Environment and Social Psychology (2024) Volume 9 Issue 4
doi: 10.54517/esp.v9i4.2189

RESEARCH ARTICLE

Integrating adaptation of climate change to strengthen Malaysia's disaster risk governance

Mohd Syukri Madnor[1,2,*], Aizul Nahar Harun[1], Faizah Che Ros[1]

[1] *Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia (UTM), Kuala Lumpur 54100, Malaysia*

[2] *Malaysia Civil Defence Force, Kajang, Selangor 43000, Malaysia*

*** Corresponding author:** Mohd Syukri Madnor, mohdsyukri@graduate.utm.my

ABSTRACT

As a result of changes in climate factors, the number of natural hazards has become more frequent. To achieve optimal governance of disaster risk, it is essential to consider climate change and modify the strategy so that it aligns with the agenda for reducing disaster risk. This paper's findings are the result of a qualitative methodology that included a review of the literature on the topic DRR and CCA relates to both international and domestic policy in Malaysia. It discovered gaps in the convergence of DRR and CCA in terms of policy formulation, governance systems, and linkage among actors. To close the gaps, a comprehensive approach that involves multi-level governance as well as multi-sectoral initiatives through multiple disciplinary methods would be required. This necessitates a governance system that encourages the participation of actors from both domains in order to achieve greater sustainable development and climate risk management.

Keywords: disaster risk governance; climate change adaptation; multiple disciplinary

1. Introduction

As the world's global climate evolves and changes due time, the occurrence of climate-related hazards to name a few flooding, droughts, wildfires, storm surge, sea level rise, biodiversity decline, and shortage of pure water supply is increasing[1,2]. Climate-related hazards have recently had an impact on Malaysia, which is a country in Southeast Asia. According to the Köppen-Geiger Climate Classification, 1991–2020, Malaysia is classified as a country with a tropical rainforest climate. The country's annual mean temperature is 24.5℃, with minimum temperatures in January averaging 24.9 ℃ and maximum temperatures of 25.9 ℃ in May. The average monthly precipitation in Malaysia between 1991 and 2020 was calculated as 3085.5 mm, with June and July seeing the highest average monthly precipitation of 200 mm (November and December)[3].

In this climate characteristic, Malaysia ranks 90th out of 191 countries and is vulnerable to floods, coastal floods, epidemics, droughts, and tsunamis, with a Risk Index of 3.4 in 2022 and predictions of 3.5 and 3.6 in 2050 and 2080, respectively[4]. Since the International Decade for Natural Disaster Reduction (IDNDR) was adopted in 1989, the initiative to lessen the effects of disaster[5]. In 1990, the United Nations came together to create the United Nations Framework Convention on Climate Change (UNFCCC), and Intergovernmental

ARTICLE INFO
Received: 20 October 2023 | Accepted: 22 November 2023 | Available online: 10 January 2024

CITATION
Madnor MS, Harun AN, Ros FC. Integrating adaptation of climate change to strengthen Malaysia's disaster risk governance. *Environment and Social Psychology* 2024; 9(4): 2189. doi: 10.54517/esp.v9i4.2189

Panel on Climate Change (IPCC) has been ever since concerning to evaluate and monitor how climate change is impacting current efforts and to counteract or adapt to the phenomeno[6]. Therefore, we can conclude that the agenda of sustainable development has been in place for over 30 years. It was then the assimilation of climate change into the disaster risk reduction agenda has been underway since the UNFCCC Bali Action Plan and was heavily discussed during the Hyogo Framework for Action: 2005–2015, for the present era, it remains a topic worth investigating[7].

Together with the Paris Climate Agreement and the Sustainable Development Goals (SDGs), the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) aims to create a resilient nation that can face and overcome the adverse impact of weather which led to natural disasters. Long-term local capacity is being built through risk-informed communities concerned with disaster and climate risk governance as part of the aforementioned global frameworks. Reducing disaster vulnerability through improved disaster risk governance is Priority Action 2 of the Sendai Framework[8].

Considering the rapidity with which the global climate has been shifting recently, it is urgent that a solid disaster risk reduction policy be put into place. The primary goal of this research is to identify any shortcomings in Malaysia's governance structure for managing both disaster risk reduction and climate change adaptation. This paper explores the opportunities of governing the adaptation to a changing climate as the consequences of climatic changes and global warming while reducing the risk of potential disasters and newly occurring hazards. Consequently, this research aims to learn more about disaster risk governance in Malaysia, and more specifically, the connection between disaster risk reduction policy and climate change adaptation in the country.

Finally, this paper aims to demonstrate the effectiveness of multiple disciplinary in improving the network of actors for both disaster risk reduction and climate change adaptation, improvising synergies for both fields and promotes a better governance system. It highlights the need for a multiple disciplinary approach to these issues, drawing on expertise from various fields such as environmental science, social science, engineering, and public policy, working together to solve complex climate risk.

2. Literature review

2.1. Climate-related hazards

Within this context, the frameworks of law, policy, and procedure, and the process of decision making to oversee, direct, and guide disaster risk reduction and related policy areas are what make up disaster risk governance, as defined by the United Nations Office for Disaster Risk Reduction. To lessen the severity of potential disasters and prevent the introduction of new ones, good governance must be open, inclusive, collaborative, and efficient[9]. By incorporating adaptation to climate change into the disaster risk reduction agenda, effective management, mainly the governance on reducing the catastrophic climate risk is attainable[10].

Therefore, extreme precipitation, mudslides, coastal flooding, and hurricanes are all examples of climate and weather hazards, becomes more prominent as a result of climate change, potentially leading to ecosystem degradation, decreased water, and food availability, and altered ways of life. Climate-related hazards have the greatest impact on the food and agriculture sector, followed by the water sector, the environment, health, and finally the industrial sector, according to a recent survey[11].

2.2. Multiple disciplinary concept

Standard disciplinary research (also called a "single discipline approach") is limited to the confines of a single academic field, using queries, hypotheses, conceptual frameworks, and experimental designs unique to that field of study. Consequently, there is little to no overlap with related fields[12].

Multidisciplinary, interdisciplinary, and transdisciplinary are common terms used to describe a spectrum in which multiple disciplines are involved. The terms "additive," "interactive," and "holistic" are frequently used to describe them. These words have different meanings and therefore cannot be interchanged. Sometimes the term "multiple disciplinary" is used when it's not clear how the various fields of study relate to one another[13].

As described in **Figure 1** below, knowledge from multiple fields is integrated in interdisciplinary work, multidisciplinary teams work independently, and transdisciplinary teams collaborate across fields and involve stakeholders to solve difficult problems [14].

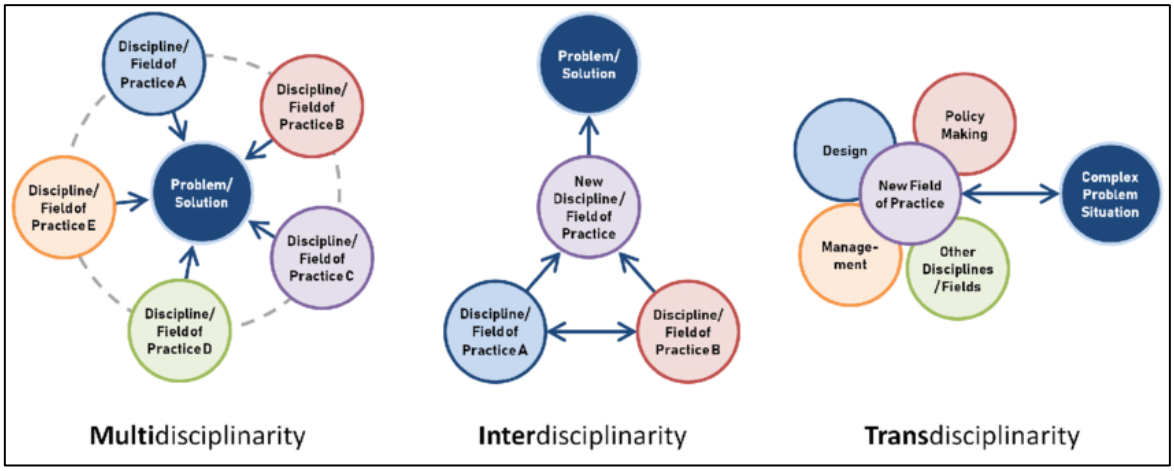

Figure 1. Comparison between multidisciplinary, interdisciplinary, and transdisciplinary.

The term "multidisciplinary" refers to the practice of bringing together elements from different academic disciplines without straying too far into any one of them. The goal of "interdisciplinarity" is to develop a more comprehensive understanding of a subject by drawing on the tools and perspectives of different academic disciplines. "Transdisciplinary" in the humanities essentially eliminates the division between the hard sciences and the soft sciences like sociology and psychology. By bringing together scientists from different fields, as well as non-scientists and other stakeholders, and by releasing and expanding roles, the main objective of transdisciplinary research is to analyze the state changes of complete systems from a more all-inclusive and holistic perspective[15].

2.3. Malaysia's climate profile

Malaysia is being impacted by climate change in various ways. Increases of 17% for 1 hour, 29% for 3 hours, and 31% for 6 hours were observed between 2000 and 2007 compared to 1970 and 1980 in Malaysia[16]. Moreover, temperatures in Malaysia are expected to rise by 1.5 ℃ by 2050. Over the period from 2020 to 2029, Peninsular Malaysia, Sabah and Sarawak are predicted to experience greater negative anomalies as a result of highest simulated rainfall. According to projections made by the Malaysian Meteorological Department, the rate of rainfall increase will accelerate between the years 2090 and 2099[17].

Flooding, landslides, drought, and infectious disease epidemics are just a few of the climate-induced threats to Malaysia's safety within the context of this climate profile. Global warming has increased precipitation and sea level, which in turn has increased the frequency of coastal erosion, storm surge, and saline intrusion[3,16,18,19].

The loss of 6% of Malaysia's annual GDP by 2030, compared to a baseline scenario, is attributed to the multiplicative effect of climate-induced disasters. Major drops in export demand and countervailing effects

from the collapse of the forestry and fishing industries were to blame. Perceived economic and monetary losses causing from of the natural environment deterioration and its aforementioned risks[20]. Consequently, it is essential to develop strong connections on Malaysia's capacity for disaster risk governance, and the linkages between disaster risk reduction and adaptation to climate change.

2.4. DRR and CCA gaps in global context

Dangers arise from climate-related hazards. The degree of vulnerability and exposure greatly determines the intensity of the effects of weather and climate events which are exacerbated by the many interconnected risk factors. This highlights the need for governance at all levels to develop resiliency and decreasing disaster risks into account. Before, the Hyogo Framework for Action was released, local, state, and federal governments have become more cognizant to the significance of incorporating DRR into development planning and interventions[11].

However, it has been found that the agenda for reducing the risk of natural disasters, as well as the adaptation to climate change, are both undervalued in development plans. This is due to the fact that countries are only concentrating on the stage of response and recovery only, rather than the entirety of the disaster management cycle[10]. The need for stronger disaster risk governance is highlighted by the fact that climate management and environmental protection policies are not being adequately adapted to disaster risk reduction, and that both strategies are being implemented independently in silo across nations[21–23].

In addition, when compared to international and regional multi-stakeholder platforms, a common challenge in disaster risk governance is insufficient funding for national and local governments to adapt disaster risk reduction policies and only focus on the emergency phases. Most national strategies are focused on firefighting rather than long-term climate adaptation and future global risk factors. This has resulted in poor urban development, which, when combined with disaster risk reduction strategies, adds an unprecedented new hazard to the urban population[12].

Most research articles emphasize the implication of integrating disaster risk reduction and climate change adaptation to enhance disaster risk governance[24–32]. However, incorporating the concept of disaster risk governance with the goal of lowering the potential risk for catastrophic events while also adapting to the effects of climate change is quite challenging. Difficulties arise from the realization that DRR and CCA have different policies, different actors, and thus different ideologies and goals; there is no consistent funding mechanism; there is little to no knowledge sharing; and there is poor governance over available resources[22,32–38].

Achieving sustainability at the global, regional, national, and local levels should be the primary focus of efforts to integrate DRR and CCA. Organizational capacity building, efficient resource allocation, educational and awareness programs, a holistic network of stakeholders, coordinated and collaborative efforts, a focus on vulnerable sectors, common policy and political will, and the establishment of political institutions are all part of this[22,24].

Developing resilient communities requires fostering effective urban governance[21]. When addressing the twin challenges of disaster mitigation and climate change adaptation, it is rather crucial to employ both adaptive and anticipatory governance. Adaptive governance is used in situations where the governance itself is rigid, while anticipatory governance is employed in situations where the responses to disasters are reactive[39].

Coordinating preparedness measures in response to climate change can help improve disaster management[21,33,40,41] Stakeholders or major actors in both fields can work together more effectively if their roles are clearly defined, and information can be shared and networks are well established[39–43].

Comprehensive policy and effective implementation are required to resolve the tension between lowering the risk of natural disasters and adapting to outcomes of global warming[33,37,40,41]. Furthermore, adequate financial protection and budget allocation for disaster risk reduction and climate change adaptation agendas is necessary to implement good disaster risk governance[21,33,42,43].

In conclusion, despite the fact that incorporating climate change into risk reduction efforts so that catastrophic weather events can be avoided is fraught with difficulty on a global scale, doing so is absolutely necessary in order to improve disaster risk governance. It is possible to find a solution to the integration problem as long as actors working in both fields share a common goal, there is an appropriate network and coordination, there is efficient financial spending, and there is a robust institutional framework.

3. Methodology

Few publications address the question of how Malaysia may enhance its disaster risk governance through the integration of policies for adapting to climate change and mitigating disasters. Most studies only look at one facet of the larger problem of reducing disaster risks, adapting to climate change, or building resilient communities[17,21,23,44].

Thus, the preliminary idea is to search for related articles published by all journals that have explored the relevant topic in terms of the global idea to make sure no extremely relevant publications are missed. Literature reviews were undertaken using the online databases Web of Science, Scopus, and ScienceDirect to determine the relationship between disaster risk reduction and climate change adaptation as it relates to disaster risk governance. By adapting the previous systematic review, the authors conducted three rounds of document study by using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) flowchart[45]. The technique is to determine the search criteria, summarizing the current research and exploring the topics which are related to disaster risk reduction, climate change adaptation and disaster risk governance. In the original search for papers which are limited to title, keyword and abstract that contain the terms “disaster risk reduction,” “climate change adaptation,” and “governance” were all used. In order to derive the concept of DRR and CCA integration, those papers discussing the topic that also included the element of governance were included in the final selection. Since 2015 is the timeframe of the emergence of SFDRR and the Paris Agreement, we restricted the publication year range to 2014–2023 in order to locate publications written in the last decade on these subjects.

The literature findings were analyzed using Scientometrics analysis. Academics literatures can use scientometric methodologies to detect systematic findings in the realm of literature by identifying the code and themes that may be missed in manually searching and reviewing. Scientometrics is concept to understand how scientific knowledge is produced and disseminated, and how this process is shaped by broader factors[46]. VOSviewer has been used for a content analysis to determine and examine the themes and concepts presented in the scientific publications. This can provide insight into the research topics and trends within a particular field of governance in DRR and CCA. Scientometrics content analysis involves the systematic examination and interpretation of the themes, and concepts of the publications[47]. The content analysis begins by defining a research question of the major keywords which are “disaster risk reduction”, “climate change adaptation” and “governance”. As result, a coding scheme determines a set of rules or categories that are used to identify and categorize the content of the publications being analyzed.

In searching for domestic deficiencies relating to governance in disaster risk reduction and climate change in Malaysia, the literature review was narrowed down. Yet, the results returned to be insufficient for this study. Most of the search results define global disaster risk governance in terms of how to mitigate disasters and adapt to climate change. Therefore, the current national policy of DRR and CCA, in addition to reports from the

UNDRR, the World Bank, and local researchers, were retrieved to support this extensive research in the Malaysia context and help fill the information gap regarding the adaptation of climate change into disaster risk reduction in Malaysia. This includes identifying the actors, the governance framework, and present practices in disaster risk reduction and climate change adaptation.

4. Results and findings

4.1. Literature review using PRISMA

Figure 2 below shows the literature review process using PRISMA method through various databases such as Scopus, Web of Science and ScienceDirect. After further screening, Scopus yields 113 publications in the narrow field of study surrounding the keywords, title and abstract for "disaster risk reduction" AND "governance" AND "climate change adaptation" between 2014 and 2023, while the Web of Sciences yields 155 publications and ScienceDirect yields 131 publications. Following a thorough analysis, the entire search results list was consolidated, and any duplicate search results were deleted. In addition, another 28 Malaysia's local and global reports pertaining disaster risk reduction and climate change were included in the analysis. The total number of documents analyzed for this study is 222.

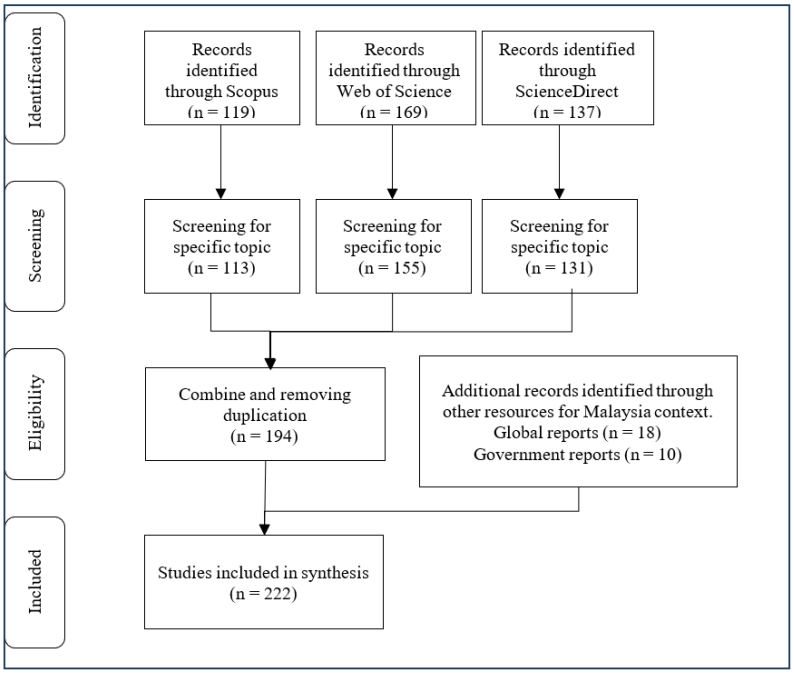

Figure 2. Literature review using PRISMA.

4.2. Scientometrics analysis findings

By using VOSViewers software, the content of literature reviews was analyzed to define their major concept. Publication papers and related documents. Disaster risk reduction, climate change adaptation, and governance are the three primary terms that serve as the basis for this content analysis's study question. Thus, a coding scheme is established, which specifies a set of criteria or categories used to identify and classify the content of the publications under study. Disaster risk reduction, climate change adaptation, and governance are the three primary terms that serve as the basis for this content analysis's study question. Thus, a coding scheme is established, which specifies a set of criteria or categories used to identify and classify the content of the publications under study. Disaster risk reduction, climate change adaptation, and governance are the three primary terms that serve as the basis for this content analysis's study question. Thus, a coding scheme is

established, which specifies a set of criteria or categories used to identify and classify the content of the publications under study. The result shows in **Figure 3** as below:

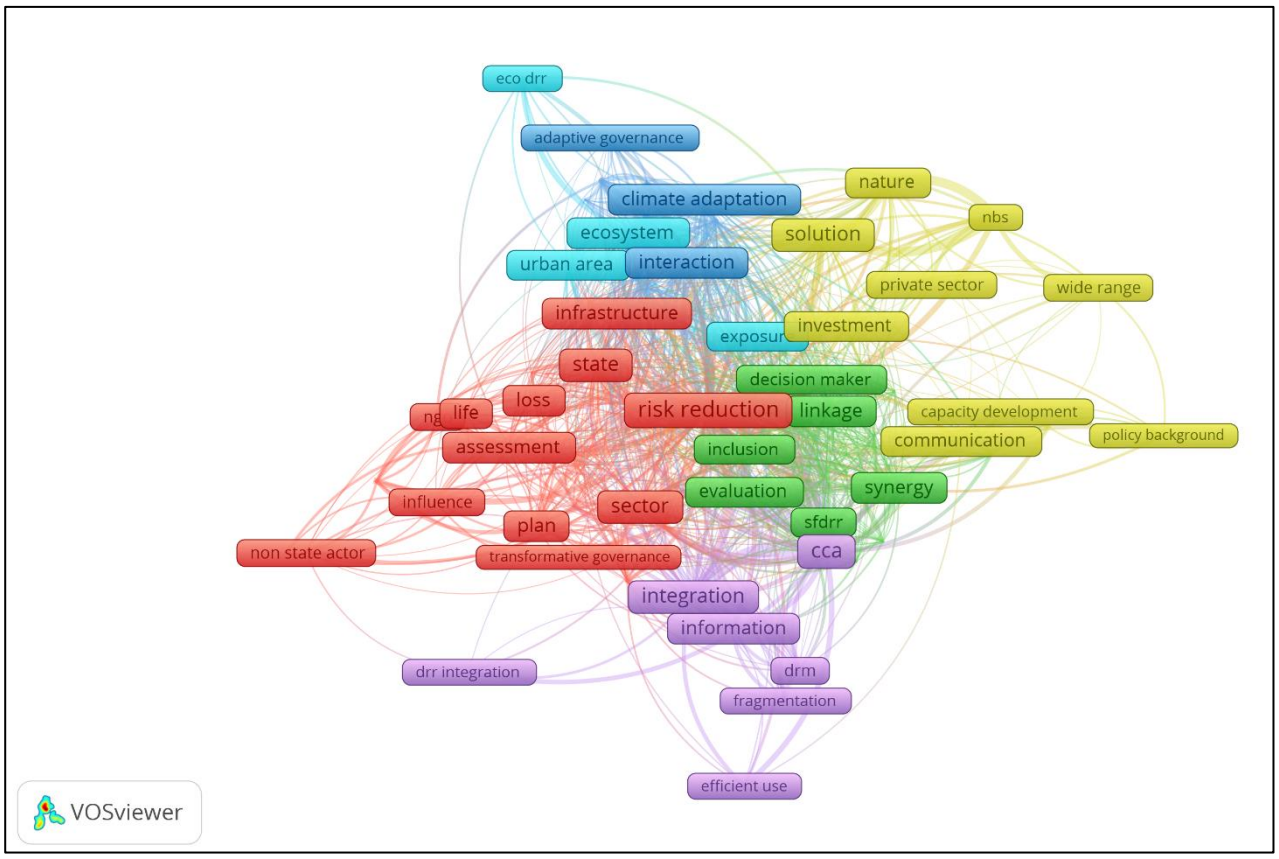

Figure 3. Scientometrics analysis result using VOSviewer.

Major keywords are condensed and precise descriptions of a research paper's topic, and they are used while discussing the idea of governance in DRR and CCA. A keyword co-occurrence network has been utilized to identify trending themes in the domain of knowledge over a certain time frame. The growth graph can be used to trace the historical evolution of a topic of study. **Figure 2** shows how VOSviewer was used to generate a co-occurrence network consisting of 7 clusters and 86 total link strength. The size of each node in this network is based on the frequency with which a certain word appears in the bibliometric record where the most common terms associated with seven important terms are "risk reduction," "integration," "CCA," "NBS," "decision maker," "exposure," and "interaction."

Words that are related with "risk reduction" are "adaptive capacity", "adaptation measures", "disaster governance paradigm", "non state actor", "NGO", "infrastructure", "local level", "preparedness", and "coordination". This analysis shows how crucial it is to improve cooperation between non-state actors, NGOs, and local communities in order to increase preparedness and adaptive capacity, which is essential for reducing risks. As a result, in a context where disaster response necessitates adaptation planning and coordination across many sectors, realizing the adaptation measures calls for a transformative governance.

The second cluster returns the keyword of "climate change risk" interconnect with the term "community member", "critical infrastructure", "decision maker", "disaster risk governance", "inclusion", "linkage", "local government", "resilience building, "sustainable development". "science" and "synergy". This underscores the need of decision-makers, local governments, and communities working together to address climate risk. The goal is to strengthen disaster risk governance that promotes sustainable development and resilience.

The third cluster defines the keyword of "account", "adaptive governance", "citizen", "climate adaptation", "collaboration", "interaction", "responsibility", "municipality", and "transformation". CCA and DRR governance involves important concepts of the responsibility of governments and other stakeholders to be transparent and accountable in their actions related to climate change adaptation and disaster risk reduction. This requires an adaptive governance which is a flexible and iterative approach to decision-making that is responsive to changing environmental and social conditions and promotes collaboration among different stakeholders and encourages them to take responsibility in reducing the risks of climate change and disasters.

The fourth cluster discusses the terms of "capacity development", "communication", "investment", "nature-based solution", "policy maker", "private sector", "wide range" and "solution". Effective CCA and DRR governance involves capacity development, communication, investment, and collaboration across a wide range of stakeholders, including policy makers, the private sector, and communities, and the use of nature-based solutions and a range of other solutions to address the impacts of climate change and disasters.

For the fifth, sixth and seventh cluster providing the result of CCA, DRR, integration, efficient use, information, eco DRR, exposure, risk assessment, local community, partnership, and sustainability. To summarize, in the context of CCA DRR governance, successful integration of climate change adaptation (CCA) and disaster risk reduction (DRR) efforts requires efficient use of information and collaboration among stakeholders, including local communities, to conduct risk assessments and reduce exposure to hazards. Eco DRR and the use of nature-based solutions can promote sustainability, and partnerships can facilitate effective CCA DRR governance.

Through the content analysis, it is possible to conclude that an efficient governance of CCA and DRR requires interaction and collaboration between players and decision makers, including at the local level, to advocate for improvement of policies and administrative institutions through nature-based solutions, emphasizing the need to strengthen disaster risk governance for sustainable development and resilience. Adaptive governance through a multiple disciplinary approach is necessary to respond to changing environmental and social conditions, promote collaboration among stakeholders, and reduce risks. Capacity development, communication, investment, and partnerships are essential for effective CCA DRR governance, along with the use of nature-based solutions and risk assessments to reduce exposure to hazards and promote sustainability. Successful integration of CCA and DRR efforts involves efficient use of information and collaboration among stakeholders, including local communities.

4.3. Gaps in disaster risk and climate change adaptation in Malaysia

The review of the relevant literature revealed that there is a dearth of comprehensive research in Malaysia that focuses on the adaptation to climate change and the mitigation of the risks posed by natural disasters. Previous research has demonstrated that Malaysia is having difficulty enhancing its disaster resilience as a result of ineffective policy making, particularly in relation to climate change and urban planning. The majority of difficulties can be traced back to a lack of planning, an insufficient level of commitment and investment from stakeholders, and a disregard for the rule of law. In certain instances, Malaysia is challenged by a lack of data sharing as a result of the bureaucratic and compartmentalized approach to administration[44].

To further promote sustainable development, Malaysia still requires assistance in implementing good policy on disaster risk reduction and adaptation to climate change. The present policy for dealing with natural disasters is a top-down notch that needs a noticeable and effective integration with the climate change adaptation up to the local level, even though the country faces a low risk of climate-induced disasters compared to its neighbors[16,48]. The policy's reach is limited, it hasn't been updated much, and it's being implemented

inefficiently[16]. Similarly, the National Policy on Climate Change was published in 2009 and to date, there is no updated policy on climate change and the agenda does not reflect to the current global scope[49,50].

Directive No. 20 of the National Security Council is the current policy of disaster risk reduction; it was published in 1997 and updated in 2012. Meanwhile, the National Policy on Climate Change was released in 2009[49,51]. Both were enacted before the 2015 Sendai Framework for Disaster Risk Reduction and the 2015 Paris Agreement, can be concluded that not reflect the new global approach to reducing climate and disaster risks[8,52].

In addition, there is an absence of the Climate Change Act as well as the Disaster Risk Reduction Act. They both are still in the progress of drafting but have not been passed even though there has been an initiative in the past to enact both acts[16,19,53,54]. It has been discovered that neither agenda has a comprehensive policy approach, nor do they have any details on the financial allocation or specific targets to reach[55].

Malaysia has a Type C Disaster Risk Management system, according to the International Federation of Red Cross and Red Crescent Societies. The Type C system is a more nuanced disaster system that may include elements of early warning and recovery in addition to its primary focus on emergency preparation and response in the face of natural and some technological hazards[56,57]. There is a lack of a readily adoptable established competence framework on climate change, as well as a lack of enforcement, legislation, and policies related to climate change, particularly with regard to monitoring the development and economic activities that severely damage the ecosystem. Not enough is being done to enforce existing laws and create new ones concerning climate change, particularly with regard to keeping an eye on the growth and economic activities that are wreaking havoc on the environment and potentially contributing to the emergence of new man-made hazards[58,59]. Implementation of the climate change act is complicated by the fact that Peninsular Malaysia, Sabah, and Sarawak have not adopted the same set of environmental protection laws[50].

Inconsistencies exist in either the national, state, or local levels of government that prevents the national disaster mechanism NSC Directive No. 20 from being fully implemented[60]. Within a comparable context, climate change has typically moved to the top of the national agenda but has yet to permeate the state and local levels[61]. The lack of community participation, empowerment, and readiness to face future climate-induced hazards may be attributable in part to the top-down, authoritarian approach taken by disaster management in the past[48,62]. The insufficient incorporation of climate change policy into local governance, as well as the absence of inter-agency collaboration at all levels from the local to the federal, makes it exceptionally challenging to collect relevant data and to implement the initiatives locally[58,63]. For this reason, it is imperative that public policy in Malaysia demonstrate action plans and commitments at the grassroots level of government in order for Malaysia to make a visible and fruitful local-level integration with the adaptation to climate change[16,64].

It is also discovered that climate change and disaster management in Malaysia face obstacles such as multi-stakeholder collaboration and cross-sectoral participation. When it comes to regulating climate risk, Malaysia needs to be adaptable, forward-thinking, and transboundary[65]. It is crucial in this respect to note that the current disaster management policy in Malaysia has a narrow scope[16]. The government is completely in charge of the rescue operation, reliefs, financial aids, and shelter management in the aftermath of a natural hazards[66]. This result to low public participation in disaster risk reduction efforts, due to the current DRR policy does not explicitly mention disaster education, broadcasting of information, or post-disaster development[67]. There is little public involvement in preventing climate-related disasters, and even less privateinvolvement in terms of data reporting due to disclosure concerns about sustainability and climate change[50,68,69]. As such, the government, private sector, and general public of Malaysia need access to

environmentally responsible policies that cover green development planning, awareness, and instilling environmentally ethical behaviors[59,65].

Managing disaster risk in Malaysia is rather challenging because of the lack of transparency in public finances and the difficulty in ensuring adequate allocations to preventative measures[16]. The government's ability to share data is limited, and there are not publicly available, all-encompassing policies to guide this process[50,63]. There is still a severe lack of quality, quantity, and breadth of data in the area of climate risk adaptation with inadequate reporting structure and lack of transparency regarding data resources at all levels[58].

Poor state-level communication, coordination, and collaboration contribute to a dearth of funds at the district level[70]. There is obviously no solid legal foundation for line agencies to coordinate their activities, which is causing this problem[16]. It caused friction not only among emergency responders but also within government at all levels, the business community, and NGOs[71]. Also, most organizations are only concerned with their own goals and tasks when it comes to addressing climate risk, and there is little coordination between relevant ministries to implement policy action[50,58,63,68].

Within the official perspective, communities hit by a climate-induced disaster are categorized as victims, which leads to them being seen as passive, dependent, and helpless. Disaster management in Malaysia still follows the conservative disaster management technique[48,62]. There is a lack of public access to the NSC Directive No. 20 and National Policy on Climate Change, the policy lacks clear direction and goals for response agencies incorporating towards disaster resilience, and the disaster policy hierarchy is incomplete[66]. As a result, local community lack both an awareness of disaster risks and a culture of disaster preparedness[72]. Urban planners' differing priorities, visions, and values lead to a breakdown in community participation within the development plan and a dearth of participatory from other relevant disaster-related stakeholders, as well as a failure to incorporate adaptive disaster preparedness measures into the local development plan[73].

Therefore, we can conclude that there is a deficiency in a comprehensive policy approach, as there are no additional details on the monetary allocation or specific targets to accomplish both the DRR and CCA agendas in Malaysia[55]. There is a disconnect between DRR and CCA policies, with the former failing to set up adequate budget measures for DRR and the latter failing to integrate the two into a unified strategy[16]. There is no plan in place to deal with climate-related disasters. Malaysia needs an effective disaster risk reduction strategy and climate change adaptation within urban planning and management to achieve sustainability in the face of the unpredictability of climate change, the escalation of flood events, and coastal erosion[16,63,74]. The majority of the response to the disaster was reactive rather than preventative[48]. This is one of the biggest obstacles that Malaysia has faced when trying to adapt to climate change while also reducing the risk of natural disasters[25]. Climate change and other disaster risk factors are not considered by the current policy. Malaysia's policy emphasizes environmental hazards at this early stage of UNFCCC and Kyoto Protocol implementation rather than adapting climate change measures to lessen disaster risk[50,65].

In light of the foregoing, it shouldn't be shocking to learn that preparing for the effects of climate change while simultaneously decreasing disaster risks presents significant challenges for Malaysia, as it does for many other nations. This means that Malaysia's disaster risk governance could advance thanks to better policy implementation. Climate change and its contrary consequences are not widely known or understood. Many Malaysians still lack on the awareness of climate change and its impacts on their risky and vulnerable communities, despite government efforts to raise their cognizance. People in Malaysia are especially vulnerable to the effects of climate change and natural disasters due to inadequate infrastructure and lack of proper planning. Although the government of Malaysia has taken action to mitigate the effects of climate change and disasters, not enough funding has been set aside to do so. Because of this, efforts to adapt to

changing conditions and lessen potential harm may be slowed. Communities are often actively engaged and actively participate in adaptation to climate change and disaster risk reduction efforts. Community involvement in such endeavors, however, is often lacking in Malaysia. Without widespread support and cooperation, it will be difficult to implement effective adaptation and risk reduction strategies.

4.3. Actors for disaster and climate change management in Malaysia

There are a total of 46 government agencies in Malaysia that play a significant role in climate change action. The Malaysia Climate Change Action Council (MyCAC), led by the Prime Minister and overseen by the Ministry of Natural Resources, Energy, and Climate Change, is the primary policymaker (NRECC)[75].

In terms of disaster management, the National Disaster Management Policy and Mechanism engaged the participation of 45 federal, state, and district government agencies. The designated minister (Prime Minister, Deputy Prime Minister, or Minister under Prime Minister's Office (PMO)) is the national level chairperson[51]. The National Disaster Management Agency (NADMA) represent as the national disaster management secretariat, with the Malaysia Civil Defence Force (APM) serving as the state and district secretariat. State and district committees shall be chaired by the State Secretary and District Officers, respectively[16,76].

As shown in **Figure 4** below, nine (9) agencies play dual roles in managing climate change and disaster management.

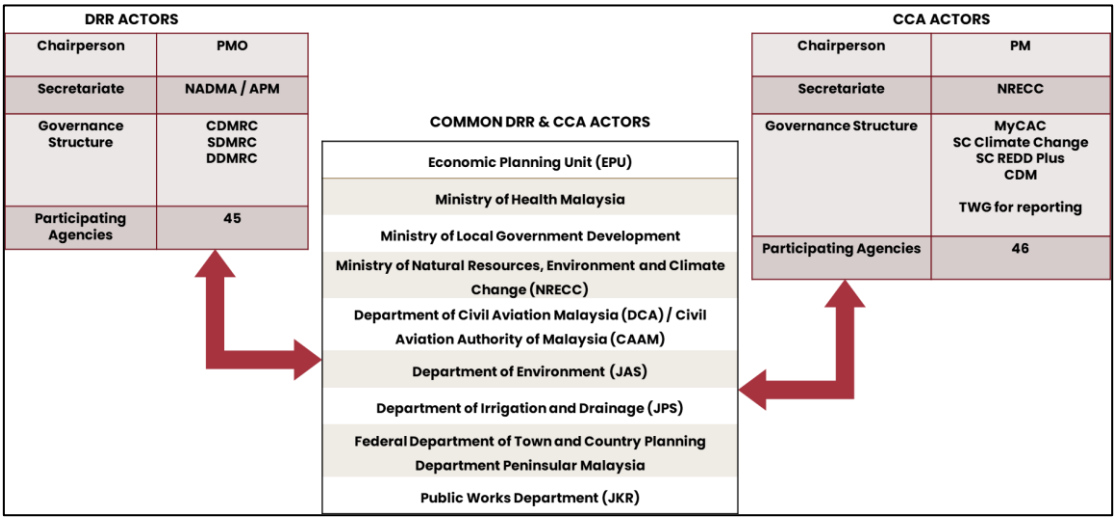

Figure 4. Actors in disaster management and climate change in Malaysia.

4.4. Multiple disciplinary solving the issues of adaptation to climate change and risk reduction

In order to maximize policy synergies and enhance disaster risk governance, several studies emphasized the need to address both disaster risk and climate change adaptation simultaneously through the involvement of multiple actors in making decision in terms of climate-related hazards[28,32,34,41,42].

To better understand and address the challenges associated with climate change and disaster risk, multiple disciplinary theory such as transdisciplinary approach can help to bridge the gap between different sectors, stakeholders, and knowledge domains in the context of adaptation and disaster risk governance[77]. Transdisciplinary approach emphasizes the importance of collaboration and participation among stakeholders from various disciplines, sectors, and communities in order to create solutions that are inclusive, equitable, and sustainable. It acknowledges the essentiality of a comprehensive approach that considers the interplay of social, economic, political, and environmental factors in the face of the challenges posed by climate change and disaster risk[78].

We could see how DRR and CCA's were practiced in a different set of governance. However, DRR and CCA initiatives can be amalgamated via shared interests and activities not only cause their efforts to overlap more, wasting time and money, but also open up new opportunities for collaboration (increasing efficiency and effectiveness)[34]. People working in DRR engage in CCA practices through determination in politics suppression for concrete and highly impact measures. Those in charge of putting DRR and CCA into action, on the other hand, face the same bureaucratic and institutional obstacles. Both DRR and CCA initiatives are unable to be realized due to a lack of funds. Both approaches require researchers to deal with the same types of data and information gaps. In many ways, DRR and CCA projects, programs, and interventions are similar[33].

The knowledge required to deal with global warming and natural disasters is often dispersed across different sectors and communities, but this is something that transdisciplinary theory acknowledges. Therefore, it promotes the amalgamation of scientific, traditional, and indigenous wisdom in order to fully grasp the issues at hand and craft appropriate responses[79].

To develop adaptation strategies that are efficient, equitable, and socially inclusive in the face of climate change, a transdisciplinary perspective can help to convene stakeholders from various sectors, such as government, civil society, and the private sector. Incorporating local and indigenous knowledge alongside scientific research and employing participatory methods can help give a voice to underrepresented communities[41,77].

The interconnected nature of many of the environmental linking with social and economic factors that contribute to disaster risk makes transdisciplinary approaches useful for reducing that risk. Incorporating social and economic analysis into hazard and vulnerability assessments and involving local communities and stakeholders in decision-making are ways to achieve this[79]. Historically, for the purpose of characterizing a single type of hazard, physical models have been purported. The models are now gradually expanding to simulate multiple types of hazards. A variety of numerical models are used to analyze these complex dynamic processes with multiple phases and physical fields. Finding a remedy requires research that covers both the science and practice of averting climate-related disasters, governance system, and dynamic policy which include the harmonization among human and adaptation to the climate change[80].

Example of multiple disciplinary in adapting to a changing climate while also working to reduce the likelihood of catastrophic events are through promoting research innovation center[81], collaboration of network in tourism-related crisis and disaster[82], vulnerability assessment for local government concentrating on ecosystems[83], integrating the health sector within the scope of DRR[84], evaluating risks and performing damage assessment, incorporate risk perception, and promoting disaster financing[85]. Those efforts sought to identify gaps that currently exist in research and development priorities while promoting the inception CCA into DRR.

Science and technology have been recognized as key factors in the creation and use of major disaster-reduction frameworks worldwide. But bridging the gap between scientists and policymakers, like those who deal with climate change, is important if we want to make the most of what we learn from scientific research and technological development for DRR. Along similar lines, the UNISDR Science and Technology Advisory Group (STAG) has proposed increasing communication and engagement between practitioners of the scientific and technological, as well as those responsible for disaster preparedness policies, in order to fortify the research-policy interface[79].

Scientists and practitioners agree that developing policies based on facts is the best way to lessen global climate risks. Previous discussions have focused primarily on effectively applying scientific methods for

reducing disaster risks and have focused on facilitating the spread of information and knowledge. The actual claims that guide action, however, have received less scrutiny. To address this bias, the DRR research field should develop a list of research priorities, links between different areas of knowledge, and strategies for dealing with how difficult it is to cross topics and disciplines. Conceptualization, measurement, and causality issues must also be addressed[86].

In a nutshell, either transdisciplinary, multidisciplinary, or interdisciplinary approaches offer a promising avenue for addressing the complex and interconnected challenges posed by climate change and disasters. Multiple disciplinary approaches offer the most potential of the three. These approaches have the potential to help generate solutions that are both more comprehensive and innovative, as well as to build communities that are more resilient and sustainable because they can bring together a variety of perspectives from different set of stakeholders.

5. Conclusion

It is undeniable that global warming posed a threat to the entire planet. Every year, more and more countries are hit by natural disasters brought on by climate change. Globally, the world has been threatened with climate-induced disasters that have annually increased and most nations are facing the impact either socially, economically or vulnerability. The adaptation of climate change into disaster risk reduction strategy is crucial in order to enhance disaster risk governance. Adapting the climate change factor into the disaster risk reduction policy has been widely discussed globally and Malaysia should enhance the integration for both factor in the disaster risk governance system through a multiple disciplinary approach. As limited study has been done on Malaysia governance policy and the multiple disciplinary, therefore, it is a good opportunity to investigate the current strategies, linking to the main player who should derive the policy. This study simply explored the governance gaps in disaster risk reduction and climate change adaptation in Malaysia through literature analysis and presented a multidisciplinary paradigm as a solution to the challenges. Future research should explore establishing the governance structure, the methodology to improve actors' networks, existing local practice, and obstacles in managing both DRR and CCA in order to get deeper information and understanding.

Therefore, this research has the potential to fill in gaps in knowledge and enhance disaster risk governance in Malaysia by revealing the current gaps related to disaster risk reduction and adaptation to climate change. As a proposed solution, the governance system needs to be improved through multiple collaborations among various actors related to the fields. The involvement of government, private, NGO's, community, and academia in the field of disaster risk reduction and climate change adaptation could be the focus of future study into the current state of disaster risk governance theory and practice. That view suggests broadening the scope to include an examination of the existing stakeholders and the network formation between the actors in the two fields.

Concurrently, Malaysia is aiming for green growth, multi-sectoral collaboration, environmental protection, and behavioral changes among the general public in order to promote community resilience through the 12th Malaysia Plan. The climate change agenda has been underlined in the 11th Malaysia Plan, and multiple efforts will be made to ensure progress is made. The 12th Malaysian Plan includes a climate change statement that aims to promote green growth in the country through measures such as adopting a circular economy, collaborating to become a low-carbon nation, taking actions based on evidence and risk assessment, and advocating for a more equitable distribution of benefits[87]. Malaysia is now working on a National Adaptation Plan (MyNAP). MyNAP will address public health, infrastructure, security, and water resources, as well as agriculture and forestry and biodiversity. The Malaysia Climate Change Action Council (MyCAC) determined

that it is crucial to strengthen the country's resilience and planning for the purpose of reducing the negative effects of climate change[75]. As a result, we may witness an increase in climate change adaptation within the context of disaster risk reduction in Malaysia in the future. This necessitates a multi-actor effort within government agencies to engage with commercial sectors, academic researchers, nonprofit organizations, and the community at risk towards building a symbionese environment to form better climate-disaster risk-informed communities. It is intended that the findings of this article will be used as complementary research to develop a new policy for disaster risk reduction and climate change adaptation.

However, the global framework and the difficulties of implementing international agendas in Malaysia could be the subject of further study in the future. Before disaster risk reduction and climate change adaptation can be integrated into Malaysian policy, the common and different characteristics of each must be identified and the actors must be unified. This allowed us to foresee the incorporation of climate change adaptation into disaster risk reduction policy and formulate a workable policy recommendation for enhancing disaster risk governance in Malaysia. Hopefully, the goals of the Paris Agreement, the Sendai Framework for Disaster Risk Reduction 2015–2030, and the Sustainable Development Goals will be achieved in the not-too-distant future.

Author contributions

Conceptualization, MSM and ANH; methodology, MSM; validation, MSM, ANH and FCR; formal analysis, MSM; writing—original draft preparation, MSM; writing—review and editing, ANH and FCR; supervision, ANH and FCR. All authors have read and agreed to the published version of the manuscript.

Acknowledgments

This research was supported by the Malaysia-Japan International Institute of Technology (MJIIT), Universiti Teknologi Malaysia (UTM), Kuala Lumpur, Malaysia and the author would like to thank UTM for the contributions.

Conflict of interest

The authors declare no conflict of interest.

References

1. UNDRR. Technical Guidance on Comprehensive Risk Assessment and Planning in the Context of Climate Change. Geneva, Switzerland; 2022. Available at: https://www.undrr.org/publication/technical-guidance-comprehensive-risk-assessment-and-planning-context-climate-change (accessed on 2 December 2022).
2. World Bank. Nature-based Solutions for Climate Resilience and Adaptation. 2022. Available at: https://thedocs.worldbank.org/en/doc/111a397e3cdec79a7f1ee6db6b329fb4-0020012022/original/WB-Nature-Based-221102-1838.pdf (accessed on 5 December 2023).
3. The World Bank Group and the Asian Development Bank. Climate Risk Country Profile: Malaysia. 2021. Available at: https://www.adb.org/publications/climate-risk-country-profile-malaysia (accessed on 19 September 2022).
4. INFORM. INFORM - Global, open-source risk assessment for humanitarian crises and disasters. 2022. Available at: https://drmkc.jrc.ec.europa.eu/inform-index/ (accessed on 13 December 2022).
5. United Nation. United Nations General Assembly Resolution A/RES/44/236. New York; 1989.
6. United Nation. United Nations Framework Convention on Climate Change. 1992.
7. UNISDR. Adaptation to Climate Change by Reducing Disaster Risks: Country Practices and Lessons. Geneva; 2009. Available at: http://www.unisdr.org/eng/terminology/terminology-2009-eng.html (accessed on 19 September 2022).
8. UNISDR. Sendai Framework for Disaster Risk Reduction 2015 - 2030. Third World Conference on Disaster Risk Reduction, Sendai, Japan, 14-18 March 2015. 2015. 1–25 p. doi:A/CONF.224/CRP.1

9. UNDRR. Report of the open-ended intergovernmental expert working group on indicators and terminology relating to disaster risk reduction. December 2016. Available at: http://www.preventionweb.net/drr-framework/open-ended-working-group/ (accessed on 13 December 2022).
10. Tierney K. Disaster governance: Social, political, and economic dimensions. Annual Review of Environment and Resources. 2012. pp. 341–363. doi:10.1146/annurev-environ-020911-095618
11. Valente M., Trentin M., Ragazzoni L., et al. Aligning disaster risk reduction and climate change adaptation in the post-COP26 era. The Lancet Planetary Health. 2022; 6(2): e76–e77. doi:10.1016/S2542-5196(22)00013
12. Gall M., Cutter S., Nguyen KH. Governance in Disaster Risk Management. Integrated Research on Disaster Risk. 2014. doi:10.13140/2.1.2130.2568
13. Choi BCK., Pak AWP. Multidisciplinarity, interdisciplinarity, and transdisciplinarity in health research, services, education, and policy: 2. Promotors, barriers, and strategies of enhancement. Clinical and investigative medicine. 2007; (6): 224–232. doi:10.25011/cim.v30i6.2950
14. McPhee C., Bliemel M., van der Bijl-Brouwer M. Editorial: Transdisciplinary Innovation (August 2018). Technology Innovation Management Review. March 2018; 8: 3–6. doi:10.22215/timreview/1173
15. Choi BCK., Pak AWP. Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 1. Definitions, objectives, and evidence of effectiveness. Clinical and investigative medicine. 2006; 6: 351–364.
16. UNDRR. Disaster Risk Reduction in Malaysia: Status Report 2020. Bangkok, Thailand: United Nations Office for Disaster Risk Reduction (UNDRR), Regional Office for Asia and the Pacific; 2020. Available at: https://www.undrr.org/publication/disaster-risk-reduction-malaysia-status-report-2020 (accessed on 3 November 2022).
17. Rahman HA. Climate Change Scenarios in Malaysia: Engaging the Public. International Journal of Malay-Nusantara Studies. 2018; 1(2). Available at: https://journal.unhas.ac.id/index.php/IJoM-NS/article/view/5518/3051 (accessed on 11 November 2022).
18. CFE-DM. Malaysia Disaster Management Reference Handbook. 2022. Available at: https://www.cfe-dmha.org (accessed on 5 December 2023).
19. CFE-DM. Malaysia Disaster Management Reference Handbook. Hawaii; June 2019. Available at: https://www.cfe-dmha.org/ (accessed on 3 December 2020).
20. World Bank and Bank Negara Malaysia (BNM). An Exploration of Nature-Related Financial Risks in Malaysia. Kuala Lumpur; March 2022. Available at: https://www.bnm.gov.my/WB-Report2022 (accessed on 11 November 2022).
21. UNDP. 10 things to know on Disaster and Climate Risk Governance in UNDP. 2017. Available at: https://www.undp.org/publications/10-things-know-about-disaster-risk-governance (accessed on 17 October 2023).
22. Forino G., Von Meding J., Brewer GJ. A conceptual governance framework for climate change adaptation and disaster risk reduction integration. International Journal of Disaster Risk Science. 2015; 6(4): 372–384. doi:10.1007/s13753-015-0076-z
23. Forino G., Von Meding J., Brewer GJ. Governance of climate change adaptation and disaster risk reduction integration: strategies, policies, and plans in Australian Local Governments. International Journal of Disaster Risk Reduction. 2017; 24: 100–108.
24. Begum RA., Sarkar MSK., Jaafar AH., et al. Toward conceptual frameworks for linking disaster risk reduction and climate change adaptation. International Journal of Disaster Risk Reduction. 2014. pp. 362–373. doi:10.1016/j.ijdrr.2014.10.011
25. Begum RA., Abidin RDZRZ., Pereira JJ. Initiatives and market mechanisms for climate change actions in Malaysia. Journal of Environmental Science and Technology. 2011; 4(1): 31–40. doi:10.3923/jest.2011.31.40
26. Tierney K. Disaster governance: Social, political, and economic dimensions. Annual Review of Environment and Resources. 2012; 37: 341–363. doi:10.1146/ANNUREV-ENVIRON-020911-095618
27. Gero A., Méheux K., Dominey-Howes D. Disaster risk reduction and climate change adaptation in the Pacific: The challenge of integration. 2010. Available at: https://www.preventionweb.net/files/14925_UNSWDRRandCCAinthePacific1.pdf (accessed on 5 December 2023).
28. Dedekorkut-Howes A., Vickers J. Climate change adaptation in Pacific countries. 2017. 401 p. doi:10.1007/978-3-319-50094-2
29. IPCC. Mitigation of Climate Change Climate Change 2022 Working Group III contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. 2022. Available at: https://www.ipcc.ch/site/assets/uploads/2018/05/uncertainty-guidance-note.pdf (accessed on 5 December 2023).
30. UNSDG. Integrating Disaster Risk Reduction and Climate Change Adaptation in the UN Sustainable Development Cooperation Framework. August 2020. Available at: https://www.undrr.org/media/47679/download (accessed on 5 December 2023).

31. Shi P., Ye Q., Han G., et al. Living with global climate diversity—suggestions on international governance for coping with climate change risk. International Journal of Disaster Risk Science. 2012; 3(4): 177–184. doi:10.1007/s13753-012-0018-y
32. Forino G., Von Meding J., Brewer G., et al. Disaster Risk Reduction and Climate Change Adaptation Policy in Australia. Procedia Economics and Finance. 2014; 18: 473–482. doi:10.1016/s2212-5671(14)00965-4
33. Islam S., Chu C., Smart JCR. Challenges in integrating disaster risk reduction and climate change adaptation: Exploring the Bangladesh case. International Journal of Disaster Risk Reduction. 2020; 47: 101540. doi:10.1016/J.IJDRR.2020.101540
34. Islam S., Chu C., Smart JCR., et al. Integrating disaster risk reduction and climate change adaptation: a systematic literature review. International Journal of Disaster Risk Reduction. Elsevier Ltd; 1 August 2019; 47. doi:10.1016/j.ijdrr.2020.101540
35. Rahayu HP., Haigh R., Amaratunga D., et al. A micro scale study of climate change adaptation and disaster risk reduction in coastal urban strategic planning for the Jakarta. International Journal of Disaster Resilience in the Built Environment. 2020; 11(1): 119–133. doi:10.1108/IJDRBE-10-2019-0073
36. Fleming K., Abad J., Booth L., et al. The use of serious games in engaging stakeholders for disaster risk reduction, management and climate change adaption information elicitation. International Journal of Disaster Risk Reduction. 2020; 49. doi:10.1016/j.ijdrr.2020.101669
37. Hallwright J., Handmer J. Progressing the integration of climate change adaptation and disaster risk management in Vanuatu and beyond. Climate Risk Management. 2021; 31. doi:10.1016/j.crm.2020.100269
38. Nemakonde LD., Van Niekerk D. A normative model for integrating organisations for disaster risk reduction and climate change adaptation within SADC member states. Disaster Prevention and Management. 2017; 26(3): 361–376. doi:10.1108/DPM-03-2017-0066
39. Ni'mah NM., Wibisono BH., Roychansyah MS. Urban sustainability and resilience governance: review from the perspective of climate change adaptation and disaster risk reduction. Journal of Regional and City Planning. 2021. pp. 83–98. doi:10.5614/JPWK.2021.32.1.6
40. Forino G., von Meding J., Brewer GJ. A Hybrid Governance Framework for Climate Change Adaptation (CCA) and Disaster Risk Reduction (DRR) in Australia. Proceedings ANDROID Residential Doctoral School - 5th International Conference on Building Resilience. Newcastle, Australia: NCP; 2015. pp. 182–195.
41. Serrao-Neumann S., Crick F., Harman B., et al. Maximising synergies between disaster risk reduction and climate change adaptation: Potential enablers for improved planning outcomes. Environmental Science and Policy. 2015; 50: 46–61. doi:10.1016/j.envsci.2015.01.017
42. Shaw R., Pulhin JM., Pereira JJ. Climate change adaptation and disaster risk reduction: An asian perspective. Community, Environment and Disaster Risk Management. 2010; 5: 1–18. doi:10.1108/S2040-7262(2010)0000005007
43. Pereira JJ., Tiong TC., Komoo I. Mainstreaming climate change adaptation and disaster risk reduction: A malaysian approach. Community, Environment and Disaster Risk Management. 2010; 5: 147–167. doi:10.1108/S2040-7262(2010)0000005014
44. Rani WNMWM., Mohd Kamarudin KH., Hassan RC. Climate and Disaster Resilient Cities: Challenges for Malaysia. 2nd International Conference on Sustainable Urban Design and Livable Cities (SUDLiC 2017). 2017. Available at: https://www.researchgate.net/publication/321070656_climate_and_disaster_resilient_cities_challenges_for_malaysia (accessed on 10 January 2018).
45. Liberati A., Altman DG., Tetzlaff J., et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate healthcare interventions: explanation and elaboration. 2009; 339. doi:10.1136/bmj.b2700
46. Sooryamoorthy R. Scientometrics for the study of sociology. International Sociology. 2020; 35(5): 461–479. doi:10.1177/0268580920957911
47. Ampratwum G., Osei-Kyei R., Tam VWY. A scientometric review of public-private partnership in critical infrastructure resilience. IOP Conference Series: Earth and Environmental Science. 2022; 1101(5): 52007. doi:10.1088/1755-1315/1101/5/052007
48. Shariff NNM., Hamidi Z. Community-based approach for a flood preparedness plan in Malaysia. Jàmbá Journal of Disaster Risk Studies. 2019; 11. doi:10.4102/jamba.v11i1.598
49. NRE. Malaysia National Policy on Climate Change. Malaysia: Ministry of Natural Resource and Environment; 2009. Available at: https://www.pmo.gov.my/2019/07/national-policy-on-climate-change/ (accessed on 11 September 2022).
50. UNICEF. Impact of Climate Change on Children: A Malaysia Perspective. Putrajaya; 2021. Available at: https://www.unicef.org/malaysia/reports/impact-climate-change-children (accessed on 22 December 2022).
51. MKN. National Security Council Directive No 20: National Disaster Management Policy and Mechanism. 2nd edn. Majlis Keselamatan Negara. Malaysia: Majlis Keselamatan Negara; 2012. Available at:

https://www.ump.edu.my/doc/arahan-mkn-no.20-semakan-semula-09_02_2013.pdf (accessed on 10 February 2018).
52. UNFCCC. The Paris Agreement. Paris Climate Change Conference - November 2015. UNFCCC; November 2015. Available at: https://unfccc.int/process-and-meetings/the-paris-agreement (accessed on 11 November 2022).
53. Abdul Majid A. Malaysia's Climate Change Act? What to Expect. ZICO Law. 8 December 2021; Available at: https://www.zicolaw.com/resources/publications/malaysias-climate-change-act-what-to-expect/ (accessed on 28 November 2022).
54. NADMA and JICA. Final Report for the Survey on Disaster Risk Reduction and Management (DRRM) Capacities of State and Local Governments in Malaysia. Kuala Lumpur; October 2021. Available at: https://www.humanitariancap.com/projects/survey-on-drrm-capacities-of-state-and-local-governments-in-malaysia/ (accessed on 11 March 2022).
55. Varkkey H. Winds of Change in Malaysia: The Government and the Climate. Heinrich Böll Foundation. 2019. Available at: https://th.boell.org/en/2019/02/27/winds-change-malaysia-government-and-climate (accessed on 9 November 2022).
56. IFRC. The Handbook on Law and Disaster Risk Reduction. Geneva; 2015. Available at: https://www.ifrc.org/document/handbook-law-and-disaster-risk-reduction (accessed on 2 March 2023).
57. IFRC. Malaysia | Resilience Library. International Federation of Red Cross and Red Crescent Societies. 2022. Available at: https://www.rcrc-resilience-southeastasia.org/disaster-law/disaster-law-mapping-asean-agreement-on-disaster-management-and-emergency-response/country-profiles/malaysia/ (accessed on 14 November 2022).
58. CAN., CGM. Towards a Low Carbon Emissions Pathway. 2022. Available at: https://www.bnm.gov.my/documents/20124/3770663/jc3_can_cgm_report_2022.pdf (accessed on 13 January 2023).
59. Yaacob M., So WWM., Iizuka N. Exploring Community Perceptions of Climate Change Issues in Peninsular Malaysia. Sustainability (Switzerland). 2022; 14(13). doi:10.3390/su14137756
60. Khairilmizal S., Hussin MF., Yassin AIM., et al. Policy on disaster management in Malaysia: The need of supporting governance. Advanced Science Letters. 2016; 22(12): 4213–4215. doi:10.1166/asl.2016.8108
61. Zen IS., Al-Amin AQ., Doberstein B. Mainstreaming climate adaptation and mitigation policy: Towards multi-level climate governance in Melaka, Malaysia. Urban Climate. 2019. doi:10.1016/j.uclim.2019.100501
62. Sandaran SC., Selvaraj S. Government agencies and their discourses of flood disaster preparedness: Impact on response, action and community empowerment. GEMA Online Journal of Language Studies. 2021; 21(4): 294–313. doi:10.17576/gema-2021-2104-15
63. Palermo V., Hernandez Y. Group discussions on how to implement a participatory process in climate adaptation planning: a case study in Malaysia. Ecological Economics. 2020; 177: 106791. doi:10.1016/J.ECOLECON.2020.106791 (accessed on 8 November 2022).
64. Marquardt J., Delina LL., Smits M. Climate change governance in Southeast Asia. Governing Climate Change in Southeast Asia. 2022. pp. 249–260. doi:10.4324/9780429324680-14
65. Mustafa M., Sufian A., Kader SZSA. Progression of Policies and Laws Towards Addressing Climate Change and Sustainability Issues: Recent Initiatives from Malaysia. Human and Environmental Security in the Era of Global Risks: Perspectives from Africa, Asia and the Pacific Islands. 2018; 133–147. doi:10.1007/978-3-319-92828-9_7/COVER (accessed on 8 November 2022).
66. Salleh S., Mohamed Yusof N., Saimy IS., et al. Opportunities and Challenges for Building Community Preparedness Towards Disasters in Malaysia. 2020. pp. 2141–2147. doi:10.3850/978-981-14-8593-0_4206-cd
67. Sobian A. An Overview of the Participation of Community and Faith-Based Organisations (FBO) in Disaster Preparedness in Malaysia. IKIM Journal of Islam and the Contemporary World. 2016; 9. doi:https://doi.org/10.56389/tafhim.vol9no1.4
68. Apurva Sanghi. On climate change, Malaysia has three stories to tell. The Star Online. 13 November 2022; Available at: https://www.thestar.com.my/news/focus/2022/11/13/on-climate-change-malaysia-has-three-stories-to-tell (accessed on 22 December 2022).
69. Omar NB., Amran A. Corporate Governance and Climate Change Reporting in Malaysia. International Journal of Academic Research in Business and Social Sciences. 2018; 7(12). doi:10.6007/ijarbss/v7-i12/3607
70. Radi MFM., Hashim JH., Jaafar Mohd Hasni et al. Lessons on environmental health and disaster preparedness, response and recovery from the severe Kelantan flooding in 2014. International Journal of Emergency Management. 2019; 15(1): 26–53. doi:10.1504/IJEM.2019.099204
71. Zubir SNA., Thiruchelvam S., Mustapha KNM., et al. An Evaluation on Factors Influencing Decision making for Malaysia Disaster Management: The Confirmatory Factor Analysis Approach. IOP Conference Series: Materials Science and Engineering. 2018. doi:10.1088/1757-899X/291/1/012023
72. Shakirand HHJ, Utaberta N. The Importance of Culture in Disaster Management in Malaysia. In: Awang Mokhtar and Isa MH (ed.) The Advances in Civil Engineering Materials. 2019. pp. 56–65. doi: 10.1007/978-981-13-2511-3_7

73. Norizan NZA., Hassan N., Yusoff MM. Strengthening flood resilient development in malaysia through integration of flood risk reduction measures in local plans. Land Use Policy. 2021; 102. doi:10.1016/j.landusepol.2020.105178
74. The World Bank Group. Malaysia - Vulnerability | Climate Change Knowledge Portal. The World Bank Group. 2022. Available at: https://climateknowledgeportal.worldbank.org/country/malaysia/vulnerability (accessed on 8 November 2022).
75. KASA. Malaysia's Third Biennial Update Report submitted to the United Nations Framework Convention on Climate Change. Putrajaya; 2020. Available at: https://unfccc.int/sites/default/files/resource/MALAYSIA_BUR3-UNFCCC_Submission.pdf (accessed on 13 May 2023).
76. CEDMHA C for E in DM and HA. Malaysia: Disaster Management Reference Handbook 2016. 2016. 1–100 p. Available at: http://reliefweb.int/report/malaysia/malaysia-disaster-management-reference-handbook-2016 (accessed on 1 May 2022).
77. Serrao-Neumann S., Schuch G., Harman B., et al. One Human Settlement: A transdisciplinary approach to climate change adaptation research. 2014; doi:10.1016/j.futures.2014.08.011
78. Klein JT. Evaluation of Interdisciplinary and Transdisciplinary Research: A Literature Review. American Journal of Preventive Medicine. 2008; 35(2, Supplement): S116–S123. doi:10.1016/j.amepre.2008.05.010
79. Matsuura S., Razak KA. Exploring Transdisciplinary Approaches to Facilitate Disaster Risk Reduction at National and Local Levels Through Education, Training and Field Practice. 2019. doi:10.1108/DPM-09-2019-0289
80. Cui P., Peng J., Shi P., et al. Scientific challenges of research on natural hazards and disaster risk. Geography and Sustainability. 2021; 2(3): 216–223. doi:10.1016/J.GEOSUS.2021.09.001 (accessed on 30 March 2023).
81. Zuccaro G., Leone MF., Martucci C. Future research and innovation priorities in the field of natural hazards, disaster risk reduction, disaster risk management and climate change adaptation: a shared vision from the ESPREssO project. International Journal of Disaster Risk Reduction. 2020; 51: 101783. doi:10.1016/J.IJDRR.2020.101783 (accessed on 30 March 2023).
82. Aliperti G., Sandholz S., Hagenlocher M., et al. Tourism, Crisis, Disaster: An Interdisciplinary Approach. Annals of Tourism Research. 2019; 79: 102808. doi:10.1016/J.ANNALS.2019.102808
83. Myers MR., Barnard PL., Beighley E., et al. A multidisciplinary coastal vulnerability assessment for local government focused on ecosystems, Santa Barbara area, California. Ocean & Coastal Management. 2019; 182: 104921. doi:10.1016/J.OCECOAMAN.2019.104921
84. Burkle FM. Challenges of global public health emergencies: Development of a health-crisis management framework. Tohoku Journal of Experimental Medicine. 2019; 249(1): 33–41. doi:10.1620/tjem.249.33
85. Ishiwatari M., Sasaki D. Special Issue "Disaster Risk Reduction and Climate Change Adaptation: An Interdisciplinary Approach". International Journal of Environmental Research and Public Health. 2023. doi:10.3390/ijerph20032641
86. Nohrstedt D., Parker CF., von Uexkull N., et al. Disaster risk reduction and the limits of truisms: Improving the knowledge and practice interface. International Journal of Disaster Risk Reduction. 2022; 67: 102661. doi:10.1016/J.IJDRR.2021.102661 (accessed on 3 April 2023).
87. EPU. Twelfth Malaysia Plan 2021-2025 (Twelfth Plan): A Prosperous, Inclusive, Sustainable Malaysia. Putrajaya; July 2021. Available at: https://rmke12.ekonomi.gov.my/en (accessed on 5 December 2023).