Int J Disaster Risk Sci
DOI 10.1007/s13753-017-0125-x

www.ijdrs.com
www.springer.com/13753

ARTICLE

A Systematic Study of Disaster Risk in Brunei Darussalam and Options for Vulnerability-Based Disaster Risk Reduction

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Abstract This systematic study of disaster risk and disaster management efforts in Brunei Darussalam uncovers the reasons why floods and landslides in particular continue to inflict significant social, economic, and psychological toll. Vulnerability to the impacts of hydro-meteorological hazards continue to rise despite international awareness and improved disaster governance and information, and regardless of the vast financial and material resources spent on structural and nonstructural measures for disaster relief and community awareness. Our premise is that, a poor diagnosis of the disaster risk issue is at the root of the disaster risk dilemma in Brunei Darussalam. We conducted our vulnerability-centered disaster risk assessment based largely on the Pressure and Release (PAR) Model proposed by Wisner et al. Our research results reveal that: (1) Hazard-risk in Brunei is high due to the impact of global climate change, the country's local geography, and Brunei's relative location in the Asia–Pacific Region. Limited reporting of localized disasters to international databases however fuels the misperception of low disaster risk in Brunei; (2) High community vulnerability and disaster risk is due to limited knowledge, awareness, and motivation among the general population, which prevents effective mitigation and adaptation to low magnitude but recurrent hazardous events; and (3) Partial incorporation of disaster risk reduction into governance structures and development plans contributes to heightened disaster risks. Integrated frameworks are proposed that can minimize social vulnerability, reduce disaster risk, and enhance community resilience and adaptive capacity as part of a strengthened governance mechanism. Coupled with improvements in preparedness, response, recovery, and reconstruction promoted by the National Disaster Management Centre (NDMC), vulnerability and disaster risk can be minimized, and a more inclusive and sustainable growth can be generated.

Keywords Brunei Darussalam · Community vulnerability · Disaster risk reduction · Pressure and Release Model (PAR)

1 Introduction

Disaster signifies extreme impacts suffered when hazardous physical (and/or human-induced) events interact with vulnerable social conditions to severely alter the normal functioning of a community or a society in such a way that recovery is unlikely without external aid (Wisner et al. 2004; UNISDR 2007, 2009a, b; Lavell et al. 2012). This characterization of disaster puts emphasis on the maximum possible damage endured by a maximum possible number of people or as defined by Wisner et al. (2004): when a significant number of vulnerable people experience a hazard and suffer severe damage and/or disruption of their livelihood system. These definitions are in line with international disaster databases such as EM-DAT (International Disasters Database) (CRED 2014), which requires that, for a disaster to be entered into the database, at least one of the following criteria must be fulfilled: ten or

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Published online: 13 June 2017

more people reported killed; a hundred or more people reported affected; declaration of a state of emergency; call for international assistance (CRED 2015). This approach ignores high frequency, low impact disasters, whose cumulative effects over time could be very significant socially and economically. In the context of the present study, even when the effects of a hazard are frequently suffered by only a few members of a society over extended time periods, a succession of low impact disasters in a limited area also can constitute a significant disaster. This additional aspect of the definition is particularly relevant because it situates disasters in the general context of hazards, exposure, vulnerability, and risk, all uniquely intertwined, affecting, and in turn are affected by, a society's resilience, which can lead to the potential development of death and destruction (Wisner et al. 2004).

Social vulnerability and exposure are therefore key determinants of disaster risk and help explain why non-extreme physical events and chronic hazards can also lead to extreme impacts and disasters, while some extreme events do not (Lavell et al. 2012). To effectively and efficiently reduce vulnerability and minimize disaster risk, social components of the system in which hazardous events occur must be well known and understood. Effective reduction of risk and adaptation to risk- and vulnerability-generating systems require an understanding of the diverse ways in which social processes and development pathways shape disaster risk (Lavell et al. 2012). The risk of disaster is perceived in this article as a compound function of a natural hazard and the number of people who occupy a particular space at the time of exposure to the hazard event, characterized by the population's varying degrees of vulnerability to that specific hazard (Wisner et al. 2004). The most frequent empirical drivers of social vulnerability (SV) include demographic characteristics, socioeconomic status and health factors, and psychological factors such as risk perception and coping capacity (Rufat et al. 2015). These variables, which can be coupled with political and economic factors and other multifarious forms of risk, may be the foundation and root cause of disasters risks and social vulnerability (Wisner et al. 2004).

This contextualization is necessary because social vulnerability is not homogeneous but quite complex and diverse, and depends on local context (Rufat et al. 2015). Social vulnerability, however, remains difficult to quantify because psychological aspects are often largely neglected (Grothmann and Patt 2005). Disaster risk reduction (DRR) became popular in the 1990s with a strategic shift in disaster management practices towards an integrated disaster risk reduction approach. This new perspective includes incorporating DRR planning into the development process of countries and regions (Co-Chairs of the Preparatory Committee 2014). This was recently reiterated in the Hyogo Framework for Action 2005–2015 (UNISDR 2007, 2009a, 2014) and the Sendai Framework for Disaster Risk Reduction 2015–2030 (UNISDR 2015, 2016). These inclusive frameworks for disaster risk assessment encompass all the components cited above. Therefore these strategic plans are effective tools with which to detect hidden vulnerabilities that subtly increase disaster risk at both national and local community levels. This is particularly relevant to Brunei Darussalam, located on the island of Borneo in Southeast Asia, and one of the 10 member states of ASEAN (Association of Southeast Asian Nations). The country has a relatively small surface area with a small population compared with the regional average (Table 1); Brunei's population density is 79.3 persons/km^2, spread across four districts, 77% of which is now urbanized (NIDM 2014; UNISDR 2011).

In a broader regional perspective, the Asia–Pacific Region (APR) is incontestably a hotspot for natural hazards. ASEAN nations—located at the heart of the APR—have a combined population of 622 million, and experience average direct economic losses from disasters worth USD 4.4 billion annually. This level of loss represents enormous socioeconomic costs that threaten sustainable development and livelihoods (UNISDR 2016). Four ASEAN member states were ranked among the top 10 countries most affected by climate and other disasters between 1996 and 2015; half of global disaster mortality occurred in Southeast Asia—between 2004 and 2014, the region recorded 354,000 out of 700,000 total deaths due to disasters worldwide (Lassa and Sembiring 2017). Despite its location in a hazard and disaster hotspot, Brunei has historically been perceived as one of the countries least prone to natural hazards in Southeast Asia, and generally is referred to as being vulnerable only to low-level hazards from earthquakes, cyclonic storms, floods, landslides, seasonal forest fires, and smoke/haze (ADB 2009; Oxford Business Group 2009, 2010; ADRMI 2010; ASEAN Disaster Risk Management Initiative 2010; AIPA 2012; NIDM 2014; JICA 2015; Lassa and Sembiring 2017). Threats from pandemics such as H1N1 (swine flu) and H5N1 (Bird flu) also have a low level impact on Brunei (Oxford Business Group 2009). This perception of low hazard risk status was recently reiterated in the INFORM risk index that classifies Brunei as a very low risk area (INFORM 2017) (Fig. 1a).

In reality however, floods remain unarguably the most vivid and costly threat in Brunei Darussalam (Table 2). Out of the total annual losses and percentage of annual social expenditure from multiple hazards amounting to about USD 37.31 million and 3.62% respectively, up to USD 31 million worth of losses and 3.0% of social expenditure respectively are incurred from floods alone (CRED2015). However, the occurrence and impacts of landslides have

Table 1 Basic country statistics and indicators for Brunei Darussalam *Source* NIDM (2014), UNISDR (2011)

District	Capital	Population (2011 Census)	Area (km^2)
Belait	Kuala Belait	60,744	2724
Brunei-Muara	Bandar Seri Begawan	279,924	571
Temburong	Pekan Bangar	8852	1304
Tutong	Pekan Tutong	43,852	1166
Population	People		417,784
Urban	% total population		76.561
Rural	% total population		23.439
Urban population growth	% annual		1.779
Population density	People/km^2		79.3

remained largely under-reported in international disaster databases

Under the constant threat of floods, landslides, forest fires, haze, and other hazards, disaster management in Brunei has been institutionalized under multi-stakeholder District Disaster Management Councils (DDMC) in all four districts of the Sultanate. Activity in these districts is coordinated by a National Disaster Management Centre (NDMC) set up by the Disaster Management Order of August 2006 (ASEAN Disaster Risk Management Initiative ASEAN 2010; AIPA 2012). This organizational structure was intended to enhancing preparedness and response to weather-related natural hazards (Brunei Darussalam Government 2009; Oxford Business Group 2009). Details of the roles, achievements, and legislative and operational aspects of disaster management in Brunei are provided in numerous published reports (Brunei Darussalam Government 2009, 2011a, 2011b; Oxford Business Group 2009; AIPA 2012; NIDM 2014; JICA 2015). Two things stand out in these publications. First, extensive financial provisions in each national development plan are allocated for structural measures to improve the drainage system in flood-prone areas. About USD 236 million and USD 136 million were allocated during the 8th (2001–2005) and 9th (2007–2012) National Development Plans respectively, and a further USD 122 million was allocated under the Flood Action Plan (FAP) of 2012 (Brunei Darussalam Government 2011a). A second suite of developments is NDMC's innovative approaches that enhance capacity building in disaster response through the formulation of a Strategic National Action Plan (SNAP) for Disaster Risk Reduction, the creation of National Standard Operating Procedures (NaSOP) for response (AIPA 2012), and the development of a Community Based Disaster Risk Management Program (CBDRM) (Oxford Business Group 2010; Brunei Darussalam Government 2011a).

Despite Brunei's disaster management efforts being lauded across the ASEAN community, the anticipated results have not been achieved. Numerous areas around the country continue to be affected by floods and landslides on an annual basis. The costly infrastructural projects already undertaken have not reduced the risk of severe flooding and associated damage within numerous communities in the country. Instead, these projects may have compounded flood damage. Similar results have been noted by Tobin (1995), Etkin (1999) and Fordham (1999), who demonstrate how short-term response measures, such as improvements in drainage and infrastructure in flood-prone areas, can increase flood vulnerability and hence flood risk.

Land-slide mitigation and response in Brunei has received less attention and publicity relative to floods. Limited awareness of the risks and dangers of landslides in the country was recognized and, in an effort to remediate this problem, a conference was convened on 15 January 2014 in Bandar Seri Begawan under the theme "Awareness on Landslide Risks: Its Causes, Mitigation and Prevention." The conference was attended by engineers, developers, project implementers, contractors, educators, and researchers. Participants recognized that although no fatalities have been reported from landslides, slope failure constitutes a real danger to life and property as well as to the sustainable development of the country. Conference discussions also revealed that there are no real mitigation strategies for landslides and that current reactive measures are neither effective, efficient, nor very unsustainable, despite USD 3.6 million of government funds being spent on average annually on slope rectification projects. This situation is not unique to Brunei or even the Asia–Pacific Region. According to a report on the assessment of global performance in the area of disaster risk reduction, a decade since the adoption of the Hyogo Framework for Action (HFA) in 2005, exposure of people and assets in all countries has increased faster than vulnerability has decreased. This counter intuitive situation is generating new risk and a steady rise in disaster losses with significant socioeconomic impacts in the short, medium, and long

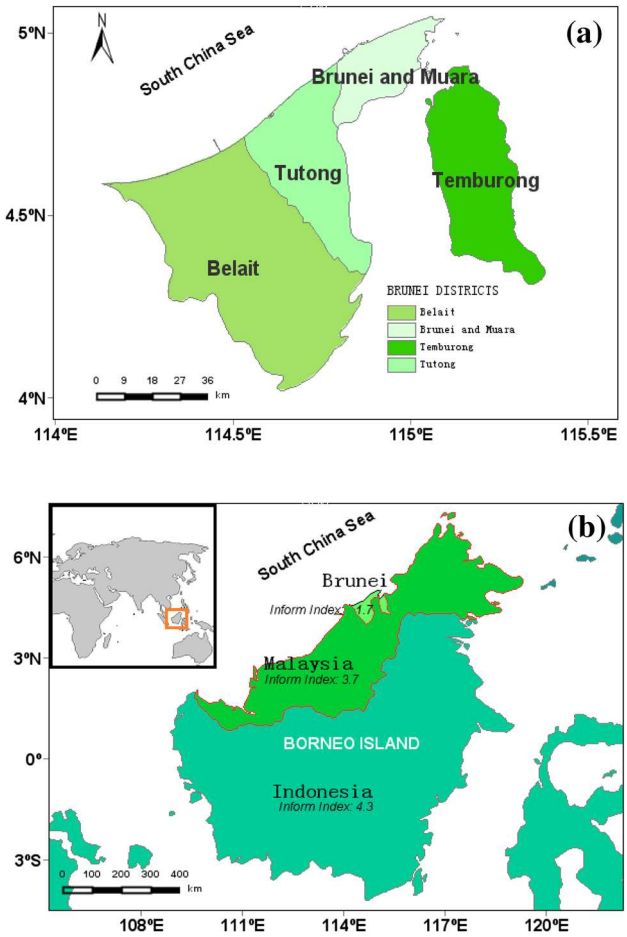

Fig. 1 The study area: Brunei Darussalam (located on Borneo Island); **a** Map of Brunei Darussalam showing the four administrative districts, **b** Map of Borneo Island; both maps are produced by the author with MeteoInfo 1.4.1 (GIS Software for Meteorological Data). Figure **b** also shows Inform Risk Index for Brunei (1.7), Malaysian Borneo (3.7), and Indonesian Borneo (4.3), corresponding to very low risk, low risk, and medium risk respectively. *Note* The INFORM model adopts the three aspects of vulnerability reflected in the UNISDR definition, including: physical exposure and physical vulnerability aspects integrated in the hazard and exposure dimension; fragility of the socioeconomic system is INFORM's vulnerability dimension while lack of resilience to cope and recover is treated under the lack of coping capacity dimension

terms, especially at the local and community levels (Co-Chairs of the Preparatory Committee 2014). Amidst these realities, Brunei Darussalam nevertheless continues to be free from severe natural hazards such as earthquakes, volcanic eruptions, and typhoons, and experiences only low level threats from thunderstorms, monsoon and flash floods, landslides, and haze (INFORM 2017; Lassa and Sembiring 2017). In this context, it is important not to conflate the terms "hazard" and "vulnerability." Brunei may not have had cataclysmic hazards but is not immune to them, given its location. Moreover, although the country may be affected only by low level high frequency hazard events, it also has a relatively large population of vulnerable people. This is a recipe for disaster, often causally related to ongoing, chronic, or persistent environmental, economic, or social risk factors (Lavell et al. 2012).

A major issue with regard to disaster risk in Brunei is the total lack of reporting of relatively small recurrent hazard episodes, particularly annual floods and landslides, to international disaster databases. This continues to fuel the erroneous assumption that the risk of landslide and extensive damage from floods is very low, such that large-scale disasters are not expected (JICA 2015). The JICA report mentions that only three landslide events occurred in Brunei, and that flood and flash flood, the most frequent disasters of the country, occurred only six times since 1960, and killed 10 people (JICA 2015). In recent years, relatively large floods and landslides have been consistently recorded in Brunei almost on an annual basis as with the most severe cases observed in 1999, 2009, 2011, and 2014. These events have caused significant social distress and suffering among thousands of victims nationwide (Ndah et al. 2016). Recent floods have been classified as the worst cases in 40 years (Oxford Business Group 2009). With regards to landslides, in January 2014 alone, out of the 154 reported cases of landslides in the country, 21 were classified as dangerous, 121 as moderate, and 11 as not dangerous (Ndah et al. 2016), coupled with over 115 cases of flooding (Shams and Juani 2015). It is well known that

Table 2 Average annual loss (AAL) by hazard. *Source* CRED (2015); http://www.preventionweb.net/countries/brn/data/. Accessed in September 2016

Hazard	Absolute (Million USD)	Capital stock (%)	Social expenditure (%)	Gross savings (%)
Earthquake	5.94	0.008	0.576	0.109
Storm Surge	0.02	0.000	0.002	0.000
Tsunami	0.40	0.001	0.039	0.007
Flood	**30.95**	**0.043**	**3.004**	**0.567**
Multi-Hazard	37.31	0.052	3.621	0.68

Average annual loss (AAL) is the expected loss per annum associated with the occurrence of future perils assuming a very long observation timeframe

Bold is used to highlight floods as the dominant, most frequent cause of disasters, and the most important hazard in Brunei Darussalam

most losses from natural hazards result from the cumulative effects of high-frequency, low-impact disasters; the poorest members of the community, low income households, and small and medium enterprises constitute a high percentage of all losses (UNISDR 2013; Co-Chairs of the Preparatory Committee 2014).

Moreover, limited hazard risk assessments have been conducted in Brunei by various individual agencies such as the Town and Country Planning and the Public Works Department. These assessments are part of their core responsibility to upgrade the country's infrastructure, and are the basis upon which disaster reduction actions and policy are made. But national level multi-hazard and multiagency risk assessments that encompasses all relevant risks to the population have not been undertaken. This means that no existing studies, reports, or atlases exist on multi-hazard risk assessment in Brunei and in ASEAN (Brunei Darussalam Government 2011b). Integrated disaster risk reduction is therefore not fully implemented across policy and practice and among key stakeholders. Nonetheless various government agencies are involved in infrastructure development, as well as the upgrade and maintenance of storm drains, roads, and other disaster mitigation projects. The department-level projects are generally disconnected from one another, and have separate legislative, financial, and management mechanisms (Brunei Darussalam Government 2011b). National policy and the legal framework for disaster risk reduction exist with quasi-decentralized responsibilities and capacities. But institutional commitment is neither comprehensive nor substantial and DRR is inadequately included in development plans and strategies (Brunei Darussalam Government 2011b).

Inadequate reporting, lack of a sustainable solutions to disasters, and limited integration constitute the underlying motivation of the present study. It is within this context that the present study will attempt to uncover the reasons why 10 years after the adoption of the National Disaster Management Act and the implementation of numerous, costly engineering projects, vulnerability to floods and landslides remains high and on the rise in Brunei. This study therefore seeks to ascertain the dynamic patterns and drivers of vulnerability in Brunei, and to propose measures that could strengthen integration and reduce future vulnerabilities and disaster risks.

2 Study Framework

The present research is a case study-based descriptive and analytical approach applied to a compilation of published and digital material available on disasters and disaster management in Brunei Darussalam. The study focuses on a critical appraisal of Brunei's efforts to encourage DRR, and briefly introduces a vulnerability-centered disaster risk assessment framework established based on elements of the Pressure and Release (PAR) model (Wisner et al. 2004) and the Vulnerability and Adaptability Model (Preston and Stafford-Smith Preston 2009), with a psychological component adopted from Grothmann and Patt (2005). Finally, integrated frameworks are constructed and proposed as effective aids to improve disaster governance and effective mainstreaming of DRR into sustainable development plans.

3 A Vulnerability-Based Disaster Risk Assessment Model (VDRAM) Applied to Brunei Darussalam

Understanding hazard risk usually reveals exposures and sensitivities. Insight into actual vulnerability can only come from access to the internal configuration and dynamics of specific communities and groups at the local and national levels who are exposed to hazards. Efforts that focus on both the hazard and social vulnerability aspects of the disaster risk spectrum (referred to in this article as a deep vulnerability assessment) must be encouraged. To understand disaster risk in Brunei in terms of vulnerability analysis need to take account of the general background of existing hazard risks. To accomplish this goal, a vulnerability-focused approach is adopted. The proposed VDRAM seeks to assess the sensitivity and exposure of populations in Brunei to various interlocking pressures and hazards that culminate to induce disasters. It is largely modelled after the PAR model by Wisner et al., which is based on the premise that a disaster is the intersection of two opposing forces: processes generating vulnerability on one side, and the natural hazard event on the other. The concept of "release" represents the reduction of disaster risk or the release of pressure, due mainly to reduced vulnerability either via policies and practices aimed at reducing disaster risk or enhancing coping capacity (Wisner et al. 2004). The Vulnerability assessment model presented in the present study retains the five original compartments in the generic PAR Model. The model views vulnerability as proceeding in three stages—root causes, dynamic pressures, and unsafe conditions—that reflect the sensitivity and exposure of the entire system at risk. For a disaster to occur, the root factors or background conditions, dynamic pressures, and unsafe conditions must coincide in space and time with an ongoing hazardous condition such as flooding, landslide, forest fires, or haze. The VDRAM also incorporates an element of adaptive or coping capacity proposed by Smit and Wandel (2006) that provides an easy way to ascertain vulnerability to different risk factors such that adaptive and mitigation strategies can easily be defined and applied (Preston and Stafford-Smith 2009) to the underlying pressures or drivers

of high vulnerability. A psychological component proposed by Grothmann and Patt (2005) that encompasses steps to taking action in response to risk perception and perceived adaptive capacity has also been incorporated in the "adaptive and coping capacity" component of the present model. The specific items in each component are adapted specifically to the case of Brunei Darussalam, making this a novel area-specific vulnerability model (Fig. 2).

3.1 Model Description

This model proposes a simple tool that shows how disasters occur when natural hazards coincide with socially and economically vulnerable components of a society. In the context of Brunei, the 'root causes' of vulnerability that give rise to dynamic pressures are separated into national level and local/community level factors, which are intertwined with the dynamic pressures and unsafe conditions.

3.1.1 National Level "Root Causes" of Vulnerability

The centralized top-down political system that creates inertia at the lower levels of governance, the economic dependence on the oil and gas sector, excessive dependence on immigrant labor, increasing urbanization and high rates of deforestation in the most populated Brunei-Muara and Tutong Districts are perceived in this article as major factors contributing to national vulnerability to disasters.

Limited reporting of disasters in Brunei to international databases constitutes yet another major national cause of vulnerability. According to JICA (2015), the need to map the distribution of major transport infrastructure and industrial parks relative to the distribution of major natural hazards (disaster risk/vulnerability maps) for international investment purposes has not been undertaken and has even been deemed irrelevant. This indifference is mainly due to the erroneous assumption that natural hazards risk is low,

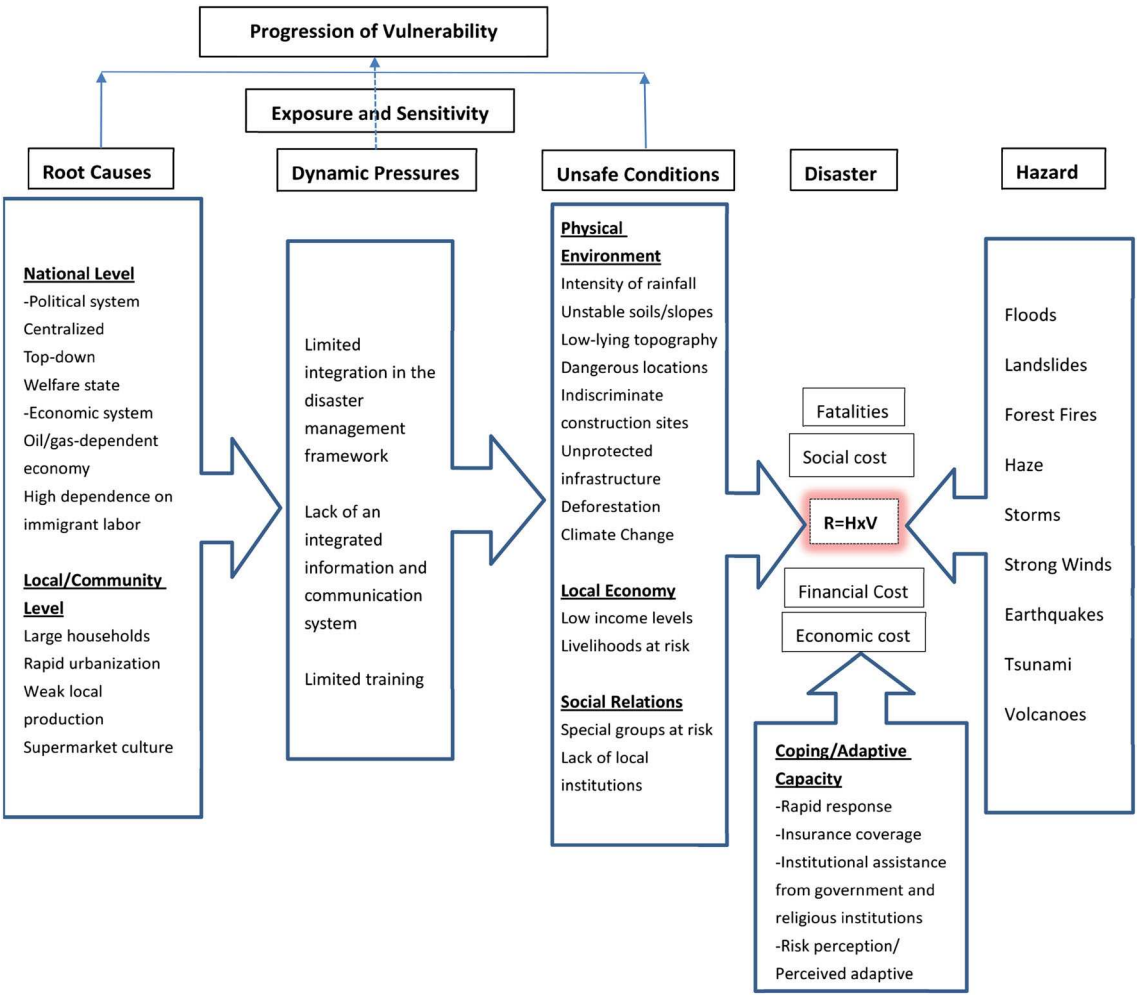

Fig. 2 Vulnerability-based disaster risk assessment framework for Brunei: modeled after the Pressure and Release (PAR) Model. *Source* The author

as well as the limited information on disasters in Brunei. The issue of limited reporting also constitutes a major driver of economic vulnerability to disasters in Brunei. According to the JICA report, among corporations in Brunei, risk management for natural hazard-induced disasters is regarded as less important than other corporate risks due to the expected low frequency and impact of these disasters. As a consequence, governmental and enterprise circles assume that risk to the economy and businesses from disaster damage is quite low. There is limited interest in the development of business continuity plans (BCP) by industrial and commercial establishments (JICA 2015). Overall, Brunei's economic and productive-sector policies and plans have not been adequately implemented to reduce the vulnerability of economic activities (Brunei Darussalam Government 2011b). The government is said to be making efforts to implement a national strategy to reduce economic vulnerability, including the development of a national BCP, as well as other stipulations in its long-term national plan referred to as Wawasan 2035 (Brunei Darussalam Government 2011b).

Limited integration in regional disaster management system causes further vulnerability. Brunei Darussalam is generally praised for its efforts to foster regional integration of disaster issues in ASEAN. The country actively participates in dealing with the region's trans-boundary haze issues as well as addresses health issues by developing a pandemic preparedness and response system such as the Influenza-like Surveillance System operated by the Ministry of Health (MOH). This system gives warning of emerging threats from novel strains of viruses such as Influenza A (H1N1) and (H5N1), which increases the nation's capacity to prepare the community for prevalent haze and infectious diseases hazards (Brunei Darussalam Government 2011b). But the country's disaster management system is very simplistic and inadequately integrated. Vital stakeholders are either left out or are not sufficiently consulted in the disaster management process or framework. There appears to be a strong mismatch between the urban management and the civil engineering services and the country's environmental/climatic realities. Research institutions in academia as well as the national media appear to be only loosely affiliated with the disaster management framework—they are consulted from time to time, but are not key actors. Regular weather reports are an integral part of news reporting, but media outlets only go abuzz with disaster-related information during the onset of a major natural hazard event. Based on these dynamics, disaster management needs exceed the capabilities of Brunei's Civil Engineering Department and National Disaster Management Council, or any other single institution/agency, individually, or even in their current loosely integrated and poorly coordinated way. Moreover, DRR has not been incorporated into school curricula (Brunei Darussalam 2011b Government) and thus does not constitute a systematic strategic effort compared with disaster response mechanisms in place in Brunei.

Brunei's disaster information reported to regional and global disaster databases is very limited and scanty. Both a disaster information sharing system and disaster database are currently nonexistent, although the need to establish a systematic data-sharing procedure among relevant stakeholders has been recognized (Brunei Darussalam Government 2011b).

3.1.2 The "Local Level" Root Causes of Vulnerability

Natural hazards in Brunei only constitute disasters when specific factors have induced pressures that render human lives, livelihoods, and economic and social stability vulnerable to these hazardous events. Some community level factors in Brunei that drive high vulnerability to hazards and increase disaster risk include low income levels and the site selection process for government housing schemes (GHS) as stipulated by the country's Land Use Master Plan. GHS is a Government effort to provide accommodation to low income and unemployed persons. The GHS site selection process has resulted in agglomerations of homes around the country, which are expanding fast as the population grows. The low level of disaster risk awareness and the failure to employ hazard risk assessment maps and data to guide site selection prior to construction mean that GHS communities are most exposed, vulnerable, and at greater risk from disasters. Because there is no provision of safe land for low income households and communities (Brunei Darussalam Government 2011b), these settlements are simply contented with what is handed to them by the government with no ability to decide for themselves. Most groups benefitting from the GHS are generally involved in marginal livelihoods in petty-trading of food and vegetables from stalls in their compounds. Floods not only destroy property in such communities, but also seriously disrupt their limited livelihood activities. Wisner et al. (2004) demonstrate that it is such social groups with little economic or political power that are most at risk during times of disaster. In Brunei, numerous public infrastructure such as roads, schools, power stations, and businesses are often inundated by flood waters, which affects people in large areas of the urban landscape irrespective of social class or nationality (Fig. 3).

Other important factors considered as important causes of high vulnerability include: (1) limited disaster risk awareness; (2) low literacy rate among low income communities; (3) the large size and composition of most households, which are composed predominantly of the very young, youthful, and aged people; (4) rapid urbanization

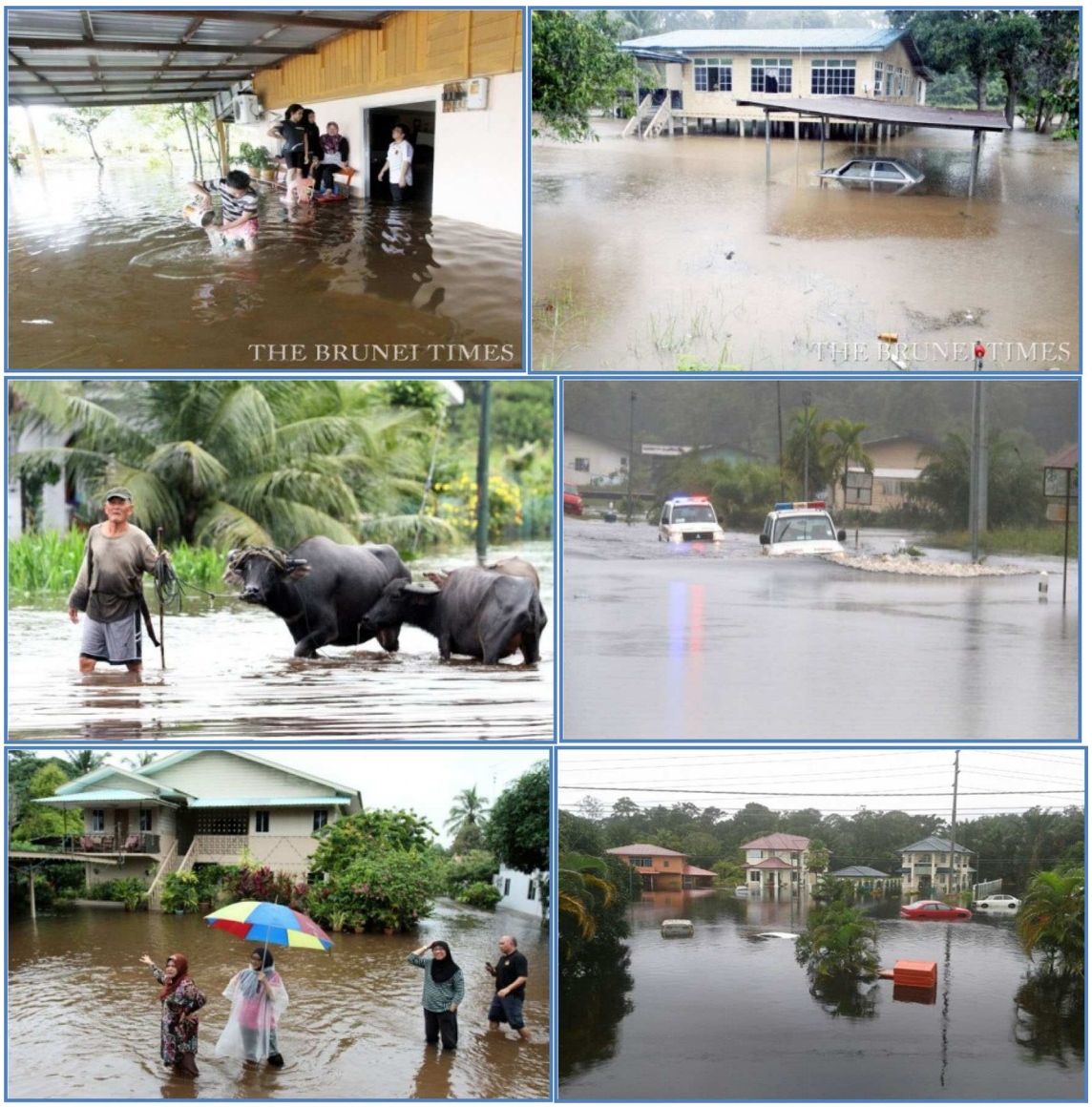

Fig. 3 Some cases of flooding in Brunei, January 2014. *Source* Courtesy of the Brunei Times (23 January 2014, http://www.bt.com.bn/frontpage-newsnational/2014/01/23/floods-and44landslides; 20 January 2011, http://ireport.cnn.com/docs/DOC542736). Accessed in March 2014

with about 97% of the population living in urban areas; (5) weak local food production and a supermarket culture (most people rely on immigrant laborers for most basic activities in areas of farming and fisheries); and (6) over-reliance on government assistance.

3.1.3 Unsafe Conditions

Geographically, because of its low-lying coastal location, Brunei suffers the adverse effects of coastal flooding due to the sea level[1] rise or large scale coastal flooding induced by a tsunami. Neither of these possibilities is adequately recognized and incorporated into the disaster management framework through careful risk assessment and planning.

The Negara Brunei Darussalam Master Plan (NBD Master Plan) 1987–2005 and the National Land Use Master Plan (2006–2025) stipulate the protection of forests, natural resources, and environmentally sensitive areas through land use zoning (MIPR 2008). But effective implementation that reduces the impact of hazards has been negligible, especially in the more urbanized parts of the country. The JICA report of 2015 mentions that there are no items dealing land use or urban development in times of disaster, restoration, and/or reconstruction in any of the relevant government Acts, and there is insufficient information about existing regulations for riverine zones or building

[1] http://www.GlobalFloodMap.org. Accessed in March 2015.

standards. Consequently, the rate of deforestation is on the rise especially in the rapidly urbanizing Brunei-Muara and Tutong Districts (Ndah et al. 2016).

On the hazard side, recent increase in intensity, frequency, and unpredictability of anomalous rainfall events linked to monsoon climatic changes along with other natural and human-induced hazards have generally been understood to induce hazardous floods and landslides; and extreme dry conditions also may be related to the change in monsoon intensity favor forest fires and haze in Brunei.

Although changes in monsoon conditions could be effectively described as driven by climate change, there is a general perception in the country and in related literature that global warming is the main culprit in unusual weather events and thus the cause of frequent floods and landslides (Shams and Juani Shams 2015). This perception only serves to reinforce the lack of understanding of social vulnerability by assigning causation to factors outside local control. This mindset is erroneous for the following reasons:

1. It diminishes incentives to undertake research and provide scientific explanations to specific meteorological phenomena at different spatial and temporal scales;
2. Since the most conspicuous characteristic of weather and climate is its variability, dismissing every anomalous meteorological phenomenon as global warming may undermine understanding of specific processes and interactions at the ocean–atmosphere interface, which may be at the origin of such phenomena;
3. Management of meteorologically-induced disaster based on the perception that seasonal monsoonal climatic conditions are generally stable limits the ability to detect short-term changes and anomalies, which are generally subtle until their impacts become suddenly apparent in forms such as flash floods and landslides (Ndah et al. 2016);
4. Numerous recent studies have recognized that separating climate change from the wider context of disaster risk is counterproductive, since climate change is just one contributor to disaster risk among many and is not necessarily the most prominent or fundamental contributor (Kelman et al. 2015). We maintain that climate change ought to be a subset within disaster risk reduction, and disaster risk reduction should be integrated within development and sustainability (Kelman et al. 2015). The need for such integration was recently espoused by Bendito and Barrios (2016), who criticized fragmentation in global-level agreements—disaster risk reduction (DRR), human development, climate change adaptation (CCA)—aimed at dealing with cross-cutting issues. Bendito and Barrios argue that by developing these agreements within independent communities of practice, their effectiveness is undermined because of limited cross-fertilization. To overcome these limitations, the present study proposes a trans-disciplinary, multi-stakeholder strategy that effectively integrates disciplines, approaches, and knowledge systems to generate more sustainable and cost-effective outcomes. Although there are investments in drainage infrastructure in flood prone areas designed to reduce flood disaster risk in vulnerable urban settlements, much needs to be done with regards to slope stabilization in landslide prone areas and with the training of masons on safe construction technology (Brunei Darussalam Government 2011b). Shallow urban storm water drains, canalization of streams and rivers in the city center, and inadequate research on slope stability and soil water retention characteristics prior to construction and real estate development play a major role in floods and landslides.

3.1.4 Coping/Adaptive Capacity

Vulnerability expresses the potential to suffer the consequences of a hazard and not necessarily to experience the actual suffering itself; Meze-Hausken (2000) demonstrates that people in potentially hazardous circumstances or marginal regions can succeed in averting risks and coping with disaster events by developing a great variety of adaptation mechanisms. Because Brunei is an economically strong state with the second highest GDP per capita among the ASEAN countries after Singapore, the country possesses the financial resources necessary to cope with disasters at the national level. Disaster funds are allocated to three ministries, which are primarily available to NDMC for disaster prevention and response operations. But it is stipulated that for DRR activities such as Community-based Disaster Risk Management (CBDRM), special funds are available to NDMC with which to plan and carry out DRR activities such as public awareness programs via CBDRM. Such programs would not only reduce the physical impact of disasters but also could significantly boost coping capacity and recovery after a hazardous event. However, local awareness, which is the focus of CBDRM, is only partially achieved, and this information gap constitutes one of the drivers or causes of vulnerability. Therefore, the CBDRM program cannot presently remediate vulnerability or significantly reduce disaster risk. Although limited community participation and decentralization funds are available for focal organizations, preference still is given to response, mitigation and adaptation. No budget allocation is made for DRR at the local level, and only limited measures are undertaken to address

gender-based issues in recovery (Brunei Darussalam Government 2011b).

The most notable and effective aspect of disaster management in Brunei is the response mechanism put in place to minimize the impact of disasters and facilitate post-disaster recovery and coping. The government allocates huge funds for disaster recovery and flood mitigation schemes, offers financial and material assistance to affected families and communities for reconstruction, and subsidizes daily subsistence when necessary. Religious establishments such as mosques also play an active role by housing catering activities for disasters victims, which often include multiple households. Provision of this basic resource by government and religious institutions constitutes an important aspect that enhances coping capacity during disaster events. Over-reliance on the government can also undermine self-reliant capacity to cope and adapt, and can contribute to limited psychological preparation for disaster events and an erroneous perception of low disaster risk. Consequently, despite the high frequency of floods and landslides, communities and public authorities always appear baffled after every major flood or landslide disaster. Our vulnerability-centered approach to disaster risk assessment requires that individual causes of vulnerability be linked to and tailored for specific resolution or remediation. This specific attention to each specific hazard addresses on a one-to-one basis every vulnerability within each community that presents a potential risk of exposure. This is a more comprehensive approach to tackling disaster risk that ensures continuous assessments, provides more timely and actionable threat responses, and enables more effective long-term, cost effective remediation.

4 Discussion

As a direct consequence of the lack of disaster risk assessment and a focus on response and mitigation strategies, disaster management in Brunei is flawed in several major ways. Response to disaster events is driven by a hazard-centered approach to disaster perception and a reliance on short-term engineering solutions. The vulnerability-based model presented in this study reveals that both national and local level vulnerability-inducing factors, coupled with unsafe conditions, contribute to the development of dynamic pressures that result in the high vulnerability of the general population to different hazard events. Since the current practice in Brunei is to provide post-disaster financial support and relief goods in order to assist disaster victims and facilitate the recovery of affected communities, the population is therefore not sufficiently motivated to engage in self-reliant practices, which limits their capacity to cope. Under such circumstances, should a hazard of greater magnitude than currently experienced occur, its effects could be grievous socially and economically. Consequently, the 2014 and 2016 WorldRiskIndex positions Brunei Darussalam at the 12th and 7th most at-risk countries in the World (Bündnis Entwicklung Hilft and UNU-EHS 2014, 2016). Although Lassa and Sembiring (2017) question the accuracy of Brunei's position within the top 15 most-at-risk countries, their doubt may be driven by the general misunderstanding of the concepts: disaster risk, vulnerability, and hazard.

Although Brunei has been spared from the devastation caused by major natural hazards in the region, the state is surrounded by nations that have not been so lucky. The devastation brought by the Indian Ocean Tsunami of 2004 and the recent major typhoons that ravaged the Philippines are major warnings signs. The status of increasing disaster risk in Brunei is perceived here as the result of a poor diagnosis of the country's disaster condition, which has led to the prioritization of structural measures for flood loss reduction. Consequently, as observed by Wisner et al. (2004), although those with power are attempting to do something about hazards, they seem unable to make their work effective enough because of a failure to incorporate vulnerability and risk analysis into the political governance and national development planning.

This point was stressed in the Zero Draft of the post-2015 Framework for Disaster Reduction. This document called upon political leadership to prevent disaster risk creation and to reduce existing levels of disaster risk through economic, social, cultural, and environmental measures. A more people-centered approach that addresses exposure and vulnerability, and thus strengthens resilience, was the recommended vehicle by which to achieve those goals (Co-Chairs of the Preparatory Committee 2014; McClean 2014).

Our model thus provides a framework with which to perceive disasters from the perspective of social and economic vulnerability, as well as to elevate the importance given to natural hazard risk. The vulnerability-based approach has demonstrated a more valid contribution to DRR vis-à-vis the agent specific approach. A vulnerability-based perspective seems to incorporate the correct diagnosis of the disaster situation in Brunei because it highlights the deep-rooted processes that cause "multiple exposure" to multiple threats (Kelman et al. 2015), which lead to high vulnerability and increasing disaster risk. In its present form, the vulnerability model is simply qualitative and needs to include the quantitative component required for actually measuring vulnerability. Using a number of quantifiable indicators on which data may be collected, the model can be further refined and applied to measure vulnerability, beyond the economic and social cost

components currently being measured by international organizations.

According to Preston et al. (2011), assessment of vulnerability should be framed with respect to what values are assessed and the underlying determinants of vulnerability that are considered under the auspices of benefiting stakeholders in order to ultimately influence perceptions of the primary driving forces of vulnerability as well as preferences regarding management alternatives.

4.1 Proposed Integrated Frameworks for Mainstreaming DRR into the Governance Mechanism

Preston et al. (2011) proposed an integration of vulnerability determinants into a common map as a means of effectively assessing the underlying determinants of vulnerability. They also observe that presently, vulnerability assessment studies lack direct engagement with stakeholders and the field of vulnerability mapping remains an emergent and subjective practice associated with a number of methodological challenges. As a result, Brunei's capacity for disaster risk reduction and recovery as well as human security and social equity is not effectively integrated into national development plans and actions (Brunei Darussalam Government 2011b). Due to the lack of integration and limited coordination, the emergence of diverse policies, legislation, and strategies only serve to create an ineffective and inert public policy environment. As a result of these issues, disaster management in Brunei and across ASEAN and the world in general is presently not robust enough to handle the level of sophistication required to effectively incorporate vulnerability remediation efforts for DRR into national development plans. The sectoral approach/institutional fragmentation inherent in environmental disaster management is not unique to Brunei. In general it is a product of fragmented global educational systems and the disaggregation of science into smaller individual sub-disciplines undertaken by independent scholars, who publish their research findings in peer-reviewed journals. Equally culpable is the

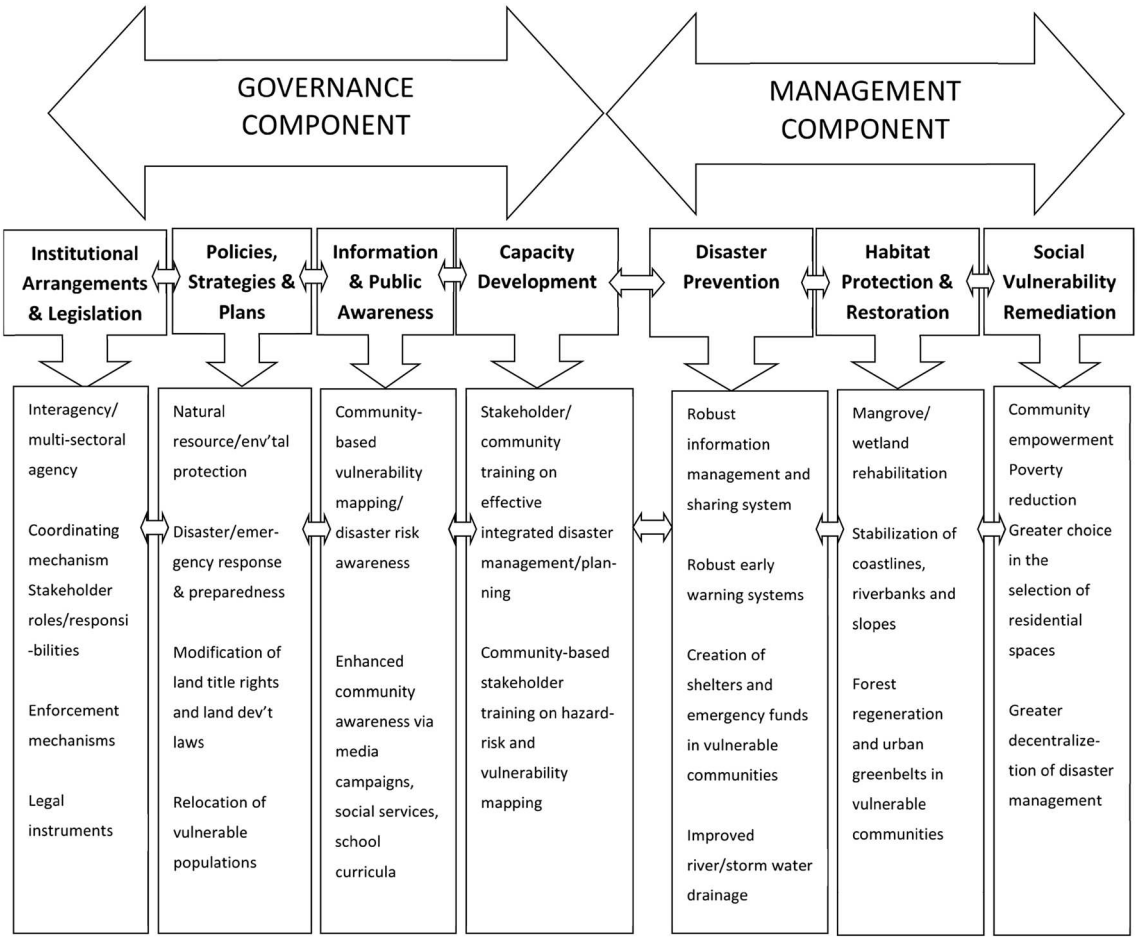

Fig. 4 Proposed integrated framework for disaster governance and management. *Source* The author

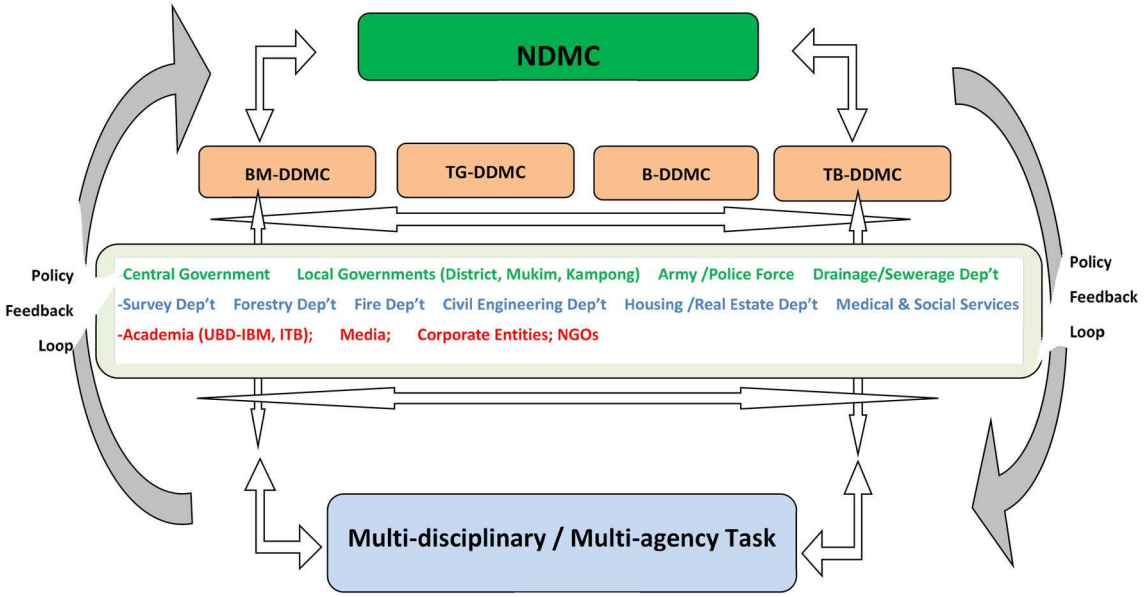

Fig. 5 Proposed integrated coordination setup for sustainable disaster governance. The disaster management councils are abbreviated in the figure: NDMC (National Disaster Management Council); BM-DDMC (Brunei-Muara District Disaster Management Council); TG-DDMC (Tutong District Disaster Management Council); B-DDMC (Belait District Disaster Management Council); TB-DDMC (Temburong District Disaster Management Council); Mukims refer to sub-districts, Kampongs are villages; UBD-IBM refers to Universiti Brunei Darussalam IBM Centrer; ITB stands for Institute Teknologi Brunei Darussalam. *Source* The author

fragmentation of national governments into independent and often conflicting departments. In order to position DRR centrally in Brunei's development plan, the focus of disaster management must be the reduction of socioeconomic vulnerability. This could be facilitated by an effectively integrated disaster governance and management framework characterized by a shared information management system institutionalized in the national governance mechanism at all levels. We propose an integrated proactive disaster management framework for Brunei which if adopted could boost the country's capabilities in dealing with complex phenomena associated with hazards, risks, and vulnerability (Fig. 4).

This integrated framework, if embedded in Brunei's national development plan, will serve the overall need for effective disaster management and DRR. In addition to an effectively integrated disaster governance mechanism, disaster management should be multidisciplinary and must constitute a diverse and effectively integrated and coordinated array of stakeholders, including (but not limited to) climate scientists, meteorologist, physical oceanographers, disaster management councils (NDMC and DDMCs), the national media, urban community management and civil engineering departments, real estate developers, other relevant stakeholders in academia, social services, business and economic sectors, grass-root nongovernmental organizations (NGOs), and religious institutions (Fig. 5). This will facilitate the speed and ease with which information is disseminated within the management and governance structure as well as to the general public, and should create an informed and aware citizenry and policymakers.

Proactive engagement of stakeholders in disaster risk management is a requisite for reinforced resilience against disasters. According to Mojtahedi and Oo (2016), in a disaster management system, stakeholder attributes and the proactive and reactive approaches they employ constitute an important aspect for successful DRR. In addition, communication and data/information should be fluid and accessible at all levels, in both horizontal and vertical dimensions. Figure 6 presents a framework designed by Science Council of Japan (SCJ) for the Tokyo Conference on International Study for Disaster Risk Reduction and Resilience, aimed at revealing the intricate link between sustainable development and disaster risks. This model further reiterates the need for an integrated disaster governance mechanism and the need for mainstreaming DRR in national development plans, which could be adopted by Brunei and ASEAN.

By mainstreaming integrated frameworks for DRR in national governance mechanisms and development plans (RCC 2011), new approaches to mitigate vulnerabilities such as vulnerability shielding or remediation could be achieved automatically. This could provide more practical ways to deliver end-to-end vulnerability management (EMA 2010) rather than impracticalities that characterize the agent-specific or hazard-based approach, coupled with enhanced monitoring and enforcement capabilities.

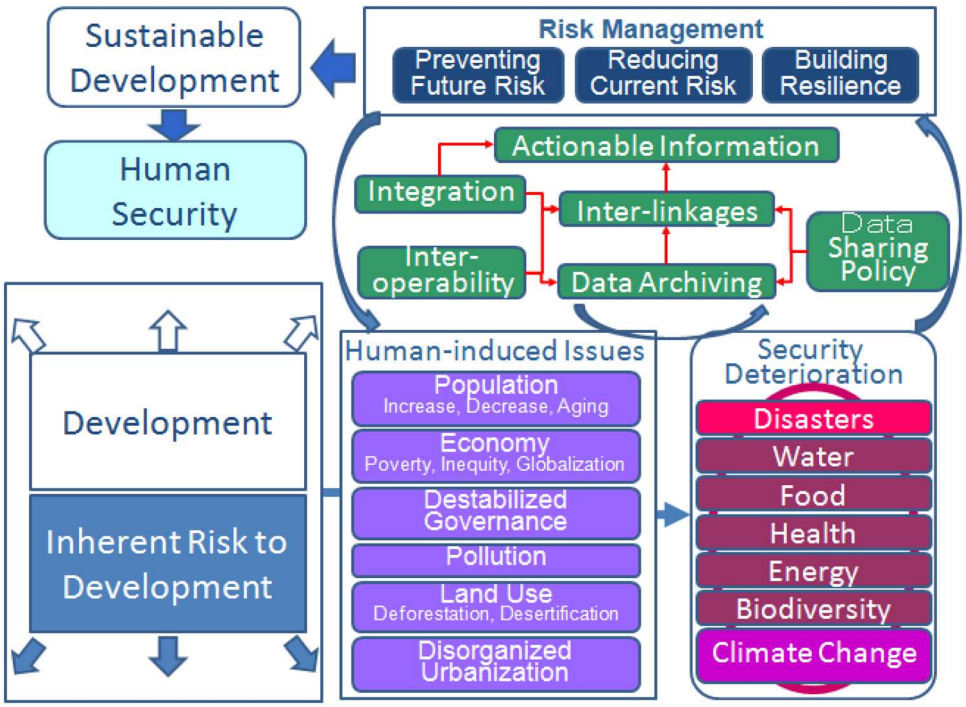

Fig. 6 General framework showing the ways in which disaster risk reduction could be mainstreamed into national governance and development planning produced by SCJ for the Conference on International Study for Disaster Risk Reduction and Resilience (2015)

5 Conclusion

Disasters are complex issues that have been oversimplified by hazard-specific management approaches. Dealing with issues characterized by multiple and not easily discernible triggers, coupled with high levels of variability and uncertainty, disaster policy and management must be guided by sound science and an effectively integrated coordination mechanism to accommodate the interaction and overlapping mechanisms involved. Investing in vulnerability remediation and reduction measures based on the results of disaster risk assessments is essential to enhance the economic, social, and cultural resilience of persons, communities, institutions and their assets, and the environment. Such measures are cost-effective and instrumental in saving lives, while at the same time preventing and reducing losses. An integrated framework will enhance science-management integration, which may facilitate the effective identification of the underlying causes (forcing mechanisms and triggers) of specific disasters so that prevention, reduction, and adaptation measures can be efficiently and effectively tailored to the causes of disasters (progression of vulnerability) rather than to the consequences or the agents (hazards) themselves. The present study reiterates the need for a statewide and multi-stakeholder effort in areas such as collection, analysis, and dissemination of data and information, advancement of research, and the development and sharing of scientific knowledge, as well as continuous monitoring and exchange of practices and learning. This is in agreement with the HFA and the Sendai Framework. Both agreements call for an integrated, multi-hazard approach to disaster risk reduction, factored into policies, planning, and programing related to sustainable development, relief, rehabilitation, and recovery activities. During disaster events in Brunei, mobilization of personnel and resources is fairly effective, coupled with the serious intent of the government to reduce disaster risk and boost recovery from disasters through investments in structural measures, financial contributions, and other forms of assistance. Yet disaster preparedness and vulnerability remediation efforts for DRR are sadly not top priority. This is because disaster management in Brunei is not robust enough and is inadequately integrated. Vital stakeholders are either left out or not sufficiently consulted in the disaster management loop. These issues are coupled with the limited reporting of disaster information to international disaster databases and the lack of a systematic information and data sharing and management system in the country. The proposed integrated disaster governance, management, and coordination frameworks have the potential to shift the focus of disaster policy and management in Brunei from overreliance on disaster response, to primarily encompass prediction, prevention, and mitigation. This would be a major contribution towards better planning and understanding of disaster risk in the country and would provide an opportunity to ensure coherence and alignment across policies, practices, and partnerships for effective implementation. This is in line with the Zero Draft of the post-2015 Hyogo and Sendai Frameworks for Disaster Reduction, which requires that to reduce disaster

risk by addressing existing challenges and preparing for future ones, there is a need to focus action on understanding risk and how it is created; strengthen governance mechanisms at all levels; invest in economic, social, cultural, and environmental resilience; and enhance preparedness, response, recovery, and reconstruction at all levels (Co-Chairs of the Preparatory Committee 2014). This follows an earlier call and reminder by UNISDR 2004 report that people everywhere, in villages and cities, male or female, rich or poor, and all walks of life, face the real threat of natural disasters at all times. It is therefore incumbent on all to work as partners, at all levels—local, national, regional, and global—towards disaster risk reduction (UNISDR 2004). DRR can, however, hardly be achieved unless vulnerability remediation is prioritized. The present study, by avoiding the conflation of the terms hazard and disaster, and the myopic perception of disaster management simply from the perspective of response measures, advocates for greater emphasis on risk and vulnerability. We propose effective institutional integration for DRR and management within and across all public, private, and community sectors. We believe that this is the best way to enhance effectiveness in reducing vulnerability to, and coping with floods, landslides, and other potential hazards that threaten lives, property, livelihoods, and the sustainable development across Brunei, from Belait to Temburong. Only in this comprehensive fashion is it possible to make a valuable contribution to the science and practice of disaster risk reduction. Studies that capture such spatial, social, political, and scientific frames associated with disasters as attempted here have a real chance to enhance understanding of disasters and develop sustainable socioeconomic systems even with the reality of ever-present hazards. The present study therefore recommends that:

1. Risk assessment in Brunei should be based on understanding vulnerability rather than on agent-specific factors that pose the risk. Indicators need to be developed and data collected for quantitative assessment of social vulnerability in Brunei;
2. Effective disaster management strategies must be based on the reduction of everyday or chronic risk factors and on the reduction of risk associated with non-extreme events, as opposed to strategies based solely on extreme events;
3. Response measures should be based on mechanisms that reduce overall vulnerability to disaster risk on a day-by-day basis rather than continued reliance on response and recovery options. An effectively integrated disaster governance and management system in Brunei should be one in which all stakeholders work together and share information with each other, in regular consultation with policymakers, and maintain as a guiding principle the reduction of social vulnerability and enhancement of DRR at all levels of society (Figs. 4, 5);
4. To be sustainable, these frameworks must be deeply entrenched in the governmental structure through enabling legislation. They will promote cooperation and sharing rather than competition among individual sectors and stakeholders, and will prevent conflicts of interest, for the sustainable development of the entire nation.
5. More importantly, incorporating proposed integrated disaster governance and management frameworks into Brunei's national governance will automatically ensure that disaster reduction targets are met, and that the monitoring and enforcement will be achieved with minimal effort. Ultimately, this should take disaster management beyond vulnerability remediation and DRR to actually driving sustainable development.

The overall benefits could enhance disaster preparedness and foster disaster risk reduction in Brunei Darussalam. Equipped with these policies, strategies, and practical tools, the NDMC can become a regional center of excellence for disaster management as well as advance its goal of building disaster-resilient communities.

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