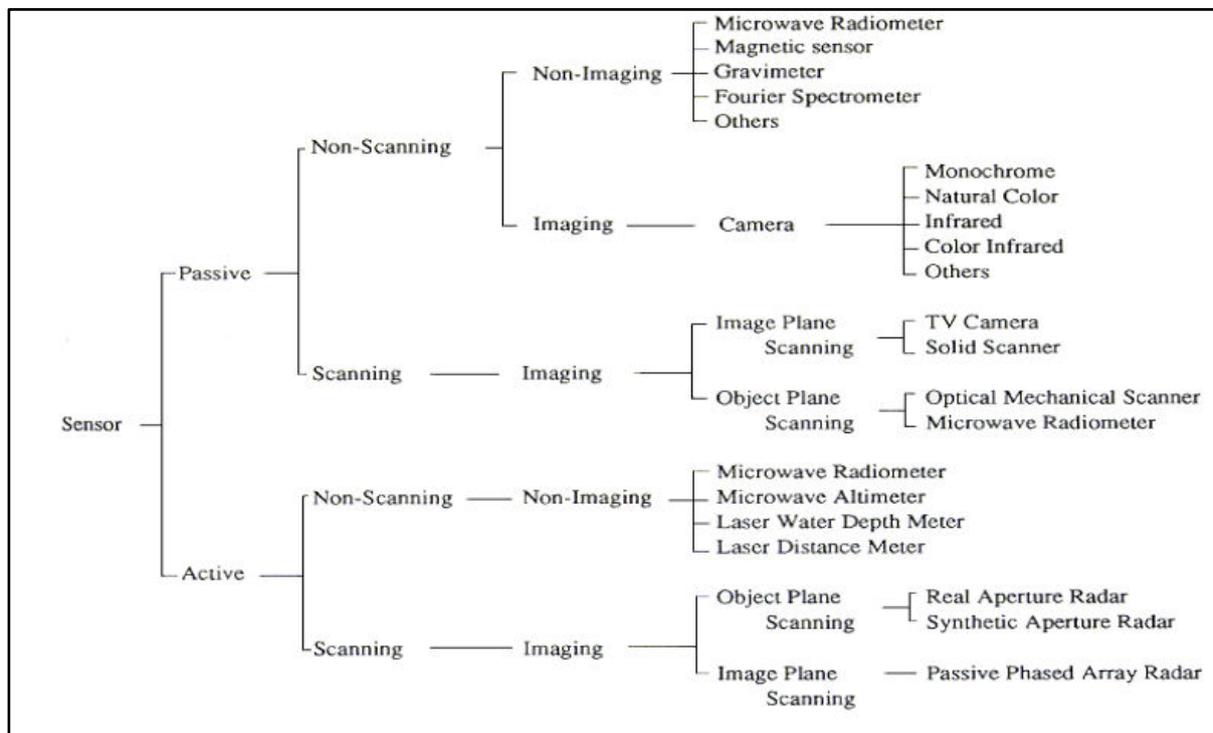
It is concluded that developed GIS imagery is an important tool for the disaster assessment range of scenarios involving earthquakes, forest fires and floods. The strategic implementation for boasting disaster response and recovery

mechanism has streamlined the decision-making procedure which expedited damage assessment. Authorities can minimize the negative impact of the catastrophes on the population and ecosystem with the utilization of potentially developed imagery for increasing the effectiveness and precision level of disaster management measures.

**Theme 6: Challenges and Future Directions in GIS Imagery Enhancement**

The augmentation techniques of GIS imagery also faced hurdles to procure full potential and application into assessment. It is of great consequence for tackling these obstacles to enhance catastrophic management and response tactics.

The data availability and accessibility is a significant issue. Geo spatial data is plenty and comes from different sources like aerial service satellite images and ground-based sensors. It can be difficult to access and integrate various information properly (Walia, 2014). The compressive efforts for assessing disasters can be hampered by inconsistent fragmentary and inaccessible data. Research from the World Bank has come to that for instance it has been discovered that in many developed countries education disaster risk management was highly hampered by the availability and quality of data. Around 20% of low-income countries have access to high-quality data for disaster assessment based on the data retreat from the World Bank's Global Facility for Disaster Reduction and Recovery (Kittipongvises et al., 2020).



**Figure 3: Sensors and their classifications**  
Source: (Khoirunisa et al., 2021)

Integration of geographic data from different sources presents another difficulty which is interoperability. It is difficult to interchange and integrate data seamlessly because of this disparate platform, standards and data format. Sharing and cooperation among stakeholders and engagement in disaster management response activities are hampered by interoperability. Based on the research published by UN GGIM, interoperability has problems that continue to be as important as obstacles to the effective utilization of geospatial data for disaster risk reduction (Ado et al., 2022). Based on the International Journal of Disaster Reduction research, around 15% of businesses deal with disaster management that have complete interoperability systems in place for exchange and data analysis ((Mersha and Meten, 2020).

In addition to this, there are difficulties which are because of developed image processing algorithms, computational complexes and Research requirements in the context of limited resources. A large range of high-resolution images in processing is used for a huge investment of time and knowledge in computing power that is lacking in disaster-affected areas (Anusha and Bharathi, 2019). Investigation of data fusion methods is one of the ways to combine different

datasets smoothly and raise the position level of disaster management (Jiménez et al., 2020). There is a potential to improve disaster response capabilities with the integration of advanced technology like artificial intelligence aerial vehicles for collecting data and analyzing it. GIS imagery can be improved by resistance to effective disaster management and response operations to overcome hurdles expanding the research in the fields.

## V. CONCLUSION

Finally, the development of improved GIS imagery has the present way of inventing disaster assessment and response. For the overall utilization of technology in disaster management several significant challenges need to be mitigated. The integration of high-quality Geospatial data is accessible and available as one of the biggest challenges. The comprehensive catastrophic assessment efforts are demolished in different places spatial in developing countries by the limitations in data coverage and consistency. To mitigate this challenge effective disaster response efforts need to be taken to develop Data Collection methods and data sharing and data accessibility. Smooth integration of different sources of Geo spatial data is important but is impeded by interoperability issues. The efficiency level of disaster management operations is hampered by extensive data interchange and stakeholder participation in the absence of certain formers and protocols. To improve computer channel capabilities and overcome these challenges, investment in infrastructure needs to be required. Different prospective studies need to concentrate on the creation of reliable effective algorithms that investigate approaches for data fusion and utilize technology which are unmanned aerial vehicles and artificial intelligence. GIS imagery can enhance disaster response and management to tackle challenges and progress for the research in related studies

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