PLANNING MALAYSIA:
Journal of the Malaysian Institute of Planners
VOLUME 23 ISSUE 3 (2025), Page 346 – 362

EVALUATION OF CLIMATE DISASTER RESILIENCE INDEX IN YAN DISTRICT'S LOCAL PLAN IN KEDAH, MALAYSIA

M Zainora Asmawi[1], Ashraf Dewan[2], Syakir Amir Ab Rahman[3], Maimunah Abdul Aziz[4]

[1,3]*Department of Urban and Regional Planning,*
Kulliyah of Architecture and Environmental Design,
INTERNATIONAL ISLAMIC UNIVERSITY MALAYSIA
[2]*School of Earth and Planetary Sciences (EPS),*
Faculty of Science and Engineering,
CURTIN UNIVERSITY, PERTH, AUSTRALIA
[4] UNIVERSITI KUALA LUMPUR BUSINESS SCHOOL UNIKL

Abstract

Assessing the resilience of urban areas is crucial for effective disaster planning and management. The Climate Disaster Resilience Index (CDRI) is a widely recognized tool used globally to evaluate the current and future risks faced by cities and guide policy development. This research focuses on the application of the CDRI in Yan, Kedah to assess the district's resilience in the context of Local Plan preparation. A comprehensive evaluation was conducted across various components, including physical, social, economic, institutional, and environmental aspects. A total of 97 respondents from agencies and communities participated in the survey through online and face-to-face methods. The physical component in Yan District exhibited the highest resilience to disasters, with all aspects receiving resilience scores ranging from 3 (moderately satisfactory) to 4 (satisfactory). However, the economic component had the lowest CDRI score of 2.99 compared to the other components, indicating a need to focus on economic development to enhance disaster resilience in the district. The overall CDRI performance of the district suggests that local stakeholders are prepared to effectively manage disasters. The findings from the CDRI assessment can guide future planning efforts to promote more resilient development in Yan District.

Keywords: Resilience, Disaster, Index, Climate Change, Environment

[1] Corresponding author. Email: zainora@iium.edu.my

INTRODUCTION

Urbanization often results in increased disaster risk due to the rapid growth of urban populations globally (Lu et al., 2020). Natural disasters have a significant impact on the physical development and safety of communities worldwide. These disasters disrupt society in various ways, including psychological, sociodemographic, socioeconomic, and sociopolitical disruptions that require careful management (Chong, Kamarudin, and Abd Wahid, 2017). Disasters, whether natural or human-caused, have significant impacts on both people and the environment. Srinivas and Nakagawa (2008) noted that environmental factors can exacerbate the impacts of disasters, and disasters can also have global environmental consequences. As a result, Malaysia is taking steps to address the increasing risks of climate-related hazards in its current five-year national development plan, the 12th Malaysia Plan (2021-2025). The plan focuses on mitigating the effects of climate change as Malaysia recognizes the growing threats it poses. Chong, Kamarudin, and Abd. Wahid (2017) emphasized that disasters have physical impacts such as human casualties and damage to properties and infrastructure, affecting the community's well-being, quality, and safety. Therefore, involving stakeholders in disaster management is essential for efficiently and effectively handling these situations.

In Malaysia, the National Disaster Management Agency (NADMA) is responsible for overseeing all aspects of disaster risk management in the country (Center for Excellence in Disaster Management and Humanitarian Assistance, 2022; Chong and Kamarudin, 2018). NADMA, operating under the Prime Minister's Department (JPM), serves as the central authority for disaster management. The agency consistently undertakes initiatives to mitigate disaster risks and enhance preparedness. It operates through a Disaster Management and Relief Committee (DMRC) system to lead and coordinate disaster management activities (Ramli et al., 2021). Before the establishment of NADMA, the country's initial official effort in disaster management and relief was Directive No. 20 (National Policy and Mechanism on Management Relief Framework) under the National Security Council (NSC). While floods are the most common natural disaster in Malaysia, the country has also experienced earthquakes, landslides, tsunamis, and sinkholes over the years. NADMA was established to address and manage more complex and multiple disasters. The roles and directives of NADMA are depicted in Figure 1.

Figure 1: NADMA roles and directives
Source: Center for Excellence in Disaster Management and Humanitarian Assistance (2022)

Since the establishment of NADMA and the restructuring of federal government entities in 2015, a proactive strategy for disaster risk and response has been implemented. In the context of land use planning, the threat of natural hazards in urban areas is typically addressed through land use zoning, development strategies, and building regulations. The impact of climate change necessitates urban planners to devise comprehensive measures to adapt to more frequent and intense hazards. Integrating disaster management into local planning is crucial to ensure preparedness is considered in Malaysia's overall land use planning system. However, according to Wan Mohd Rani, Kamarudin, Razak, Che Hasan, and Mohamad (2018), Malaysia faces challenges in assessing and mapping the degree of urban resilience as it requires cooperation and dedication from multiple stakeholders.

In this regard, this paper advocates for integrating disaster resilience into local development plans as a key adaptive strategy. It evaluates how well the local development planning system in Malaysia addresses the vulnerability and resilience needs of communities in response to climate change impacts. The study, based on a CDRI survey in Yan District, assesses the level of disaster resilience inclusion in the local plan of Yan District. The paper emphasizes the importance of enhancing participatory planning and development capacity of local authorities and communities to effectively integrate disaster resilience into local development plans.

LITERATURE REVIEW

Resilience in Urban Planning

The concept of 'resilience' has been widely used in various research disciplines and fields, including environmental studies and geographical analysis. Resilience can be classified into five spatial scales: household/individual, local, regional, national, and global society (Wilson, 2011; Berkes and Ross, 2013). The concept of resilience has expanded beyond its ecological origins to encompass disciplines like psychology, policy, and urban planning in the context of climate change (Rezaie et al., 2021; Giang et al., 2024). Resilience plays a crucial role in urban planning by helping cities withstand, adapt to, and recover from various impacts, ensuring their continued functionality in the face of challenges. Additionally, Imani et al. (2022) noted a growing trend of integrating climate change resilience into development planning and resource allocation.

Different levels of planning require the implementation of suitable natural disaster management strategies that align with the hierarchy of Malaysian development plans, such as the Structure Plan or Local Plan. Disaster resilience primarily involves disaster risk management, which should ideally be in line with Malaysia's sustainable development policy. The 12th Malaysia Plan (2021-2025) emphasizes both structural and non-structural approaches to managing disaster risks. Effective disaster management in the context of climate change involves addressing hidden risk factors and allocating significant resources to mitigate environmental instability, poverty, and urbanization-related issues.

Disaster Management in the Malaysian Planning System

Given Malaysia's vulnerability to disasters, especially flooding, the importance of disaster resilience has become a key focus in the Malaysian planning system. Currently, the Town and Country Planning Act 1976 (Act 172) establishes a three-tier administration system. At the federal level, Malaysia follows a three-tier governmental structure consisting of federal, state, and local administrations, in addition to the National Physical Plan (NPP).

PLANMalaysia introduced the 'Planning Guidelines for Disaster-Resilient Cities in Malaysia, 2019' as a specific framework for disaster management in the country. This guideline serves as a reference for State Governments and Local Planning Authorities (LPA) to evaluate urban resilience in their respective areas. The guidelines address five types of natural disasters: floods, landslides, coastal erosion, sea-level rise, and tsunamis/earthquakes. In 2022, PLANMalaysia's Director-General issued a circular on integrating disaster risk management into the development of District Local Plans (DLP). This circular, endorsed at the Central Disaster Management Committee Meeting on September 13, 2021, outlines the process of integrating disaster risk management elements into DLP preparation. As a result, all development plans must include a

section on disaster and risk management, incorporating analysis and recommendations related to disaster management.

Climate Disaster Resilience Index (CDRI)

The Climate Disaster Resilience Index (CDRI) evaluates climate disaster resilience across five dimensions: physical, social, economic, institutional, and environmental (The World Bank, 2015). Developed by Kyoto University's Climate and Disaster Resilience Initiative (Imani, et al., 2021), the CDRI serves as a planning tool. Disaster management and risk reduction require the involvement of various stakeholders, administrators, and comprehensive urban system planning. The CDRI aims to increase awareness among policymakers and practitioners about current and future climate-related disaster risks, facilitating improved planning and management to safeguard the environment and communities. By enhancing and restructuring disaster management agencies, they can better align with the country's current disaster landscape. Efforts to integrate disaster risk reduction into urban planning and development should be conducted regularly based on hazard and risk levels, taking a holistic approach. The current sectoral approach to disaster risk is inadequate for mitigating risks in multi-disaster zones. Therefore, by bridging the gap between science and policy in program implementation, it is possible to reduce disaster risks and their impacts.

Various organizations have developed tools and services to assess and enhance resilience to climate risks (Cai et al., 2018). These resources are primarily used by governments, NGOs, academia, and the private sector to aid decision-making in complex and uncertain situations (Laurien et al., 2022). According to scholars like Joerin and Shaw (2011) and Surjan, Sharma, and Shaw (2011), the CDRI aims to increase awareness of future risks faced by cities. The assessment outcomes are expected to inform the development of comprehensive disaster and climate management plans to tackle challenges related to climate change. The CDRI is crucial for promoting sustainable development, particularly in the face of escalating climate risks. It plays a vital role in fostering climate-smart, inclusive, and disaster-resilient development pathways. By ensuring that development is both sustainable and adaptable to global climate challenges, the CDRI significantly contributes to enhancing long-term resilience. In the realm of urban planning, the CDRI is essential as it assists in evaluating and improving a city or community's capacity to withstand and recover from climate-related disasters.

RESEARCH METHODOLOGY

The study utilized a CDRI questionnaire survey, which adhered to the standard format outlined in the Sendai Framework but was adjusted slightly to align with the specific characteristics of Yan District. The CDRI assesses climate disaster

resilience through five components: physical, social, economic, institutional, and environment, as outlined in Table 1. The comprehensive analysis of the CDRI is derived from the results obtained from the sub-components and parameters examined within each sector.

Table1: List of parameters considered in CDRI's five components.

Component	Sub-components
Physical	Electricity; Water supply; Sanitation and solid waste disposal; Accessibility of road; Housing and land use
Social	Population; Health; Education & awareness; Social capital; Community preparedness
Economy	Income; Employment; Household asset; Finance and savings; Budget and subsidies
Institutional	Mainstreaming of DRR and CCA; Effectiveness of city's crisis management; Effectiveness of a city's institution to respond to a disaster; Institutional collaboration with other organizations and stakeholders; Good Governance
Environment	Intensity/ Severity of natural hazards; Frequency of natural hazards; Ecosystem services; Land use; Environmental security and food security

Source: Shaw et al. (2010)

Each component is made up of five parameters, and each sub-component is made up of five indicators, totalling 125 questions in the CDRI questionnaire (Table 2). Participants are required to assign weights to variables and parameters to indicate city priorities and indicator importance. Scores for each parameter and dimension were calculated using the Weighted Mean Index (WMI) method based on survey data.

Table 2: Components, Sub-Components and Indicators in the CDRI Survey

Dimension	Parameters
Component	5
Sub-component	25
Indicator	125

Source: GP Resilience Cities in Malaysia, 2019

An initial assessment of Yan District's resilience level was carried out through a series of survey questions. The CDRI survey questions offer five response options, ranging from 1 for very low to 5 for strong. Higher CDRI values

indicate a higher level of readiness for climate change and disasters. These findings offer broad policy recommendations based on the quality of the survey data, revealing both the strengths and weaknesses in each area.

This scale will assess all indications and provide a score for each sub-component's parameters. The average score for each major component of the CDRI will be calculated based on the average score of all parameters within the sub-component. The CDRI survey for Yan District was conducted by Technical Working Groups (TWG) and Focus Group Discussion (FGD) members from various technical agencies at federal, state, and local community levels (Figure 2). A total of 97 purposive respondents participated in the survey, both in-person and online (Table 3).

Figure 2: Community participants filled out the CDRI survey form during the FGD session.

Table 3: Total Respondents Involved in CDRI Survey

Respondents	Physical	Online	Total
Agencies	27	26	53
Communities	34	10	44
Total	**61**	**36**	**97**

STUDY AREA

Yan District is located in the western region of Kedah State, bordering Kuala Muda District to the south, Kota Setar District to the north, and Pendang District to the east (Figure 3). It consists of five mukims and four islands, covering an area of 24,177.78 hectares (241.78 km^2). The Yan District Council administers the entire district. The proposed sea reclamation area for the Oil Refinery Plant

project (350 hectares) and Maritime Industrial and Trade Park (48.16 hectares) near Sungai Daun Mukim will give significant influence of development in Yan District. The best rice fields and fruit orchards can be found in Yan District, which is also rich in natural resources including beaches and islands. The Gunung Jerai range, which stretches to the sea region at Tanjung Jaga, is one of the many natural heritages found in Yan District. In keeping with Yan District's character as a tourist district, all of these local resources have the potential to be commercialised together. Additionally, there are seven islands in Yan District: Batuan Batu Kepala Rambut, Pulau Songsong, Pulau Bidan, Pulau Perak, Pulau Bunting, Pulau Telor, and Pulau Tukun Terendak which is very rich with natural assets and can become important tourist attractions to the district.

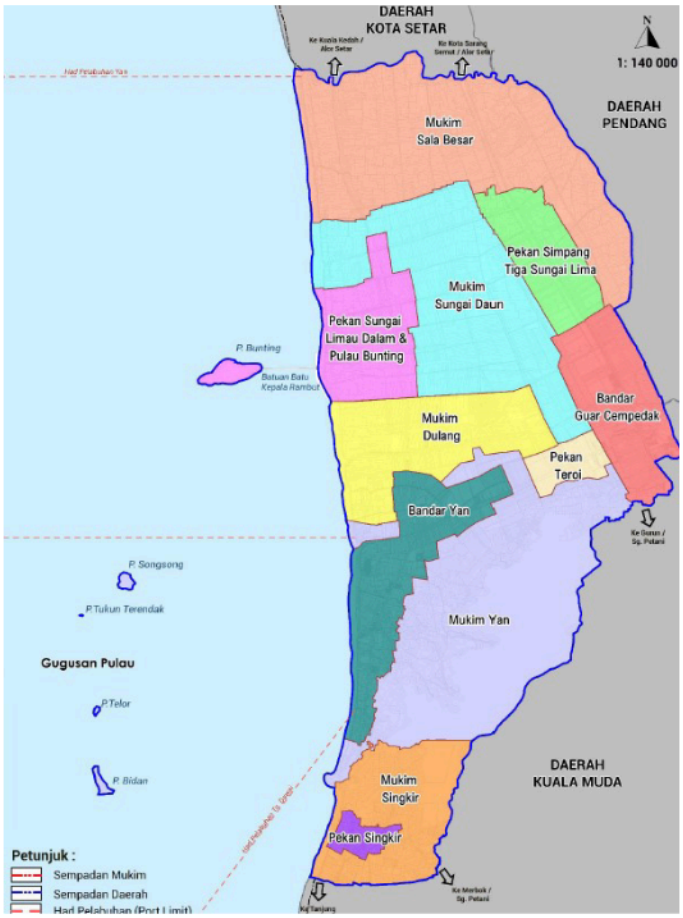

Figure 3: Study area of Yan District, Kedah
Source: PLANMalaysia (2024)

Built-up land use covers 67.33% of the total area, totalling 16,278.10 hectares. Forest land use accounts for 15.42% with 3,725.81 hectares, mainly in Mukim Yan, Mukim Singkir, and island areas. The built-up area, including residential, industrial, commercial, institutional, and transportation infrastructure, occupies 3,123.50 hectares, representing 12.91% of the total land area.

ANALYSIS AND DISCUSSION

Results of the CDRI Physical Component

The CDRI results for the physical component are crucial as they offer a structured and measurable method to evaluate the resilience of infrastructure systems to climate-related disasters. This assessment encompasses different facets of physical resilience and is vital for measuring, informing decision-making, setting benchmarks, monitoring progress, mitigating risks, planning for the long term, and enhancing investments in climate resilience. The physical component includes five parameters: electricity supply, water supply, sewage and solid waste management, road accessibility, and housing and land use. According to Teo et al. (2013), infrastructure plays a critical role in community resilience by facilitating effective responses to, endurance of, and recovery from disasters. Access to key resources like food, water, sanitation, and shelter is essential for displaced individuals during the recovery process.

The survey results showed that all aspects of the physical component received resilience scores ranging from 3 (moderately satisfactory) to 4 (satisfactory) as shown in Figure 4. Electricity supply had the highest score of 3.93, almost reaching 4. On the other hand, housing and land use, as well as sewage and solid waste management, had the lowest resilience level at 3.43. These results demonstrate the infrastructure and utilities in District of Yan show resilience, distribution, and emergency readiness during disaster events. This sets a positive example for future sustainable and resilient planning in Yan District.

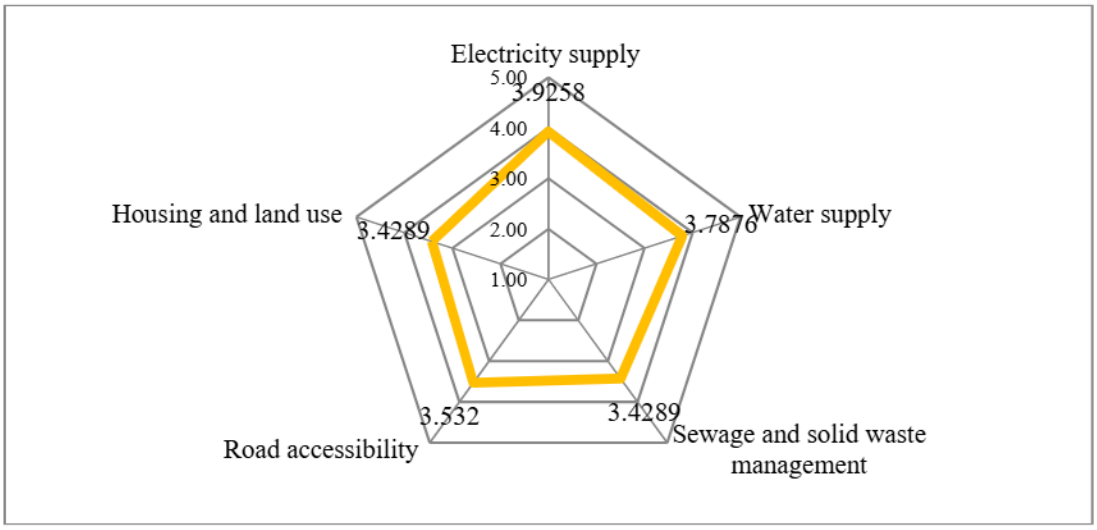

Figure 4: CDRI analysis for physical component

Results of the CDRI Social Component

The CDRI for social component is crucial for understanding and enhancing the social implication of resilience in the face of climate disasters. Therefore, it is important as it is able to identify the vulnerable groups of population, improve social cohesion and community networks, guide policy and decision-making, access to services and infrastructure, empower community, and incorporate social justice. Therefore, a specific set of question on social component is embedded in the CDRI questionnaire. The social components include population, population health, education and awareness, social capital, and community preparedness (Shaw et al., 2010).

The social component of the CDRI yielded overall resilience scores ranging from 3 to 4, indicating moderate to satisfactory levels (Figure 5). Education and awareness scored the highest at 3.61, demonstrating good disaster preparedness practices in Yan district. However, social capital scored lower at 3.34, indicating a need for improvement in building networks and relationships for effective collaboration during disasters. Strengthening social capital should be a priority for agencies involved in district planning.

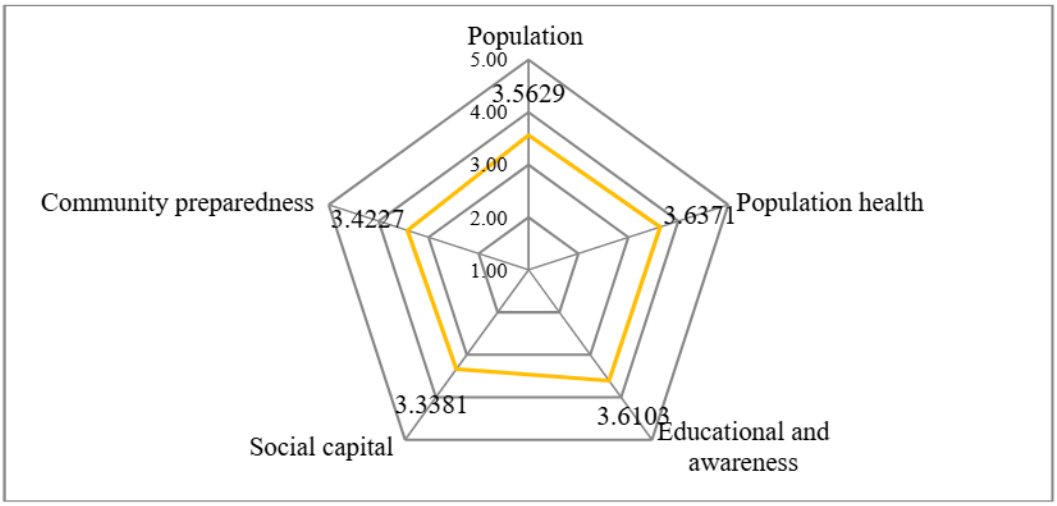

Figure 5: CDRI analysis for social component

Results of the CDRI Economy Component

Economic resilience, as defined by Dasgupta and Shaw (2013), refers to a community's ability to sustain itself with limited natural resources, particularly when it heavily relies on these resources. Economic factors play a crucial role in determining how well communities can prepare for and respond to disasters, influencing their resilience (Meng, 2024). The economic aspect is vital for a community's capacity to endure and bounce back from disasters. Therefore, it is important to assess the economic strength of a location. Robust financial stability and governance are essential to support economic activities post-disaster. Local authorities should invest in resilient infrastructure to ensure a prompt and effective recovery.

Figure 6 displays the CDRI results for the economy component in Yan District. Scores for this component ranged from 2 to 4, indicating a moderate to satisfactory level of economic development. While the physical and social parameters all had scores above 3, three economic components scored below 3. These components include income, budget and subsidies, and finance and savings, which received modest resilience scores. Household assets and employment sub-components, on the other hand, achieved a satisfactory resilience score of 3.92. This underscores the susceptibility of these sub-components to disaster impacts and their slower recovery process in this district. The economic development in Yan is heavily dependent on the agriculture sector, particularly paddy cultivation, demonstrating the district's capacity to effectively respond to disasters.

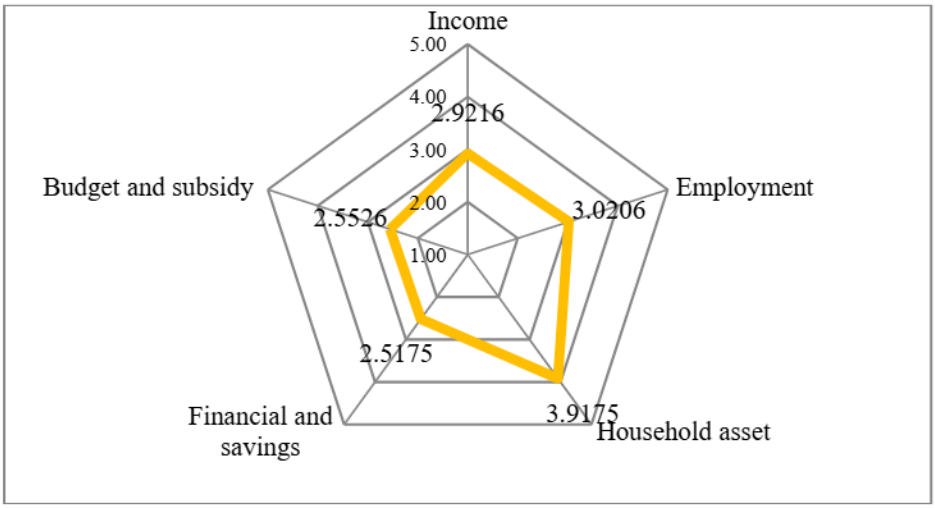

Figure 6: CDRI analysis for economy component

Results of CDRI Institutional Component

Effective disaster management relies on governance to provide the necessary structure, authority, and processes for preparing, responding to, and recovering from disasters. Good governance ensures strategic, inclusive, coordinated, and accountable disaster management. It influences decision-making, resource allocation, and community protection before, during, and after climate-related disasters (Bignami, 2024). Prioritizing the integration of climate change adaptation (CCA) and disaster risk reduction (DRR) considerations in urban planning and management is crucial for maintaining healthy populations and preventing economic disruptions (Centre for Excellence in Disaster Management & Humanitarian Assistance, 2022).

The institutional components in Yan District displayed different levels of resilience, with three sub-components scoring well and two sub-components, DRR and CCA, as well as governance, falling in the intermediate range between 2 and 3, which is relatively low (Figure 7). These results prompt necessary actions for improvement at the local level. It is essential to enhance governance, DRR, and CCA to effectively manage catastrophic situations. Increasing awareness of DRR and CCA in district planning of Yan is vital to ensure that future development can withstand disasters.

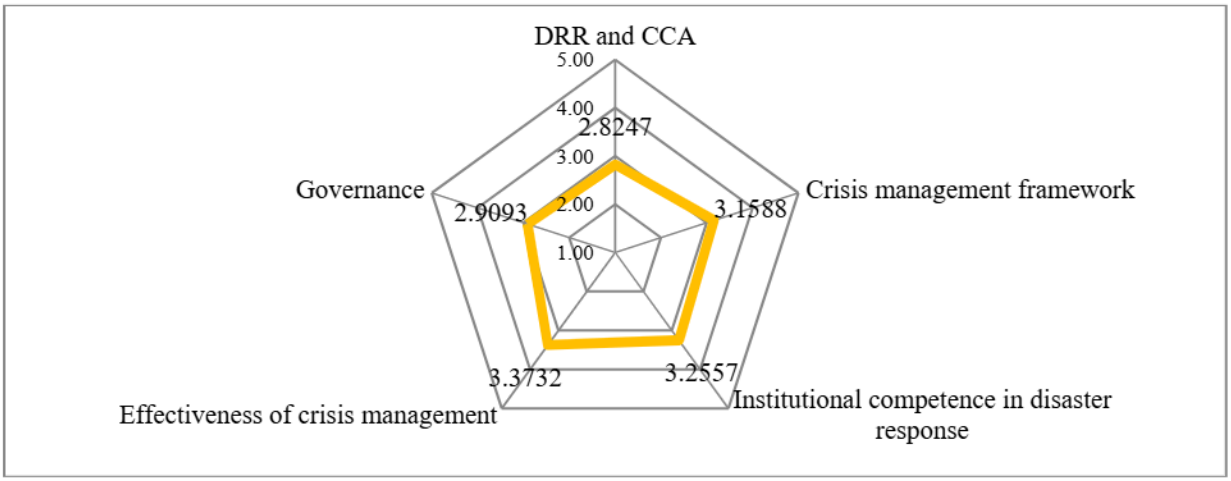

Figure 7: CDRI analysis for institutional component

Results of CDRI Environment Component

The environment is a key factor in the CDRI, as it affects exposure to and recovery from climate-related disasters, which can cause significant damage to communities. In the realm of disaster management, the environment plays a crucial role as a natural barrier against disasters, sustains livelihoods, regulates climate and weather patterns, and ensures food and security. The assessment of the environment component includes evaluating the sub-components of hazard intensity, frequency of hazards, ecosystem services, land use planning, and environmental policies.

The environmental components show good performance overall, with resilience scores above 3, except for hazard intensity which scored 2.76 (Figure 8). Debris flows contribute to this lower score, highlighting the need to strengthen environmental components for future disasters. Land use planning and environmental policy parameters indicate promising preparedness for disasters in the district. The planning system is stable and well-equipped to handle disaster-related situations.

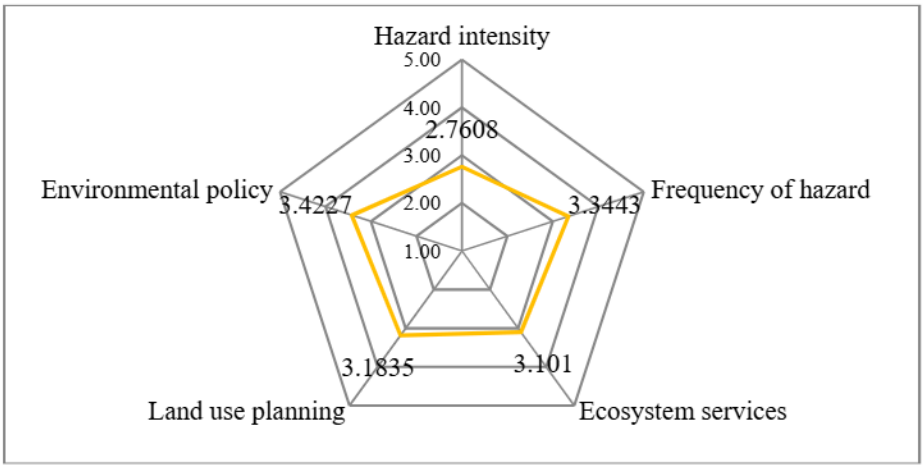

Figure 8: CDRI analysis for environment component

Results of the Overall CDRI

The overall CDRI results for Yan District reveal that economic resilience received the lowest score of 2.99, suggesting vulnerability stemming from dependence on paddy cultivation (Figure 9). On the other hand, physical development received the highest score of 3.62, indicating the community's robust capacity to withstand disasters. With four components scoring above 3 namely physical, social, institutional, and environment; Yan District is overall well-equipped and resilient to confront future challenges.

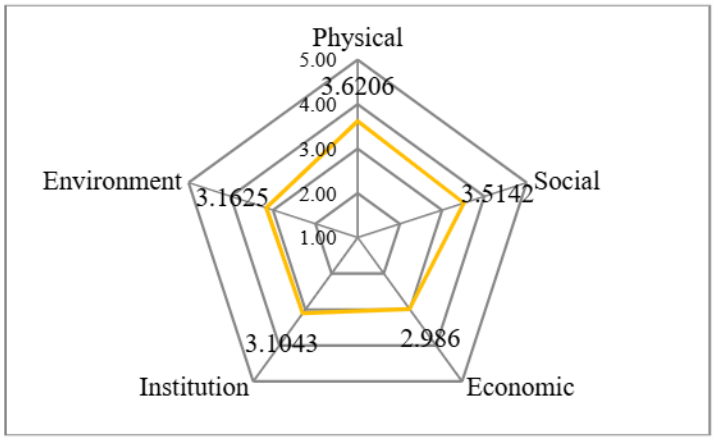

Figure 9: Overall CDRI analysis

CONCLUSION

Cities need to improve their resilience and preparedness to address future risks. This paper underscores the significance of resilience in urban planning for community safety in Yan District, Kedah. The study utilized CDRI as a standardized tool to evaluate the city's resilience to climate-related disasters. The findings of the CDRI assessment in Yan District indicate that the economic aspect received the lowest score of 2.99, underscoring the necessity to boost economic development and disaster response mechanisms. The lack of access to credit facilities and disaster risk financing in Yan District underscores the importance of enhancing financial support accessibility. This would empower local communities in disaster-prone areas to better equip themselves for and respond to future disasters. While other components such as physical, social, institutional, and environmental aspects scored above 3, they still require further attention for enhancement. The overall CDRI performance in the district reflects the preparedness of local stakeholders to effectively manage disasters. Capacity building initiatives for local residents and officials in Yan District are in place to prepare for future disasters. This will enable more effective local action to ensure the stability of all components of the Community Disaster Risk Reduction Initiative.

ACKNOWLEDGEMENT

The authors would like to thank ANZ Planners Sdn. Bhd. and the Federal Department of Town and Country Planning, Peninsular Malaysia (PLANMalaysia) for allowing them to participate in the research team that created the Local Plan for Yan District, Kedah (2035). The 1st author, M Zainora Asmawi, is grateful to the International Islamic University Malaysia for providing sabbatical leave to work on this article.

REFERENCES

Bignami, D. F., Ambrosi, C., Bertulessi, M., Menduni, G., Pozzoni, M., & Zambrini, F. (2024). Governance strategies and tools towards the improvement of emergency management of natural disasters in transboundary areas. *International Journal of Disaster Risk Reduction*, *111*, 104704. https://doi.org/10.1016/j.ijdrr.2024.104704

Berkes, F., & Ross, H. (2013). Community resilience: Toward an integrated approach. *Social Natural Resources*, *26*(1), 5–20.

Cai, H., Lam, N. S. N. N., Qiang, Y., Zou, L., Correll, R. M., & Mihunov, V. (2018). A synthesis of disaster resilience measurement methods and indices. *International Journal of Disaster Risk Reduction*, *31*, 844–855. https://doi.org/10.1016/j.ijdrr.2018.07.015

Center for Excellence in Disaster Management and Humanitarian Assistance (CFE-DMHA). (2022). *Malaysia: Disaster management reference handbook 2022*.

Chong, N. O., Kamarudin, K. H., & Abd. Wahid, S. H. (2017). Framework considerations for community resilient towards disaster in Malaysia. *Procedia Engineering*, *212*(2018), 165–172.

Chong, N. O., & Kamarudin, K. H. (2018). Disaster risk management in Malaysia: Issues and challenges from the perspectives of agencies. *Planning Malaysia*, *16*(1), 105–117.

Cutter, S. L., Ash, K. D., & Emrich, C. T. (2014). The geographies of community disaster resilience. *Global Environmental Change*, *29*, 65–77.

Dasgupta, R., & Shaw, R. (2015). An indicator-based approach to assess coastal communities' resilience against climate related disasters in Indian Sundarbans. *J. Coast. Conserv.*, *19*, 85–101.

Giang, N. T. H., Minh, T. X., Ha, H. D., & Chung, N. T. K. (2024). Assessing coastal community resilience to climate change in Central Vietnam through the Climate Disaster Resilience Index (CDRI). *Environ. Res. Commun.*, *6*, 105033. https://doi.org/10.1088/2515-7620/ad8620

Imani, M., Lo, S. L., Fakour, H., Kuo, C. Y., & Mobasser, S. (2022). Conceptual framework for disaster management in coastal cities using climate change resilience and coping ability. *Atmosphere*, *13*, 16.

Joerin, J., & Shaw, R. (2011). Mapping climate and disaster resilience in cities. 6, 47–61.

Khailani, D. K., & Perera, R. (2013). Mainstreaming disaster resilience attributes in local development plans for the adaptation to climate change induced flooding: A study based on the local plan of Shah Alam City, Malaysia. *Land Use Policy*, *30*(1), 615–627.

Laurine, F., Martin, J. G. C., & Mehryar, S. (2022). Climate and disaster resilience measurement: Persistent gaps in multiple hazards, methods, and practicability. *Climate Risk Management*, *37*(2022), 100443. https://doi.org/10.1016/j.crm.2022.100443

Lu, X., Liao, W., Fang, D., Lin, K., Tian, Y., Zhang, C., Zheng, Z., & Zhao, P. (2020). Quantification of disaster resilience in civil engineering: A review. *J. Saf. Sci. Resil.*, *1*, 19–30.

Meng, S. (2024). Environmental governance is critical for mitigating human displacement due to weather-related disasters. *Commun Earth Environ*, *5*, 363. https://doi.org/10.1038/s43247-024-01528-y

PLANMalaysia (Jabatan Perancangan Bandar dan Desa), Kementerian Wilayah Persekutuan. (2019). *Garis panduan perancangan bandar berdaya tahan di Malaysia*. Kuala Lumpur.

Ramli, M. W. A., Alias, N. E., Mohd Yusof, H., Yusop, Z., & Taib, S. M. (2021). Development of a local, integrated disaster risk assessment framework for Malaysia. *Sustainability*, *13*, 10792. https://doi.org/10.3390/su131910792

Rezaie, A. M., Ferreira, C. M., Walls, M., & Chu, Z. (2021). Quantifying the impacts of storm surge sea level rise and potential reduction and changes in wetlands in coastal areas of the Chesapeake Bay region. *Nat. Hazard. Rev.*, *22*, 04021044.

Shaw et al. (2010). *Climate and disaster resilience initiative capacity-building program*. UNISDR.

Srinivas, H., & Nakagawa, Y. (2008). Environmental implications for disaster preparedness: Lessons learnt from the Indian Ocean Tsunami. *Journal of Environmental Management*, *89*(1), 4–13.

Surjan, A., Sharma, A., & Shaw, R. (2011). *Understanding urban resilience. 6,* 17–45.

Tan, C. T., Rawshan, A. B., Koh, F. P., Lim, C. S., & Ismail, R. (2013). *Memperkukuhkan ketahanan nasional melalui pengurangan risiko bencana di Malaysia: Peranan pihak berkuasa tempatan, hospital dan sekolah*. Institute Alam Sekitar dan Pembangunan (LESTARI), Universiti Kebangsaan Malaysia.

Teo, M., Goonetilleke, A., & Ziyath, A. (2013). An integrated framework for assessing community resilience in disaster management. In *Proceedings of the 9th Annual International Conference of the International Institute for Infrastructure Renewal and Reconstruction*, Brisbane, Australia, 7–10 July 2013, 309–314.

Wan Mohd Rani, W. N. M., Kamarudin, K. H., Razak, K. A., Che Hasan, R., & Mohamad, Z. (2018). Measuring urban resilience using Climate Disaster Resilience Index (CDRI). *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *Volume XLII-4/W9*.

The World Bank. (2015). Climate and disaster resilience of greater Dhaka area: A micro level analysis. In *Bangladesh Development Series* (Paper No. 32). World Bank.

Wilson, G. (2011). *Community resilience and environmental transitions*. Routledge.

Zahari, R. K., Ariffin, R. N. R., Asmawi, M. Z., & Ibrahim, A. N. (2013). Impacts of the 2004 Tsunami: Preparedness of the Malaysian coastal communities. *Procedia - Social and Behavioral Sciences*, *105*, 569–576.

Received: 28th January 2025. Accepted: 19th May 2025

