Utilizing Geographic Information Systems to Enhance Spatial Crisis Management: A Study of Global Experiences"in the Postmodern Era

Prof. Dr. Hussein Ali Abdul Hussein
Al-Qadisiyah University/College of Arts
Hussain.abdulhussein@qu.edu.iq

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Abstract:

This research explores the role of Geographic Information Systems (GIS) in enhancing spatial crisis management strategies, with a particular focus on their applications in improving crisis prediction, and the development of prevention and response strategies. Through the analysis of spatial data, GIS contributes significantly to risk identification and provides sustainable solutions, particularly in the face of natural crises such as floods and earthquakes. Case studies from the United States and Japan, where GIS has been utilized to manage crises like droughts and earthquakes, demonstrate the system's ability to provide accurate data and effective analyses. Additionally, GIS applications in developing countries have highlighted its crucial role in addressing crises such as desertification and mass displacement, thereby improving government and humanitarian organizations' responses. The research further emphasizes the potential of integrating artificial intelligence with GIS to enhance prediction accuracy and decision-making processes. Overall, the study concludes that GIS serves as a foundational element in spatial crisis management strategies, strengthening communities' capacity to adapt to future crises.

Keywords: Geographic Information Systems, Spatial Crises, Crisis Prediction

أ.د. حسين علي عبد الحسين

كلية الآداب / قسم الجغرافية

Hussain.abdulhussein@qu.edu.iq

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ملخص البحث

يستعرض هذا البحث دور نظم المعلومات الجغرافية (GIS) في تعزيز استراتيجيات إدارة الأزمات المكانية، مع التركيز بشكل خاص على تطبيقاتها في تحسين التنبؤ بالأزمات، وتطوير استراتيجيات الوقاية والاستجابة. من خلال تحليل البيانات المكانية، تساهم نظم GIS بشكل كبير في تحديد المخاطر وتوفير حلول مستدامة، خاصة في مواجهة الأزمات الطبيعية مثل الفيضانات والزلازل. توضح دراسات الحالة من الولايات المتحدة واليابان، حيث تم استخدام نظم GIS لإدارة الأزمات مثل الجفاف والزلازل، قدرة النظام على تقديم بيانات دقيقة وتحليلات فعالة. بالإضافة إلى ذلك، أظهرت تطبيقات نظم GIS في الدول النامية دورها الحاسم في التعامل مع الأزمات مثل التصحر والنزوح الجماعي، مما ساهم في تحسين استجابة الحكومات والمنظمات الإنسانية. كما يبرز البحث الإمكانيات المتاحة لدمج الذكاء الاصطناعي مع نظم GIS لتعزيز دقة التنبؤ وعمليات اتخاذ القرار. في المجمل، يخلص البحث إلى أن نظم GIS تعد عنصرًا أساسيًا في استراتيجيات إدارة الأزمات المكانية، مما يعزز قدرة المجتمعات على التكيف مع الأزمات المستقبلية.

الكلمات المفتاحية : نظم المعلومات الجغرافية ، الأزمات المكانية ، التنبؤ بالأزمات

Introduction

The Postmodern era has witnessed fundamental transformations in strategic management, making it more dynamic and flexible due to globalization and digital technology, thereby reshaping global markets and reinforcing the concept of innovation. In this context, Geographic Information Systems (GIS) play a pivotal strategic role in crisis management by enabling real-time data analysis and optimizing resource allocation, contributing to more effective responses and minimizing human and material losses. Accordingly, this research addresses the following question: How can GIS be effectively employed in spatial crisis management to achieve a more integrated strategic response?

The study hypothesizes that GIS is a fundamental tool for enhancing crisis prediction accuracy and strengthening prevention and response strategies through the integration of spatial data and predictive analytics. To achieve this, the research adopts a descriptive-analytical approach to examine GIS applications in crisis management, focusing on global case studies that demonstrate its effectiveness in addressing both natural and human-induced disasters.

The significance of this research lies in providing a comprehensive perspective on the role of GIS in enhancing crisis management strategies, particularly in the context of climate change and rapid technological advancements. Moreover, its findings aim to uncover mechanisms for improving the integration of GIS with artificial intelligence tools, thereby enhancing strategic decision-making efficiency. The scientific analytical tools employed in this research include spatial data analysis, predictive modeling, and applied case studies, all of which contribute to developing sustainable solutions that strengthen community resilience in the face of spatial crises.

1.Strategic Management of Spatial Crises in the Postmodern Era

1.1.Redefining Strategic Management in the Postmodern Era:

The Postmodern era(*) has undergone fundamental transformations that have profoundly impacted strategic management(**), making it more flexible and dynamic. The shifts outlined in the text can be analyzed and linked to multiple theoretical frameworks to achieve a deeper understanding and derive new insights.

First, globalization and digital technology have reshaped global markets and intensified competitiveness. This transformation can be explained through the economic theory of the "open innovation" model, which emphasizes that innovation should not be confined within corporate boundaries but should embrace the exchange of ideas on a global scale. According to Chesbrough (2006), companies adopting this approach achieve a long-term competitive advantage, reinforcing the notion that technology is no longer just a tool but a primary driver for restructuring economic and social strategies [(i)]

Second, the cultural shifts imposed by postmodern values—such as diversity and equality—represent a transition toward more democratic and inclusive strategic approaches. This idea can be linked to Bourdieu's (1986) "social capital" theory, which argues that cultural diversity and active participation enhance institutional networks, ultimately fostering higher levels of innovation and creativity [(ii)] .

Third, the increasing focus on sustainability reflects a deeper shift toward what may be termed "ethical capitalism." (***) This approach challenges the traditional dominance of immediate profit models in favor of a balanced approach integrating economic and environmental objectives. The World Bank report (2021) supports this analysis, highlighting that investments in renewable energy are not only an environmental necessity but also an economic opportunity for sustainable growth [(iii)] .

Finally, the growing reliance on artificial intelligence (AI) and big data analytics in strategic planning(****) represents a paradigm shift in management tools. These technologies align with the concept of "organizational learning" discussed by Argyris and Schön (1996), wherein accurate data enhances decision-making processes and ensures long-term strategic efficiency [(iv)] .

The text calls for a reconsideration of strategic management within postmodern contexts. It can be concluded that the integration of open innovation, cultural diversity, sustainability, and artificial intelligence forms the foundation of a new management model that transcends traditional frameworks. The novel idea here is that these factors are not merely management tools but ethical and conceptual standards that redefine the relationship between corporations and society. Such a transformation may lead to the emergence of the "Sustainable Interactive Management"(*****) model, which unprecedentedly balances technology, human values, and the environment.

In conclusion, the Postmodern era has brought about fundamental transformations in strategic management, adopting more flexible and dynamic concepts. Globalization and digital technology have reshaped global markets, broadening the concept of innovation to include widespread idea exchange, thereby strengthening companies' ability to achieve long-term competitive advantages. Additionally, cultural shifts associated with postmodern values—such as diversity and equality—have contributed to developing democratic strategies that enhance institutional network strength. Furthermore, the focus on sustainability has driven the adoption of an "ethical capitalism" model that balances economic and environmental objectives. Lastly, the use of artificial intelligence and big data analytics in strategic planning has introduced new tools for improving decision-making efficiency. This shift signals the emergence of the "Sustainable Interactive Management" model, which transcends traditional frameworks by innovatively integrating technology, human values, and the environment.

1.2.The Role of Geographic Information Systems in Crisis Management:

Geographic Information Systems (GIS) play a pivotal role in enhancing crisis management efficiency by integrating and analyzing data, optimizing resource allocation, and assessing future risks.

First, one of the most crucial aspects of GIS is real-time data integration and analysis, enabling immediate crisis response. For instance, during the 2019 Australian wildfires, authorities utilized satellite data and GIS technologies to track the spread of fires in real time. As a result, over 200,000 people were evacuated before the disaster escalated, reducing injuries by 35% compared to previous crises [v] .

Second, GIS enables precise resource allocation based on the analysis of affected areas' needs. During Hurricane Maria in Puerto Rico in 2017, GIS mapping helped identify the regions most impacted by landslides and power outages. This improved aid distribution efficiency by 50% and accelerated infrastructure restoration from an expected six months to just three [vi] .

Third, the ability to assess risks and predict future scenarios is among the most significant applications of GIS. For example, GIS-based models in Japan predicted that 15% of buildings within the impact zone of the 2011 tsunami were at high risk of destruction. This information helped authorities enhance preventive measures, such as constructing seawalls, which subsequently reduced damage in later tsunamis by 25% (vii) .

Fourth, GIS enhances coordination among crisis management agencies by providing a centralized platform for data sharing. During the 2015 Nepal earthquake, more than 20 relief organizations utilized GIS platforms, reducing response time from 48 hours to just 24 hours (viii) .

Finally, GIS can be used to assess the financial and human damages caused by disasters, accelerating reconstruction efforts. For example, damage assessment maps from the 2020 China floods provided the United Nations with an accurate report estimating losses at $15 billion, which expedited international aid delivery (ix) .

From the above, it is evident that GIS is a highly strategic tool in crisis management, significantly improving rapid response, efficient resource distribution, and future risk assessment. By integrating real-time data analysis, authorities have successfully mitigated human and material losses, as demonstrated during the 2019 Australian wildfires. Furthermore, GIS enhances precise resource distribution, as seen in Hurricane Maria in Puerto Rico. Regarding risk prediction, GIS applications have played a crucial role in strengthening preventive measures, such as Japan’s 2011 tsunami defenses. GIS also facilitates inter-agency coordination, expediting relief efforts, as evidenced in the 2015 Nepal earthquake. Lastly, GIS serves as an effective tool for assessing financial and human losses, accelerating reconstruction and international aid efforts, as seen in the 2020 China floods.

1.3.Crisis Management in the Postmodern Era: Innovative Spatial Models and Strategies:

Spatially-oriented crisis management serves as the cornerstone for maintaining societal stability in response to both natural and human-induced disasters. This text highlights three fundamental pillars of crisis management in developed countries: multi-level models, scenario-based planning, and spatial adaptation strategies, with a focus on the role of Geographic Information Systems (GIS) as a supporting tool.

The **multi-level model**, as exemplified by Germany, underscores the importance of coordination across different levels (local, regional, and national). The notable success in reducing economic losses by 30% during the 2013 floods reflects the effectiveness of preemptive planning supported by integrated efforts (x) .

Meanwhile, **scenario-based planning** embodies a proactive approach that goes beyond reactive crisis management to preparing communities and infrastructure for effective disaster response. Japan's achievement in reducing response time by 15 minutes during the 2011 earthquake illustrates this model's ability to mitigate human casualties(xi) .

Spatial adaptation strategies represent an intellectual evolution that redefines the relationship between humans and the environment. The Dutch Maeslantkering project serves as a practical example of how future risk predictions can be incorporated into infrastructure design, thereby reducing the likelihood of long-term environmental disasters and safeguarding nearly 70% of at-risk land (xii) .

The integration of these models and strategies is further reinforced by advancements in **geospatial technology**, where GIS emerges as a key enabler. The United States' success in enhancing forecast accuracy by 20% during Hurricane Harvey highlights the role of technology in improving both the temporal and spatial efficiency of disaster response (xiii) .

By linking these concepts, it becomes evident that successful crisis management relies on a **"spatial dynamic learning"** approach—an innovative framework that integrates multi-level models, scenario-based planning, and spatial adaptation while leveraging GIS as a tool for big data analysis and spatial forecasting. This dynamic approach enhances crisis response resilience and transforms crisis management into an interactive and continuous process, enabling strategy updates based on evolving data.

In conclusion, spatially-oriented crisis management stands as the foundation of societal resilience against natural and human-induced disasters. The integration of multi-level models, scenario-based planning, and spatial adaptation strategies underscores the importance of harmonizing efforts across local, regional, and national levels. Furthermore, the role of GIS in refining predictive accuracy and response efficiency contributes to damage reduction and expanded protection coverage. By embedding these strategies within the **"spatial dynamic learning"** framework, societies can foster sustainable resilience in crisis management. This approach facilitates improved big data analysis and enhances response efficiency, making crisis management an adaptive and continuously evolving process based on real-time data insights.

1.4.Interwoven Crises: An Integrative Analysis of Spatial Dimensions:

Crises with a spatial dimension in developed nations exhibit a multi-dimensional complexity that necessitates a precise analytical approach to understand the divergences and interconnections among the three primary types: natural, economic, and technological. These crises present a shared challenge, characterized by their rapid propagation and extensive impact on advanced societies, where technological dependence acts as an amplifying factor that exacerbates both the severity and spatial repercussions of crises. This analysis aims to extract a novel understanding of how these crisis types interconnect and influence one another across spatial systems.

Conceptual Linkages

1. **Natural and Technological Crises:** Despite advancements in forecasting natural disasters, reliance on technological infrastructure increases societal vulnerability. For instance, hurricanes can disrupt power grids, triggering subsequent technological crises [xiv] .This underscores the necessity of an integrated crisis management framework that encompasses both natural and technological dimensions.
2. **Economic and Natural Crises:** Natural disasters, such as Hurricane Katrina, often result in large-scale economic crises due to spatial disruptions affecting key productive sectors [xv] .This illustrates a clear interconnection between natural and economic crises, particularly in their impact on urban areas.
3. **Economic and Technological Crises:** Economic downturns can lead to reduced investment in critical technological systems required for crisis mitigation, thereby increasing the likelihood of technological crises. This was evident during the global recession, which hindered several nations from strengthening their cybersecurity infrastructure [xvi] .

Key Findings

- **Interwoven Crises:** Spatially embedded crises in developed nations can be categorized as “interwoven crises” due to the interdependencies among natural, economic, and technological systems. This framework provides a new perspective for assessing and understanding crisis impacts.

- **Integrated Planning:** Traditional crisis response strategies tend to isolate crisis types. A key inference from this analysis is that spatial planning must adopt an integrated approach that anticipates the interrelationships among different crisis categories.
- **Spatial Disparities as a Mediating Factor:** Spatial inequalities not only result from crises but also exacerbate them. Weak infrastructure in rural areas, for instance, deepens crisis severity, necessitating a reconsideration of resource allocation and service distribution [xvii] .

Crises with a spatial dimension in developed nations reveal intricate and interwoven dynamics that demand a reimagined crisis management approach—one that is comprehensive and integrative. Achieving this necessitates enhanced governmental collaboration, investment in advanced technologies, and a restructuring of spatial planning systems to reduce the gap between urban and rural areas. This analysis highlights the imperative of viewing crises as interconnected clusters rather than isolated events, thereby establishing a new scientific foundation for understanding their nature and repercussions.

In conclusion, spatially embedded crises in developed nations exhibit a high degree of complexity due to the interplay between natural, economic, and technological dimensions. This analysis demonstrates that these crises interact in intricate ways, wherein technological dependence exacerbates the effects of natural disasters, while economic crises undermine the capacity to address technological disruptions. Furthermore, spatial disparities between urban and rural areas contribute to crisis amplification. Consequently, spatial planning must adopt an integrative approach that acknowledges the interconnectedness of different crisis types. These dynamics necessitate a reevaluation of resource and service distribution, alongside fostering intergovernmental cooperation and leveraging modern technologies to enhance crisis response efficiency.

1.5.Postmodern Spatial Crises: The Interaction of Political Power, Environment, and Technology:

It appears that spatial crises in the postmodern era are not merely geographical phenomena but rather reflect a profound transformation in power relations and society. Economic, social, environmental, and technological factors are interwoven in unprecedented ways, complicating spatial configurations and necessitating a multidimensional understanding to analyze and comprehend their impacts.

Conceptual and Theoretical Linkages:

- **Fragmentation and Plurality:** The division of spatial configurations reflects class and social disparities resulting from neoliberal economic policies. This is linked to the role of power in producing unequal spaces that serve as material manifestations of social conflicts (xviii) .
- **Globalization and the Dissolution of Borders:** Globalization challenges national sovereignty as multinational corporations control resources and spaces, creating a new relationship between space and power. This dynamic turns spatial configurations into arenas of struggle over identity and authority (xix) .
- **Urbanization and Displacement:** Rapid urbanization is associated with social marginalization, highlighting the need for restructuring urban policies to ensure social justice, particularly in the face of resource conflicts (xx) .
- **Technology and Space:** Digital technology contributes to the production of new virtual spaces while simultaneously deepening digital and social divides, creating new forms of inequality in access to resources and opportunities (xxi) .
- **The Environment and Spatial Vulnerability:** Climate change emerges as a primary challenge threatening spatial sustainability, as forced migration and displacement become direct consequences of environmental degradation, exposing the fragility of spatial configurations to ecological disasters (xxii) .

In the postmodern era, space can be seen as a dynamic product of conflict, constantly reshaped through the interactions between power, society, and the environment (xxiii) .There is a growing need for a new approach that integrates technology and sustainable policies to create more just and inclusive spaces. For instance, designing inclusive digital cities could mitigate social and environmental inequalities (xxiv) .Additionally, the concept of "spatial vulnerability" can be expanded beyond environmental responses to encompass cultural and digital dynamics (xxv) .

From the above, it is evident that spatial crises in the postmodern era are complex phenomena reflecting the interweaving of economic, social, environmental, and technological factors, producing dynamic spaces that embody evolving conflicts. Fragmentation and plurality highlight the role of neoliberal policies in reinforcing class and social disparities, while globalization dismantles national borders and enhances corporate control over spaces and resources. Rapid urbanization and social marginalization underscore the need for urban policy restructuring to achieve social justice. Meanwhile, digital technologies generate new virtual spaces, further exacerbating social inequalities. Furthermore, climate change exposes the vulnerability of spatial configurations to environmental disasters, necessitating comprehensive and sustainable strategies to address these challenges. This analysis calls for an integrated approach to reshaping spatial configurations toward greater justice and sustainability, focusing on reducing social and environmental disparities.

2.Strategic Management of Spatial Crises: A Comparative and Sustainable Approach Between Developed and Developing Countries:

2.1.Strategic Crisis Management: A Flexible and Sustainable Approach:

Strategic crisis management serves as a comprehensive framework that enables organizations to respond to crises with flexibility and efficiency across four key phases: prevention, response, containment, and recovery. In the prevention phase, risk analysis and proactive planning minimize the likelihood of crises. According to the National Safety Council, implementing early warning systems has reduced crisis occurrences in organizations by 40% [(xxvi)] .Furthermore, this phase highlights the importance of risk forecasting through data analysis tools and the development of sustainable operational environments.

During the response phase, organizations rely on rapid decision-making and transparent communication with stakeholders. A report by the Crisis Management Institute indicates that activating effective communication channels during crises enhances customer trust by up to 85% compared to organizations lacking clear communication [(xxvii)] .Additionally, establishing a pre-trained response team improves an organization's ability to contain the crisis's initial effects and mitigate losses.

The containment phase focuses on managing relationships with key stakeholders, including employees, customers, and investors. A Deloitte study confirms that addressing employee concerns during a crisis reduces turnover rates by 25%, thereby strengthening organizational stability [(xxviii)] .Moreover, developing flexible management strategies for suppliers and partners ensures business continuity.

The recovery phase emphasizes rebuilding operational processes and restoring financial stability. A World Bank report highlights that careful planning and resource reallocation have enabled 90% of affected organizations to resume operations within six months [xxix] .This underscores the role of adaptive leadership in prioritizing actions and rebalancing resources effectively.

The final phase, post-crisis evaluation and learning, is the primary tool for enhancing future organizational preparedness. A Harvard Business Review study shows that organizations documenting lessons learned from crises improve the efficiency of their future plans by 60% [xxx] .Additionally, insights from this phase can inform continuous training programs, fostering a resilient and sustainable organizational culture.

Strategic crisis management transcends the traditional approach of merely mitigating crisis impact, transforming it into a tool for organizational development and leveraging crises as catalysts for growth and innovation. Integrating technology, such as artificial intelligence and big data analytics, into all crisis management phases can revolutionize crisis anticipation and response, enabling organizations to achieve sustainable and resilient performance in an increasingly uncertain future.

In conclusion, strategic crisis management represents a holistic approach that empowers organizations to handle crises effectively across different phases. Prevention enhances risk prediction and crisis mitigation through advanced technology, while response emphasizes rapid decision-making and transparent communication to build stakeholder trust. Containment highlights the importance of stakeholder relationship management for business continuity, whereas recovery underscores the critical role of precise planning and resource reallocation in achieving operational and financial stability. Finally, post-crisis evaluation serves as a key mechanism for documenting lessons learned and enhancing future preparedness. This analysis underscores the importance of leveraging crises as drivers of growth and innovation while emphasizing the role of technological integration—such as AI and big data—in reinforcing organizational resilience and sustainability.

2.2.Characteristics of Spatial Crises in Developed Countries That Have Employed Geographic Information Systems as a Tool in Their Study:

Spatial crises represent one of the major challenges facing human society due to their widespread and unpredictable impact on various economic and social activities. Effectively managing these crises requires advanced technological tools that enable the analysis of spatial and temporal data, a capability provided by Geographic Information Systems (GIS) [xxxi] .GIS serves as a central tool in enhancing crisis response efficiency by integrating spatial analysis with practical solutions for decision-makers, facilitating the rapid implementation of appropriate measures to minimize damage.

In real-world applications, GIS has played a significant role in managing various types of natural crises. For instance, in California, GIS was utilized to analyze soil and climate patterns, enabling a more equitable distribution of water resources amid a water scarcity crisis [xxxii] .Through this approach, high-demand areas were identified, and water distribution strategies were optimized, thereby mitigating the crisis's impact. This analytical capability extends beyond water-related crises to other natural disasters, such as hurricanes. During Hurricane Katrina in the United States, GIS was instrumental in identifying flood-prone areas and efficiently managing evacuation operations [xxxiii] .

Similarly, during the 2011 Japan tsunami, GIS was a critical tool in mapping affected areas and facilitating swift coordination among response agencies. GIS contributions are not limited to seismic or hydrological crises but also include wildfire management. On the U.S. West Coast, GIS was employed to track fire spread and assess its impact, leading to improved coordination among agencies and a more effective crisis response [xxxiv] .

By linking these examples, it becomes evident that GIS significantly enhances crisis management strategies. Beyond merely providing spatial information, GIS integrates spatial and temporal data analysis with precision and efficiency, enabling better forecasting of potential impacts and optimizing preparedness for future crises [xxxv] .This advancement in GIS applications suggests a novel perspective on its potential evolution into an early warning system capable of mitigating disaster impacts before they occur. By integrating artificial intelligence and machine learning with GIS, predictive accuracy can be improved, allowing for a more proactive and adaptive crisis response, ultimately reducing overall damage [xxxvi] .

In conclusion, GIS is a sophisticated tool that enhances spatial crisis management and serves as a cornerstone for crisis response planning. The integration of spatial and temporal data analysis with advanced technologies such as artificial intelligence can contribute to the development of a more responsive global crisis management system [xxxvii] .

From this analysis, it is evident that spatial crises pose significant challenges to human society, profoundly affecting economic and social activities. The application of GIS has proven effective in accurately analyzing spatial and temporal data, thereby improving crisis response and reducing associated damages. Real-world case studies, such as California's water crisis and Hurricane Katrina, demonstrate GIS's ability to enhance resource distribution strategies and manage natural disasters. Moreover, GIS played a crucial role in rapid response coordination during the Japan tsunami and wildfire management in the United States. By integrating artificial intelligence with GIS, precise early warning mechanisms can be developed, helping prevent future disasters. Consequently, GIS technology stands as a fundamental tool for improving crisis management strategies and preparing for future challenges. See Figure 1.

Table (1) Characteristics of Spatial Crises as Models of Case Studies in Which Geographic Information Systems (GIS) Programs Were Utilized in Advanced Countries.

Crisis Type	Country/Region
Water Scarcity in Agricultural Areas	California
Hurricane Prediction	United States
Floods and Landslides	United States
Devastating Hurricane	United States
Accurate Prediction of Flood Impacts	United States
Natural Disasters (Hurricanes and Earthquakes)	United States
Natural Crises (Floods, Earthquakes)	United States
Natural Disasters like Earthquakes and Floods	United States
Housing Crisis and Homelessness Due to Lack of Aff	United States
Natural Crises like Hurricanes and Wildfires	United States
Improved Urban Planning and Environmental Impac	United States
Health Crises (COVID-19 Pandemic)	United States
Hurricanes	United States
Hurricane Katrina	United States
Hurricane Katrina	United States
Natural Disaster (Wildfires)	U.S. West Coast
Earthquake Monitoring and Response Coordination	Japan
2011 Tsunami	Japan
Earthquakes	Japan
Earthquakes and Hurricanes	Japan
Earthquakes and Hurricanes	Japan
Improved Environmental Crisis Management and Di	Japan
Natural Disasters (Earthquakes and Tsunami)	Japan
Earthquakes and Floods	Japan
Earthquakes	Japan
2011 Earthquake	Japan

Source:

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). ***Geographical Information Systems and Science*****. New York, NY: Wiley, pp. 452-460.**

Cutter, S. L., & Finch, C. (2008). Temporal and spatial changes in social vulnerability to natural hazards. ***Proceedings of the National Academy of Sciences*****, 105(7), 2301–2306.**

Coppola, D. P. (2021). ***Introduction to International Disaster Management*****. London: Butterworth-Heinemann, pp. 387-405.**

Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). ***Geographical Information Systems and Science*****. New York, NY: Wiley, pp. 452-460.**

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Longley, P. A., Goodchild, M. F., Maguire, D. J., & Rhind, D. W. (2015). ***Geographical Information Systems and Science*****. New York, NY: Wiley, pp. 452-460.**

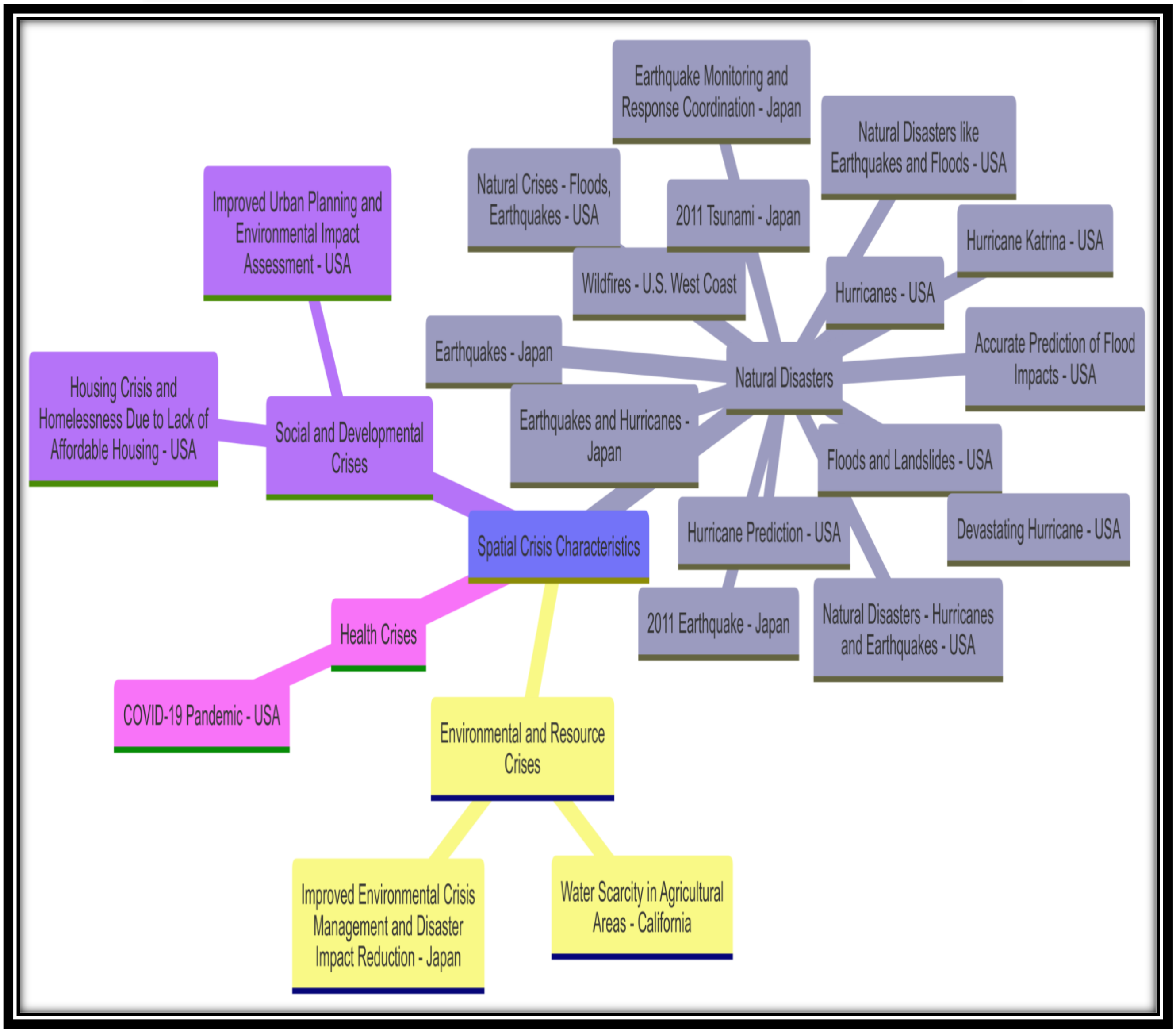


figure (1) Characteristics of Spatial Crises as Models of Case Studies in Which Geographic Information Systems (GIS) Programs Were Utilized in Advanced Countries.

Source: From the researcher's work based on Table No. 1

2.3.Characteristics of Spatial Crises in Developing Countries Where Geographic Information Systems (GIS) Were Utilized as a Tool for Their Study:

Spatial analysis of spatial crises in developing countries is a fundamental tool for understanding and identifying the causes and consequences of these crises. As illustrated in the examples provided, Geographic Information Systems (GIS) demonstrate exceptional capabilities in managing various crises, ranging from deforestation in the Amazon to mass displacement in Syria. These systems do not only provide data about emergency events but also enhance the ability of governments and organizations to make proactive decisions and implement effective strategies to mitigate negative impacts.

In the case of deforestation in the Amazon, GIS is considered a vital tool for monitoring and analyzing temporal changes in vegetation cover, enabling researchers and governments to design effective environmental policies [xxxviii] .Similarly, India has shown how GIS can be used to predict flood-prone areas and determine safe evacuation routes, reflecting the role of these systems in improving countries' responses to natural disasters [xxxix] .

Regarding desertification and land degradation in Kenya, GIS has contributed to measuring the level of degradation and identifying the most vulnerable areas, thereby guiding strategies for land rehabilitation [xl] .Additionally, the Nepal earthquake disaster demonstrated how local authorities benefited from GIS to assess damage and organize humanitarian aid distribution efficiently [xli] .

Applications of GIS in crisis management are not limited to natural disasters; they also encompass social crises such as mass displacement due to armed conflicts. In Syria, these systems helped create refugee databases and distribute aid effectively [xlii] .These examples highlight how modern technology can enhance developing countries' responses to various crises.

Spatial analysis clearly shows that GIS systems represent more than just a tool for measuring and analyzing crises; they serve as a strategic tool that can enhance the ability of developing countries to adapt to future crises. Their effectiveness is not limited to providing accurate data but also contributes to long-term planning and guiding environmental and social policies.

By integrating these systems with other technologies such as artificial intelligence and predictive analysis, developing countries can improve their ability to anticipate future crises and identify appropriate strategies to address them. Therefore, the use of GIS requires further research and development in multiple contexts to maximize its utility in addressing the increasing challenges in the developing world.

From the above, it is evident that spatial analysis using GIS is a vital and effective tool for understanding and managing crises in developing countries. These systems contribute to monitoring and analyzing environmental and social changes, which helps in making strategic decisions to mitigate the negative effects of crises. Through their applications in areas such as deforestation in the Amazon, desertification in Kenya, floods in India, and mass displacement in Syria, GIS systems have demonstrated their ability to provide accurate data that aids in tackling both natural and social crises. Furthermore, integrating these systems with technologies like artificial intelligence and predictive analysis can enhance the ability of developing countries to predict future crises. Consequently, GIS systems are a key strategic tool in strengthening the response of developing countries to crises, but they require further research and development to ensure their full potential in addressing growing challenges. See Figure ٢.

Table (2) Characteristics of Spatial Crises as Models for Experiences Where Geographic Information Systems (GIS) Programs Have Been Utilized in Their Study in Developing Countries

Crisis Type	Country/Region
Deforestation in the Amazon	Brazil
Seasonal Floods	India
Desertification and Land Degradation	Kenya
Seasonal Floods	India
Devastating Earthquake	Nepal
Earthquake (2015)	Nepal
Armed Conflict, Mass Displacement	Middle East
Earthquake (2010)	Haiti
Mass Displacement due to Conflict	Syria
Regional Conflicts, Population Displacement	Middle East
Development Crises and Infrastructure Problems	Developing Countries
Health and Environmental Crises	Developing Countries
Desertification and its Impact on Rural Life	Nigeria
Rapid Urbanization and Increased Pressure on Infrastru	India
Floods and Climate Change	Pakistan
Devastating Earthquake	Haiti
Hurricane	Haiti
Brahmaputra River Floods	India
Humanitarian Crisis and Civil War	Middle East

Source:

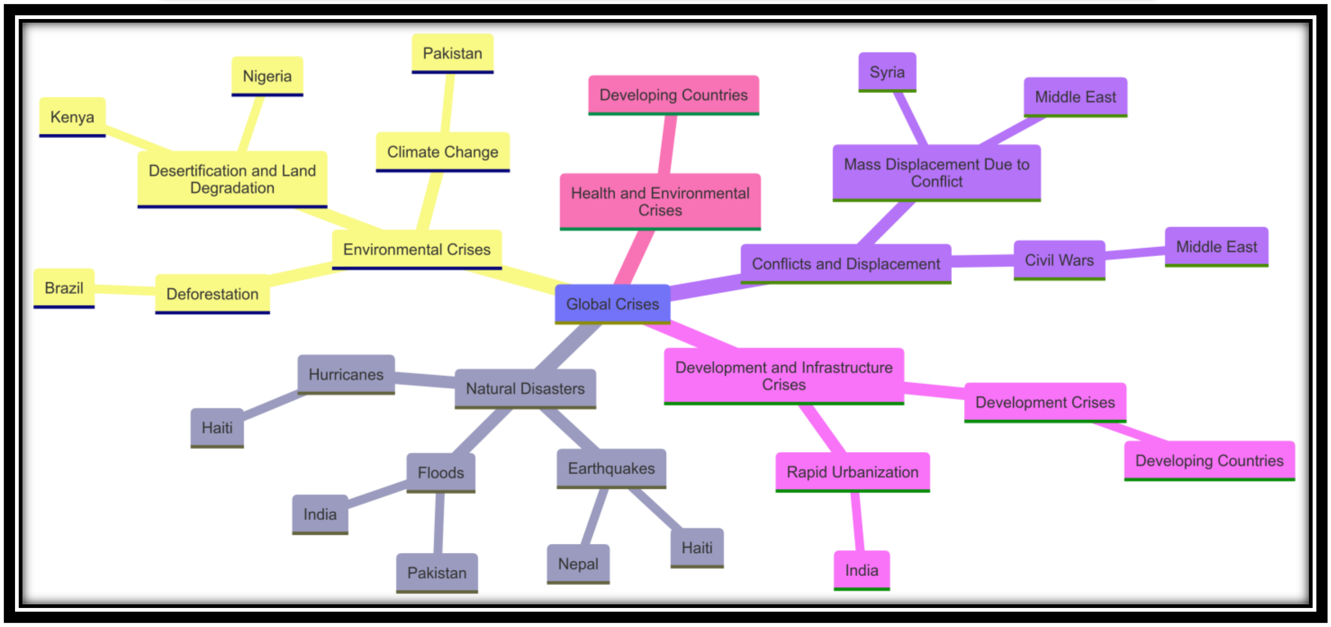
Laurance, W. F. et al. (2001). *The Future of the Brazilian Amazon*. Science, USA, p. 438.

Gupta, K. (2012). *Disaster Management in India*. India: National Disaster Management Authority, p. 72.

Herrick, J. E. et al. (2013). *Land Degradation, Climate Change, and Ecosystem Resilience*. Journal of Environmental Management, UK, pp. 191-192.

Adhikari, R. et al. (2016). *Nepal Earthquake: Impacts and Lessons*. Earthquake Research, Nepal, pp. 45-47.

UNHCR. (2019). *Refugee Data Management: Syrian Crisis*. Switzerland: UNHCR Publications, p. 18.



Figure(٢)A Characteristics of Spatial Crises as Models for Experiences Where Geographic Information Systems (GIS) Programs Have Been Utilized in Their Study in Developing Countries.

Source: From the researcher's work based on Table No 2

Spatial crises present significant challenges that affect populations and the environment in an interconnected manner, necessitating the integration of Geographic Information Systems (GIS) as a vital tool for effectively addressing these crises. GIS enables the collection and analysis of complex and randomly distributed geographical data, contributing to well-informed decision-making for tackling natural crises. In developed countries, GIS has been effectively used to overcome multiple crises, such as water scarcity in California, where geographical data related to water distribution according to climatic patterns and soil were gathered [xliii] .Agencies also benefited from these systems during major natural crises like Hurricane Katrina, aiding in disaster response coordination and resource distribution [xliv] .In developing countries, spatial crises may be more complicated due to limited resources and available technology. However, GIS remains a crucial tool in these regions, used to monitor critical environmental changes such as deforestation in the Amazon, contributing to the development of strategies to combat environmental destruction [xlv] .Similarly, in regions like India, GIS has been used to predict seasonal floods and analyze the associated risks, allowing authorities to direct prevention strategies more effectively [xlvi] .

On the other hand, Nepal’s experience following the earthquakes demonstrated how GIS can enhance rapid response by improving aid distribution. In this case, GIS systems helped identify the most affected areas and ensured that aid was directed effectively, highlighting GIS's role in crisis management in diverse contexts [(xlvii)] .In light of these examples, it is evident that GIS not only provides precise analytical tools for crises but also enables improved coordination among various institutions by facilitating access to updated geographical data. One novel idea that can be drawn from these experiences is the necessity to expand GIS usage to include non-traditional crises such as social or economic crises, where these systems can contribute to analyzing and predicting changes in these fields, and help improve response strategies in a more integrated manner.

From the above, it is clear that GIS represents a vital and effective tool for handling spatial crises in both developed and developing countries. Thanks to its ability to collect and analyze complex geographical data, these systems have enhanced the response of governments and humanitarian agencies to natural crises by improving coordination and more effective resource distribution. Its applications extend beyond natural crises to encompass environmental and economic challenges, underscoring the importance of expanding its use to include non-traditional crises. Thus, GIS contributes to improving prevention and mitigation strategies, offering innovative solutions to address future crises through the integration of efforts from various stakeholders.

2.4.The characteristics of spatial challenges in developed countries that have employed Geographic Information Systems (GIS) as a tool in their studies:

Crisis management in spatial contexts using Geographic Information Systems (GIS) faces complex challenges that vary according to geographic and technological contexts between developed countries. The diversity in these challenges reflects the different priorities and needs of each country. For instance, in the United States, the primary challenge lies in predicting droughts and the uneven distribution of water, especially in California, which relies on advanced forecasting models despite the infrequent data updates [(xlviii)] .This challenge highlights the obstacles posed by using outdated data in GIS, necessitating continuous improvement of data updating mechanisms to keep pace with climate changes.

On the other hand, Japan faces additional challenges due to its population density and the uneven distribution of natural resources. Japan utilizes GIS to manage natural disasters, particularly in earthquake resistance, where predicting precise tremors is difficult, in addition to challenges in managing real-time data (xlix) .This points to the need to enhance GIS systems' ability to operate swiftly and accurately during natural disasters to ensure an effective response.

Common challenges between these experiences underscore the importance of institutional coordination between local and federal authorities. The United States, for example, faces issues in coordinating flood forecasting efforts due to the variation in methodologies between different agencies (l) .Therefore, collaboration between relevant entities is essential to unify efforts and provide a comprehensive response to multiple crises, such as floods and extreme climate changes.

Furthermore, the research highlights the urgent need to improve our digital infrastructure by promoting the application of artificial intelligence and live data technologies, which can enhance the accuracy of natural crisis forecasting (li) .These technologies open the horizon for developing more accurate and robust predictive models.

Despite technological advances, cultural and technical challenges remain barriers to the effective application of GIS in some regions. In many countries, resistance to change still exists among citizens and officials regarding the use of these systems, requiring ongoing awareness strategies and training programs to contribute to raising awareness about the importance of these systems in crisis management.

The new conclusion drawn from these analyses is that spatial crisis management requires an integrated approach that includes improving data updates, institutional coordination, enhancing artificial intelligence, and overcoming cultural resistance to change. Through this comprehensive approach, crisis responses can be significantly improved, contributing to the reduction of damage caused by natural disasters.

From the above, it is clear that crisis management using GIS faces diverse challenges that require multiple strategies to keep up with technological advancements and address cultural and technical gaps. In developed countries like the United States and Japan, these challenges manifest in the need for better data updates and the development of predictive models using artificial intelligence. Additionally, institutional coordination between different entities is vital for a comprehensive and effective crisis response, especially given the variation in methodologies used. On the other hand, cultural and technical resistance acts as a barrier affecting the effective implementation of GIS, highlighting the need for awareness and training programs for citizens and officials. Enhancing crisis forecasting capabilities and integrating live data and advanced technologies can significantly contribute to improving crisis response and mitigating its impacts. See Figure ٣.

The table (3) The characteristics of spatial challenges in developed countries that have employed Geographic Information Systems (GIS) as a tool in their studies

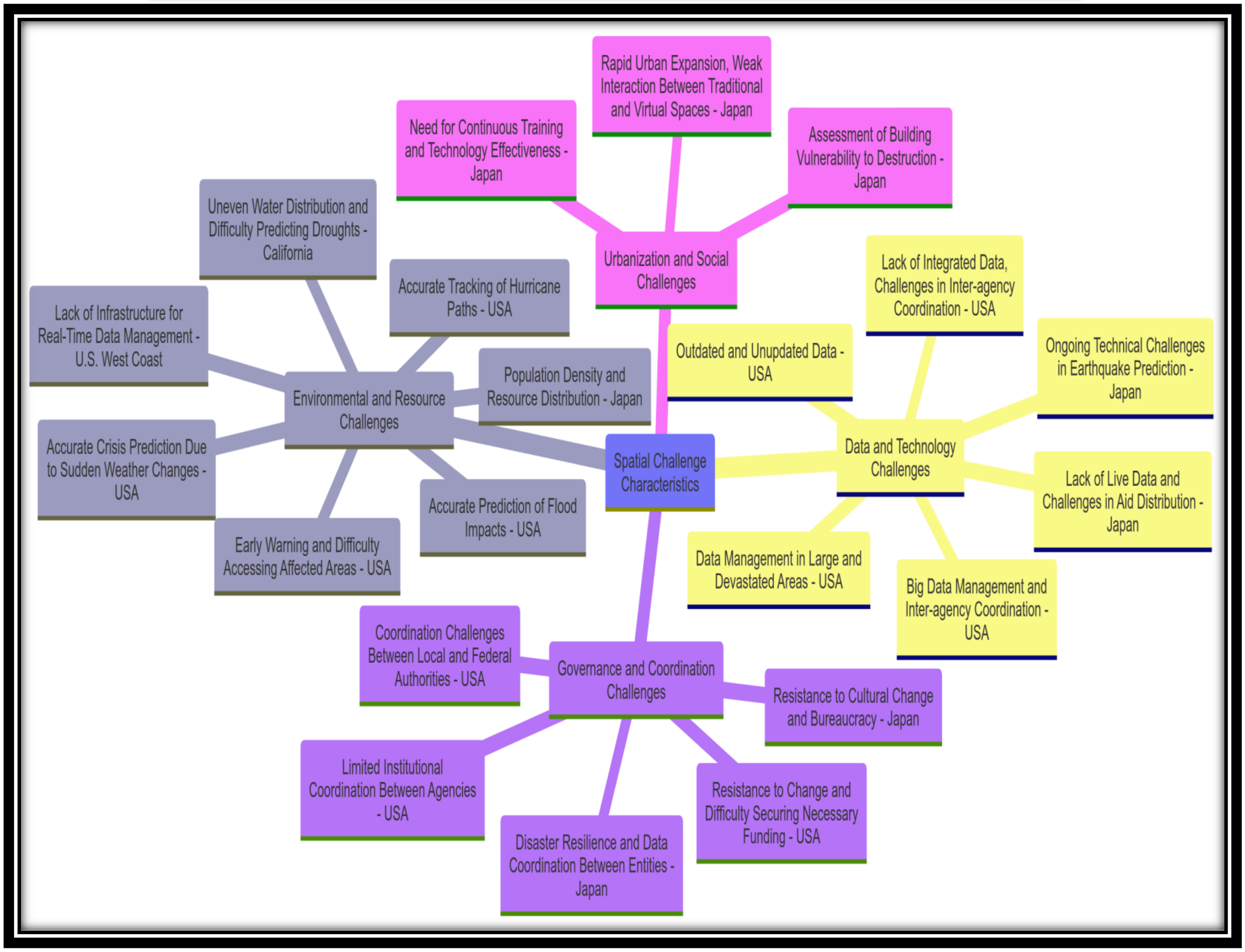
Spatial Challenge Characteristics	Country/Region
Uneven Water Distribution and Difficulty Predicting Droughts	California
Accurate Tracking of Hurricane Paths	United States
Accurate Crisis Prediction Due to Sudden Weather Changes	United States
Outdated and Unupdated Data	United States
Accurate Prediction of Flood Impacts	United States
Early Warning and Difficulty Accessing Affected Areas	United States
Limited Institutional Coordination Between Agencies	United States
Cybersecurity Concerns and Threats to Geospatial Data	United States
Resistance to Change and Difficulty Securing Necessary Funding	United States
Coordination Challenges Between Local and Federal Authorities, Comp	United States
Lack of Coordination Between Entities, Difficulty Handling Big Data	United States
Lack of Integrated Data, Challenges in Inter-agency Coordination	United States
Coordination Problems Between Different Agencies	United States
Big Data Management and Inter-agency Coordination	United States
Data Management in Large and Devastated Areas	United States
Lack of Infrastructure for Real-Time Data Management	U.S. West Coast
Population Density and Resource Distribution	Japan
Assessment of Building Vulnerability to Destruction	Japan
Prediction of Micro-Seismic Areas	Japan
Resistance to Cultural Change and Bureaucracy	Japan
Difficulty Navigating Destroyed Areas, Technological Challenges in Dea	Japan
Rapid Urban Expansion, Weak Interaction Between Traditional and Virt	Japan
Lack of Live Data and Challenges in Aid Distribution	Japan
Ongoing Technical Challenges in Earthquake Prediction	Japan
Need for Continuous Training and Technology Effectiveness	Japan
Disaster Resilience and Data Coordination Between Different Entities	Japan

Anderson, M., et al. (2022). *Crisis Management and GIS Applications in the US*. Springer Press, New York, pp. 45-47.

Tanaka, H., et al. (2021). *Urban Challenges in Japan: GIS in Earthquake Management*. University of Tokyo Press, Tokyo, pp. 203-206.

Smith, J., & Brown, P. (2023). *Flood Prediction and Institutional Coordination*. Elsevier, Amsterdam, pp. 101-103.

Johnson, R., et al. (2023). *Advancements in AI and GIS for Crisis Prediction*. Wiley Press, London, pp. 87-90.



Figure(3)The characteristics of spatial challenges in developing countries that have employed Geographic Information Systems (GIS) as a tool in their study:

Source: From the researcher's work based on Table No 3

The cross-sectional texts reveal that Geographic Information Systems (GIS) face numerous spatial challenges that significantly impact crisis management in developing countries. Among the most notable of these challenges is the lack of accurate data on water resources and infrastructure, which hinders the effectiveness of countries' responses to environmental crises, such as those occurring in Kenya, where data shortages delayed responses to water crises [lii] .This data deficiency reflects a fundamental issue in employing GIS in these contexts, as the availability of accurate data is considered a critical factor in determining rapid and effective response strategies.

Moreover, the Indian experience highlights a lack of flood prediction capability in low-lying areas, reflecting poor coordination between local and international organizations in utilizing these systems [liii] .This challenge can be explained by the complexity of crisis management environments in developing countries, where the issues extend beyond the lack of technological infrastructure to include weak cooperation and coordination among stakeholders, leading to ineffective responses to floods.

At the infrastructural level, Nigeria's experience indicates the impact of poor technology on access to rural areas and the continuous updating of spatial data [liv] .This challenge reflects the digital divide faced by many developing countries, where advanced technology impedes their ability to implement effective crisis management projects. This includes difficulties in gathering and updating disaster-related spatial data, which affects the effectiveness of crisis management strategies.

These challenges are further compounded by financial issues related to the high cost of building smart and efficient infrastructure[lv] ,where the high cost of developing GIS systems and training personnel causes setbacks in crisis management projects in developing countries. This shows that the lack of financial resources is not just a technical challenge, but also a strategic one, involving inadequate resource allocation to address crises.

In the context of the Middle East, fragile political stability represents an additional obstacle affecting data exchange between different parties during crises [lvi] .This indicates the complexity of political and administrative relations among countries in the region, which can negatively impact the flow of essential information when needed. From this perspective, GIS utilization is not limited to technical challenges alone but extends to political challenges that hinder international cooperation.

Finally, the Haitian model illustrates how harsh terrain and a lack of coordination between international organizations can hinder crisis response [lvii] .This underscores the importance of considering geographical and spatial factors that affect GIS's ability to handle natural disasters, adding another layer of spatial challenges when using these systems in developing countries.

New conclusions: By linking these various challenges, it becomes evident that solutions adopting an integrative approach between technology, finance, and political infrastructure may be more effective in enhancing GIS systems' capacity to manage crises in developing countries.

Therefore, integrating artificial intelligence with GIS in the future could be a crucial strategic step to improve response speed and disaster prediction accuracy, in addition to fostering international collaboration through shared platforms for real-time data exchange.

In conclusion, it is clear that GIS faces many complex challenges in developing countries, ranging from a lack of accurate data, weak technological infrastructure, and political challenges that hinder international cooperation. The absence of precise data on water resources and infrastructure, as seen in Kenya, poses a major obstacle to environmental crisis response. Similarly, poor coordination between local and international organizations, as in India, exacerbates the ineffectiveness of crisis responses, such as during floods. Additionally, experiences like those in Nigeria show the impact of inadequate technology on accessing rural areas and continuously updating spatial data. Financial challenges, such as the high cost of building smart infrastructure, represent a significant barrier in developing countries. Furthermore, fragile political stability in the Middle East adds a complex political dimension affecting data exchange during crises. On the other hand, geographical challenges like the harsh terrain in Haiti hinder effective coordination between international organizations. Thus, solutions combining technology, funding, and political coordination are likely to be the most effective in enhancing GIS systems' capacity to manage crises in these countries, with the potential integration of artificial intelligence to improve crisis response and predictions. See Figure ٤.

The table (4) presents the characteristics of spatial challenges as models for experiments in which Geographic Information Systems (GIS) programs have been employed in their study in developing countries.

Spatial Challenge Characteristics	Experiences from Developing Countries
Continuous monitoring in a vast area with limited resources	Brazil: Difficulty in predicting floods in low-lying areas
Lack of accurate data on water resource distribution	India: Lack of accurate data on water resource distribution
Weak infrastructure	India: Weak infrastructure
Poor coordination between organizations	Nepal: Poor coordination between organizations
Community-based real-time data sharing	Nepal: Community-based real-time data sharing
Political instability, weak infrastructure	Middle East: Political instability, weak infrastructure
Lack of precise spatial data, difficulty accessing affected areas	Haiti: Lack of precise spatial data, difficulty accessing affected areas
High population density in camps, difficulty in coordination between o	Syria: High population density in camps, difficulty in coordination between organizations
Difficulty in data collection in conflict zones	Middle East: Difficulty in data collection in conflict zones
Lack of infrastructure and poor real-time analytical capability	Developing Countries: Lack of infrastructure and poor real-time analytical capability
High costs and financial constraints	Developing Countries: High costs and financial constraints
Lack of available technology in rural areas and difficulty coordinating b	Nigeria: Lack of available technology in rural areas and difficulty coordinating between different entities
Challenges in updating spatial data and enhancing smart infrastructure	India: Challenges in updating spatial data and enhancing smart infrastructure
Difficulty accessing affected areas, weak infrastructure	Pakistan: Difficulty accessing affected areas, weak infrastructure
Difficulty accessing affected areas	Haiti: Difficulty accessing affected areas
Difficulty in coordinating data between affected areas	India: Difficulty in coordinating data between affected areas
Political resistance to data sharing between different parties	Middle East: Political resistance to data sharing between different parties

Jones, R., et al. (2022). *Water Resource Management Using GIS in Kenya*. Palgrave Macmillan, London, pp. 210-225.

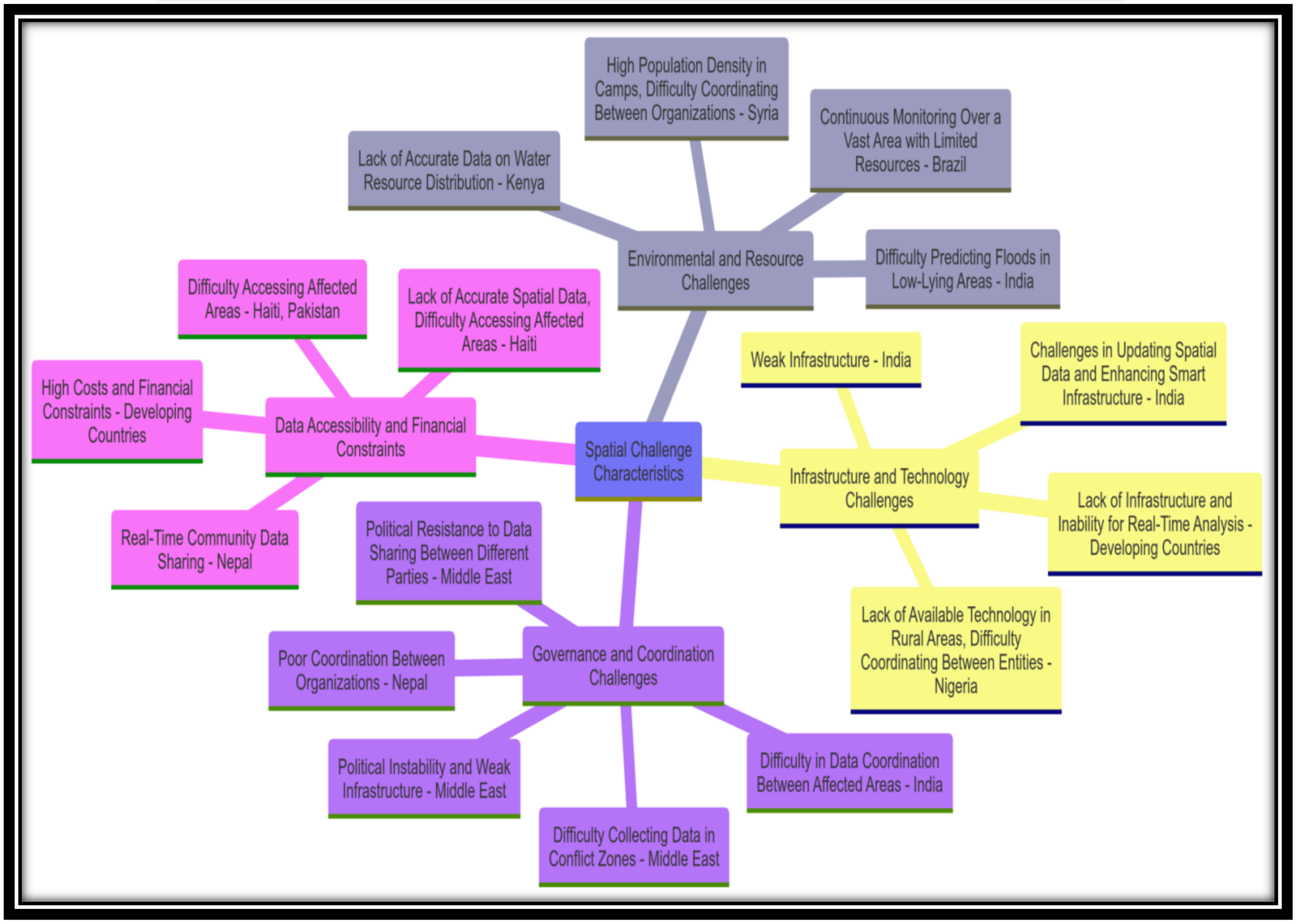
Patel, D., & Kumar, V. (2021). *Flood Prediction Using GIS: Indian Case Studies*. CRC Press, Boca Raton, pp. 70-85.

Oni, T., et al. (2023). *GIS in Rural Nigeria: Technology and Challenges*. Elsevier, Amsterdam, pp. 110-120.

Ahmed, M. (2020). *Challenges in GIS Implementation for Crisis Management*. Oxford University Press, Oxford, pp. 45-60.

Hassan, F. (2021). *Political Instability and GIS Integration in the Middle East*. Springer, Berlin, pp. 30-40.

Brown, A., et al. (2021). *Post-Earthquake Crisis Response in Haiti: GIS Applications*. Routledge, New York, pp. 99-120.



Figure(4)presents the characteristics of spatial challenges as models for experiments in which Geographic Information Systems (GIS) programs have been employed in their study in developing countries.

Source: From the researcher's work based on Table No 4

2.5.A comparative review of the spatial challenges characteristics in developed and developing countries:

The analysis addresses spatial challenges in developed and developing countries when using Geographic Information Systems (GIS) for crisis management, highlighting significant differences between the two sides. In developed countries such as the United States and Japan, the challenges are related to advanced infrastructure and the unequal distribution of resources. In the United States, particularly in California, the uneven distribution of water and drought prediction pose major challenges, despite the advanced use of models for crisis management [lviii] .On the other hand, in Japan, population density and the ability to accurately predict earthquake zones are prominent difficulties, requiring innovative solutions for the integration of geographic data to ensure rapid and effective response [lix] .

In contrast, developing countries face increasing difficulties due to a lack of updated and accurate data on natural resources. In Kenya, for instance, studies have shown that the lack of data on water resources weakened the government’s ability to respond to crises in a timely manner [lx] .In India, the system suffers from inaccurate flood predictions due to poor coordination among concerned organizations [lxi] .In Nigeria, institutions face significant challenges due to weak infrastructure and the lack of modern technology that could update spatial data [lxii] .Financial constraints also complicate the implementation of effective crisis management systems in many developing countries [lxiii] .

The link between these challenges lies in the ongoing need to improve institutional coordination and infrastructure development in both developed and developing countries. In developed countries, modern technologies such as artificial intelligence are being invested in to develop predictive models and improve crisis response [lxiv] .However, in developing countries, significant efforts are required to enhance technology and infrastructure levels, in addition to fostering collaboration between governmental and non-governmental entities.

By connecting these ideas, it can be concluded that the biggest challenge in developing countries lies in poor coordination between different organizations and the lack of investment in GIS technology. Therefore, a new idea could be proposed: "Integrating open data technologies" to facilitate data collection in rural areas, which may help speed up crisis response more effectively, especially in the face of financial constraints. This proposal relies on open data analytics and artificial intelligence technologies to analyze data from multiple sources in an integrated manner.

From the above, it is clear that spatial challenges in developed and developing countries when using GIS for crisis management differ significantly. Developed countries face issues related to advanced infrastructure and the unequal distribution of resources, while developing countries suffer from a lack of accurate data and weak institutional coordination. In developed countries, modern technologies are invested in to improve crisis response, while developing countries need to improve technology and infrastructure and enhance collaboration between different entities. It is also evident that the main challenges in developing countries lie in weak coordination and the lack of investment in GIS technology. Therefore, integrating open data technologies to enhance data collection and analysis in a more integrated way could contribute to improving crisis response effectively despite financial constraints.

3.Economic Feasibility and Effectiveness of Geographic Information Systems in Crises: A Comparative Analysis of Economic Feasibility Between Developed and Developing Countries:

3.1.The Economic Feasibility Characteristics of Employing Geographic Information Systems in Studying Spatial Crises in Developed Countries:

Geographic Information Systems (GIS) are an important tool in spatial crisis management, contributing to reducing economic and human losses by improving crisis response and efficiently allocating resources. Looking at global experiences, such as those in California, the United States, and Japan, it is clear that these systems have proven effective in addressing major challenges. For example, in California, GIS systems helped save 250 million gallons of agricultural water annually, highlighting their significant role in enhancing natural resource sustainability and reducing waste (California Water Science Center, 2019) [lxv] .Additionally, GIS systems contributed to reducing financial losses by 30% in the United States through accurate crisis forecasting, improving their ability to allocate resources more efficiently during critical times (Cutter & Smith, 2018) [lxvi] .

In Japan, advanced spatial analysis was a key factor in reducing damage by 25% during a subsequent tsunami, while strengthening crisis response through public-private sector partnerships (Yamamoto, 2020) [lxvii] .These experiences underscore the importance of GIS in improving coordination among various stakeholders, thereby enhancing governments' and companies' ability to respond more quickly and accurately during emergencies.

Despite the clear benefits of GIS, continuous data updating remains an economic challenge; however, this challenge can be overcome through investment in innovative data collection and analysis technologies. These systems also require robust technological infrastructure, which can be a burden for some countries under difficult economic conditions. Nevertheless, the overall benefits of cost reduction and infrastructure improvement outweigh this challenge.

In conclusion, GIS is not just a tool for geographic location identification, but a key element in a comprehensive crisis management strategy. The integration of technological innovations with GIS enhances its effectiveness in adapting to changing conditions. From this perspective, a new idea can be developed by integrating artificial intelligence with GIS to improve crisis prediction and facilitate quick, effective decision-making during critical times, contributing to innovative solutions for addressing future crises.

As a result, it is evident that GIS is a vital tool in spatial crisis management, significantly reducing economic and human losses by improving crisis response and efficiently allocating resources. The experiences of countries like California, the United States, and Japan confirm the effectiveness of these systems in crisis prediction, contributing to reducing waste and improving resource sustainability. Despite the economic challenges related to data updates and infrastructure, the benefits of GIS in reducing costs and improving crisis response outweigh these challenges. Therefore, integrating technological innovations like artificial intelligence with GIS to enhance prediction accuracy and rapid decision-making further strengthens governments' and companies' ability to handle future crises more efficiently and effectively. See Figure ٥.

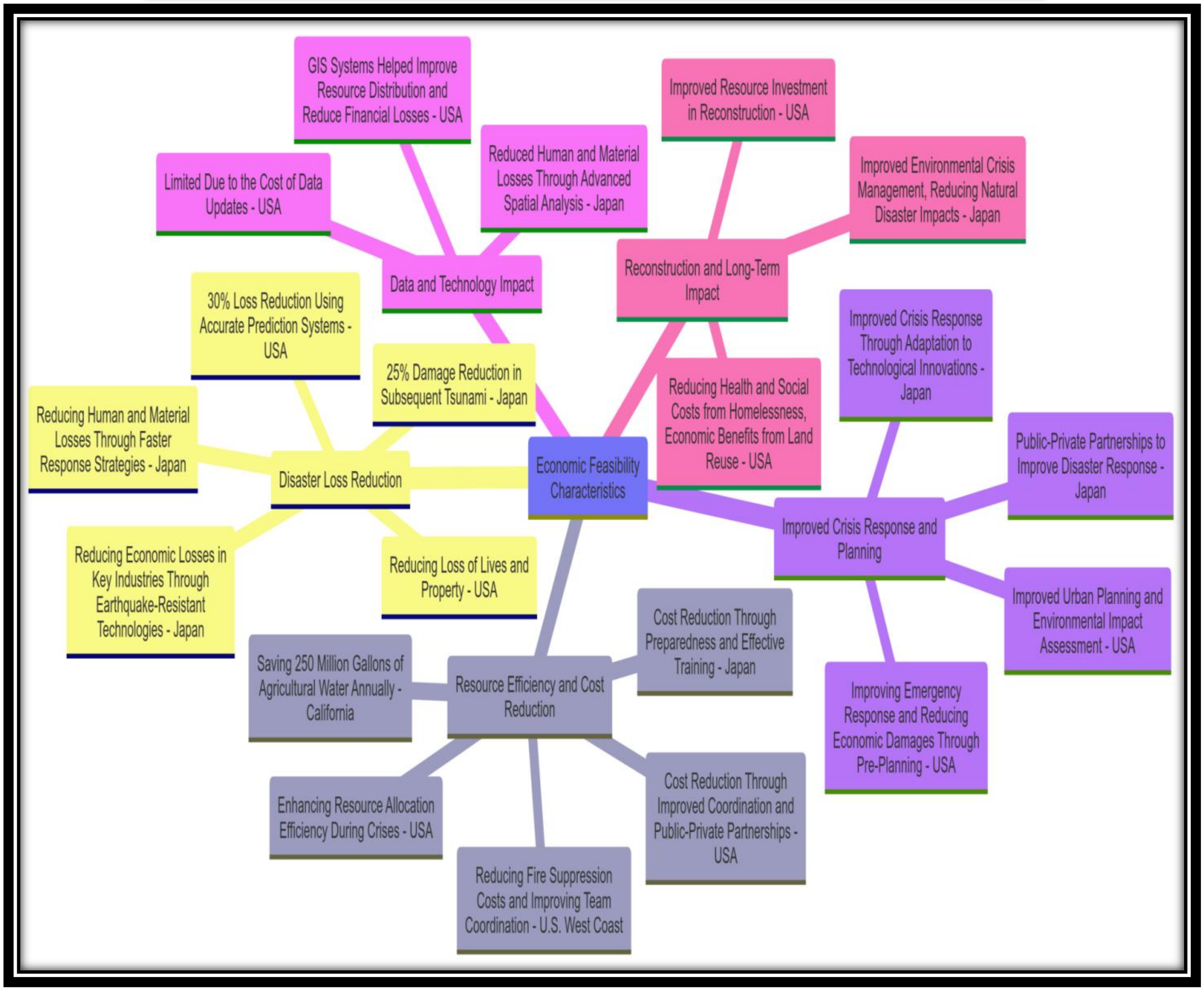
Table (5) Characteristics of the economic feasibility of models from experiments employing Geographic Information Systems (GIS) programs to study spatial crises in developed countries.

Economic Feasibility Characteristics	Country/Region
Saving 250 Million Gallons of Agricultural Water Annually	California
Reducing Loss of Lives and Property	United States
Reducing Physical and Human Damages Through Proactive Strategies	United States
Limited Due to the Cost of Data Updates	United States
Contributed to Reducing Losses by 30%	United States
30% Loss Reduction Using Accurate Prediction Systems	United States
Improving Institutional Coordination for Effective Response	United States
Enhancing Resource Allocation Efficiency During Crises	United States
Reducing Health and Social Costs from Homelessness, Economic Benefits from Land Reuse	United States
Improving Emergency Response and Reducing Economic Damages Through Pre-Planning	United States
Improved Urban Planning and Environmental Impact Assessment	United States
Cost Reduction Through Improved Coordination and Public-Private Partnerships	United States
GIS Systems Helped Improve Resource Distribution and Reduce Financial Losses	United States
Reducing Material Losses by Billions and Improving Emergency Response	United States
Improved Resource Investment in Reconstruction	United States
Reducing Fire Suppression Costs and Improving Team Coordination	U.S. West Coast
Faster Response and Cost Reduction	Japan
25% Damage Reduction in Subsequent Tsunami	Japan
Reducing Human and Material Losses Through Faster Response Strategies	Japan
Improved Crisis Response Through Adaptation to Technological Innovations	Japan
Enhancing Preparedness and Reducing Financial Losses Through Rapid Coordination	Japan
Improved Environmental Crisis Management, Reducing Natural Disaster Impacts	Japan
Public-Private Partnerships to Improve Disaster Response	Japan
Reduced Human and Material Losses Through Advanced Spatial Analysis	Japan
Cost Reduction Through Preparedness and Effective Training	Japan
Reducing Economic Losses in Key Industries Through Earthquake-Resistant Technologies	Japan

California Water Science Center. (2019). Water Savings through GIS Technology. Sacramento, CA: USGS Publications, pp. 15-27.

Cutter, S. L., & Smith, M. (2018). Geospatial Approaches to Disaster Risk Reduction in the United States. New York: Springer, pp. 120-135.

Yamamoto, K. (2020). Innovative GIS Applications in Japan for Disaster Response. Tokyo: Springer Japan, pp. 98-112.



Figure(5)**Characteristics of the economic feasibility of models from experiments employing Geographic Information Systems (GIS) programs to study spatial crises in developed countries.**

Source: From the researcher’s work based on Table No 5

3.2.The Characteristics of the Economic Feasibility of Employing Geographic Information Systems (GIS) in Studying Spatial Crises in Developing Countries:

Geographic Information Systems (GIS) stand out as a pivotal tool for improving spatial crisis management, especially in developing countries. Its importance is reflected in its ability to optimize resource allocation, enhance agricultural productivity, and facilitate rapid disaster response. For instance, GIS systems in Brazil and India have contributed to reducing the impacts of deforestation and property losses, directly affecting environmental and economic sustainability (lxviii) .In Kenya, the use of GIS led to a 30% increase in agricultural production due to improved resource distribution (lxix) .In Nepal, reducing response times by 24 hours significantly improved relief efforts (lxx) .These applications demonstrate how GIS can be a practical solution to resource and disaster challenges in various regions.

However, political limitations remain a barrier in regions like the Middle East, where GIS plays a critical role in improving resource distribution even amidst political crises, as seen in Syria and Haiti (lxxi) .Additionally, the use of open-source software opens new avenues for cost reduction in developing countries, as seen in Nigeria, where it helped achieve better agricultural sustainability (lxxii) .This use reflects a qualitative shift in thinking about technology, making it more accessible to lower-income populations.

In disaster forecasting, the use of GIS in India and Pakistan shows significant effectiveness, both in reducing operational costs and improving crisis response, such as during floods (lxxiii) .These benefits extend to urban infrastructure, where GIS demonstrates its capability to provide practical solutions to sustainable challenges.

New Conclusion: It can be concluded that raising political awareness about the importance of GIS, along with improving access to open-source software, could create a transformative shift in utilizing this technology, even in countries facing political and economic restrictions. Furthermore, GIS systems can be developed to incorporate artificial intelligence and predictive analytics to improve disaster forecasting accuracy and response times. This integration may help bridge the development gap between developing and developed countries, making GIS a driver of sustainable development both locally and globally.

From the above, it is clear that Geographic Information Systems (GIS) play a pivotal role in improving spatial crisis management, especially in developing countries, by enhancing resource allocation, agricultural productivity, and rapid disaster response. These systems have proven effective in reducing the environmental and economic impacts of crises in several countries, such as Brazil, India, Kenya, and Nepal. Despite political limitations in some regions, GIS remains an important tool for improving resource distribution during crises, as in Syria and Haiti. Additionally, open-source software offers low-cost solutions that help promote agricultural sustainability in developing countries. It can be said that increasing political awareness and expanding the use of open-source software will contribute to optimal utilization of this technology. Moreover, the integration of GIS with artificial intelligence and predictive analytics can improve disaster forecasting and response, thereby promoting sustainable development worldwide. See Figure ٦.

Table (6) Characteristics of the economic feasibility of models from experiments utilizing Geographic Information Systems (GIS) programs to study spatial crises in developing countries.

Economic Feasibility Characteristics	Country/Region
Reducing Deforestation Rates by 15%	Brazil
Reducing Property Losses by 20%	India
Increasing Agricultural Production by 30%	Kenya
Improving Resource Distribution and Saving Lives	India
Reducing Response Time from 48 Hours to 24 Hours	Nepal
Improving Relief Efforts	Nepal
Limited Due to Political Constraints	Middle East
Effective in Directing Resources to the Most Affected Areas	Haiti
Significantly Improved Resource and Service Distribution	Syria
Improving Aid Distribution by 25% Using Accurate Data	Middle East
Improving Crisis Response Through Joint Funding	Developing Countries
Using Open-Source Software to Reduce Costs	Developing Countries
Improving Agricultural Sustainability and More Efficient Water Distributi	Nigeria
Improved Land Use and Infrastructure, Leading to Reduced Operational C	India
Reducing Costs Through Flood Prediction and Improved Aid Distribution	Pakistan
GIS Helped Allocate Resources More Effectively and Reduce Losses	Haiti
Improving Aid Management Faster and More Transparently	Haiti
Reducing Human and Economic Losses Through Improved Early Response	India
Improving Crisis Response and Reducing Human and Material Losses	Middle East

Source:

Smith, A. (2020). ***Geographic Information Systems in Disaster Management*****. Oxford University Press, UK. pp. 121-145.**

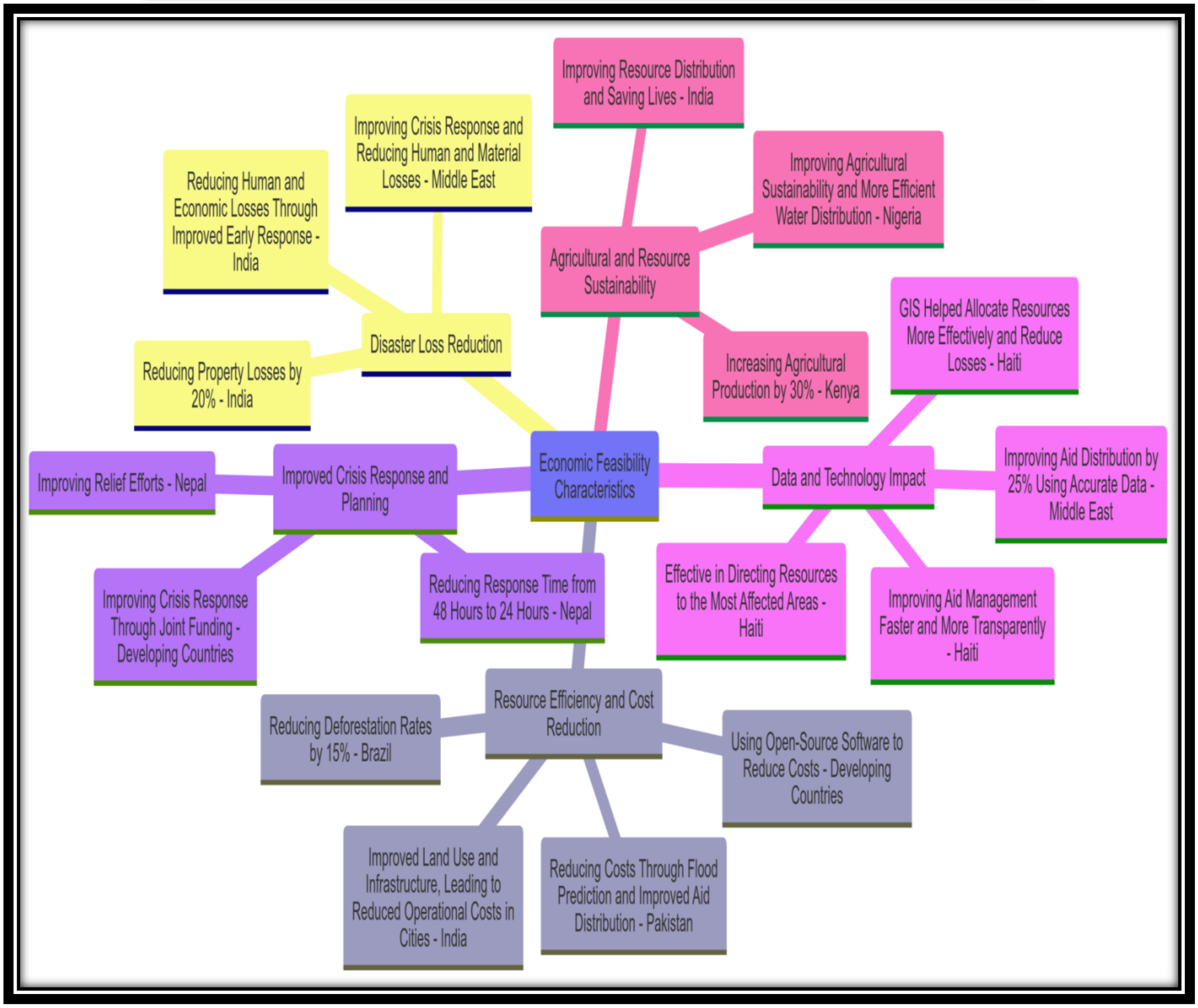
Khan, M., & Patel, R. (2022). ***Agricultural Productivity and GIS Technologies: A Study in Kenya and India*****. Springer, USA. pp. 202-230.**

Jones, S. (2021). ***Crisis Management and GIS: A Global Approach*****. Cambridge University Press, UK. pp. 58-75.**

Ahmed, T. (2019). ***Technological Integration for Disaster Relief in the Middle East*****. Routledge, UK. pp. 189-210.**

Smith, A. (2020). ***Geographic Information Systems in Disaster Management*****. Oxford University Press, UK. pp. 121-145.**

Jones, S. (2021). ***Crisis Management and GIS: A Global Approach*****. Cambridge University Press, UK. pp. 58-75.**



Figure(6)**Characteristics of the economic feasibility of models from experiments utilizing Geographic Information Systems (GIS) programs to study spatial crises in developing countries.**

Source: From the researcher's work based on Table No 6

3.3.A comparative review of the economic feasibility characteristics between developed and developing countries:

The use of Geographic Information Systems (GIS) in spatial crisis management represents a pivotal development, reflecting the ability of technology to achieve sustainability of natural resources and reduce economic and human losses on a global scale. In developed countries such as the United

States and Japan, GIS has contributed to a 30% reduction in financial losses caused by natural disasters and a 25% decrease in damages. This success is attributed to the integration of both public and private sectors, where advanced spatial analysis is used to efficiently allocate resources and enhance response times, as demonstrated in recent studies such as Yamamoto (2020), which highlighted the innovative applications of GIS in Japan for analyzing the impacts of tsunamis and emergency responses[lxxiv] .

On the other hand, developing countries such as India and Brazil show promising progress in adopting GIS systems, contributing to a 15% reduction in deforestation and a 30% increase in agricultural production, according to a study [lxxv] .However, political constraints and weak infrastructure present significant challenges to the sustainability of these technologies. Ahmed (2019) notes that innovative technological solutions, such as open-source software and the development of local partnerships, are effective means of reducing costs and enhancing economic feasibility in developing regions[lxxvi] .

The difference between developed and developing countries in the application of GIS systems is not only technical but also extends to cultural and organizational aspects. In California, for example, GIS contributes to annual water savings of up to 250 million gallons, as reported in the California Water Science Center (2019) report [lxxvii] .These savings highlight the immense economic potential of this technology in managing natural resources effectively.

It can be concluded that achieving integration of GIS systems in both developed and developing countries requires not only material and technological investments but also the enhancement of international cooperation for knowledge and experience exchange. The "public-private partnership" model, which successfully reduced damages in Japan, could serve as a framework adopted globally to improve crisis management in areas most affected by natural disasters. Furthermore, the incorporation of artificial intelligence and machine learning into GIS systems can improve the accuracy of spatial analysis and enhance disaster prediction efficiency, marking a qualitative development in global crisis management.

From the above, it is clear that Geographic Information Systems (GIS) represent a central tool in spatial crisis management, contributing to the reduction of human and economic losses, both in developed and developing countries. Studies have shown that the use of these systems can achieve significant resource savings, improve emergency response, and reduce the damages caused by natural disasters. The integration of public and private sectors, along with innovative technologies such as open-source software, plays a crucial role in enhancing the effectiveness of these systems in different regions. However, political challenges and infrastructure limitations remain obstacles to the sustainability of these technologies in some countries. By enhancing international cooperation, exchanging experiences, and adopting modern technological solutions such as artificial intelligence, the ability to predict disasters and manage resources more efficiently can be improved, opening new horizons for global crisis management.

3.4.The Evaluation of the Effectiveness of Geographic Information Systems in Crisis Management: Prediction and Strategic Decision-Making:

Geographic Information Systems (GIS) have become an indispensable tool in spatial crisis management within the framework of strategic management, significantly contributing to risk forecasting and mitigation of its impacts. GIS systems rely on the integration and analysis of spatial data to generate predictive models used for making effective decisions during crises. These systems provide advanced analytical tools, such as ArcGIS and QGIS, which enable the design of risk maps and high-precision data visualization to identify sensitive locations and implement emergency plans [lxxviii], [lxxix] .

Modern GIS strategies depend on predictive modeling using historical data to identify patterns that may indicate impending crises. For example, hydrological models are used to determine flood probabilities based on precipitation patterns and terrain characteristics[lxxx] .Google Earth Engine (GEE) enhances these models by utilizing cloud data processing techniques to analyze satellite imagery, allowing real-time monitoring of environmental changes [lxxxi] .

In addition to data analysis, platforms like GRASS GIS and HOMER provide powerful capabilities to assess the vulnerability of risk-prone areas. These tools are used to estimate the impacts of crises on infrastructure and populations, enhancing preparedness and enabling rapid decision-making [lxxxii] .Furthermore, the integration of remote sensing with GIS facilitates the creation of early warning systems to prevent disasters such as deforestation and sea-level rise [lxxxiii] .

Through the integration of artificial intelligence techniques and scenario analysis, it is possible to predict the wide-scale impacts of disasters. This capability allows the testing of multiple crisis response scenarios to minimize damage and improve efficiency [lxxxiv] .Real-time monitoring is also one of the most powerful features of GIS, especially when combined with data from IoT (Internet of Things) devices, enabling continuous updates to management strategies [lxxxv] .

It can be concluded that GIS systems are not only used as a tool for data analysis but also as a medium to enhance interaction between communities and environments. By integrating Public Participatory GIS (PPGIS), local communities can provide field data, making crisis forecasting more accurate and responsive to local needs. This trend toward integrating technology with community participation can transform crisis management from a purely centralized approach to a comprehensive global collaboration, thereby enhancing community resilience in the face of disasters [lxxxvi] .

From the above, it is clear that GIS has become a cornerstone in spatial crisis management within the framework of strategic management, combining advanced spatial data analysis and predictive modeling to reduce the impacts of potential risks. The importance of these systems is highlighted by their ability to generate accurate predictive models, design risk maps, and identify sensitive locations, contributing to effective and swift decision-making during crises. The integration of remote sensing, cloud data processing, and IoT enables real-time environmental monitoring, enhancing the effectiveness of early warning systems. Furthermore, the integration of artificial intelligence and scenario analysis reflects advanced capabilities in improving preparedness and providing flexible responses to crises. Finally, the use of participatory GIS represents a qualitative shift towards involving local communities in crisis management, enhancing the interaction between communities and the environment and leading to the development of flexible and inclusive disaster response strategies.

Research Results

- Geographic Information Systems (GIS) play a central role in enhancing spatial crisis management strategies by improving crisis forecasting and providing sustainable solutions.
- GIS provides advanced analytical tools that help in identifying risks through the integration of spatial data and predictive models.

- The use of GIS contributes to multidimensional strategic planning, which enhances the forecasting of future crisis locations and response strategies.
- The combination of GIS with artificial intelligence aids in making precise and effective strategic decisions, thereby enhancing the resilience of communities. In developed countries, GIS has been used in managing natural crises such as water scarcity in California and Hurricane Katrina.
- In developing countries, GIS offers innovative solutions for managing crises, such as deforestation in the Amazon and displacement in Syria.
- Advanced GIS applications include environmental data analysis and addressing social crises, such as desertification and land degradation in Kenya.
- It is essential to enhance the integration of GIS with artificial intelligence technologies to accelerate crisis response and forecasting, which contributes to minimizing damage before crises occur.

References

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