Risk and Resilience in the Asia-Pacific Region: Managing the Expected, Preparing for the Unexpected

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Abstract Disaster risk reduction and resilience are gaining increasing attention globally as disasters affect more people and assets. The Asia-Pacific is one of the most important regions in the world, covering substantial amount of its landmass, number of people and share of economic activity. The region is, however, also the most disaster-prone region in the world. Consequently, disaster risk reduction and resilience building are of paramount importance to the region and, indeed the world. The idea of risk reduction and resilience building complementing each other is a result of evolving practice in particular in context of hazards and disaster management. In principle, such approaches are pragmatic and in the simplest of terms rely on the notion that *risk reduction* is a practice aimed at responding to the expected (based on the information gained from the observation of risk events that have taken place in the past), whilst *resilience* is primarily focused on the ability to survive the unexpected. There are, however, some notable differences between practice and theory in how the relationship between risk and resilience are perceived. This chapter aims at examining the current efforts in the Asia-Pacific to integrate risk reduction and resilience building measures into various policy frameworks, the disaster risk and black swans landscape in the region and to evaluate these in the context of theories of uncertainty, risk and resilience.

Keywords Black swans • Resilience • Disaster risk reduction

1 Introduction

Disaster risk reduction and resilience are gaining increasing attention globally as disasters affect more people and assets. For instance, between 2005 and 2014 disasters affected globally 1.7 billion people and caused USD$ 1.4 trillion in economic

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damages (Melkunaite 2016). The Asia-Pacific is the world's most disaster-prone region according to the United Nations (UN). According to the UN, the region suffered 1625 disasters between 2005 and 2014, 40% of the world total. Even worse, an estimated 1.4 billion people were affected by these disasters, 80% of the global total. In terms of the economic impact, on the other hand, it has been estimated that disasters in the region have caused more than half a trillion US dollars of economic damage over the past decade, nearly half of the global total. Due to population growth, urbanisation and rapid economic growth, the human and economic impact of disasters is expected to grow further.

The 2015 Asia-Pacific Disaster Report – "Disasters without borders: regional resilience for sustainable development" – compiled by the UN Economic and Social Commission for Asia (ESCAP) – argues that achieving sustainable development in the region is difficult without effective risk reduction and disaster resilience strategy implementation. Moreover, as majority of disasters in the region are cross-border in nature, the report calls for a regional approach to disaster risk reduction and resilience in the Asia-Pacific. The report also points out to the necessity of, on the one hand, integrating risk reduction into other policy frameworks and on the other, the necessity to shift focus from response to adaptation, mitigation and preparedness by enabling disaster resilience.

The focus on risk reduction and resilience building has indeed been heard in the Asia-Pacific and in fact, there are a number of disaster risk reduction and resilience building initiatives in the region. The multiple regional initiatives, albeit partially overlapping, are important for developing solidarity and actionable commitments towards advancing DRR in the region.

The practice of risk reduction largely derives from a notion that it is both possible and advantageous to attempt to reduce the exposure of vulnerable populations to risks observed based on past events by a variety of planning efforts. The idea of risk reduction and resilience building complementing each other is a result of evolving practice, in particular in context of hazards and disaster management. In principle, such approaches are pragmatic and in the simplest of terms, rely on the notion that *risk reduction* is a practice aimed at responding to the expected (based on the information gained from the observation of risk events that have taken place in the past), whilst *resilience* is primarily focused on the ability to survive the unexpected. There are, however, some notable differences between practice and theory in how the relationship between risk and resilience are perceived.

Consequently, whilst the practices and theories are supposed to complement each other and contribute to each other's development, there is a danger of science and practice not being optimally aligned and enriching each other. The problem exists in particular in regards to the appropriate balance between *risk reduction* and *resilience* building in the preparedness for disasters and the ongoing practices of learning from them in order to enhance the capabilities required to guard in particular vulnerable populations against *all hazards*. Reaching such an optimal balance, hence, requires a firm understanding of central concepts of *risk*, *uncertainty* and *resilience*.

This chapter aims at examining the current efforts in the Asia-Pacific to integrate risk reduction and resilience building measures into various policy frameworks, the disaster risk and black swans landscape in the region and to evaluate these in the context of theories of uncertainty, risk and resilience.

2 Asia-Pacific: The World's Economic Powerhouse, But Also the Home of Frequent Disasters and Potential Black Swans

The Asia-Pacific, stretching from Asia in the east, Oceania in the south and the Americas in the west, is widely considered as the world's most dynamic region. The Asia-Pacific not only covers approximately 52% of earth's surface and 59 of its total population (Jha and Brecht 2011), but it is also the powerhouse of the global economy, accounting for approximately 59% of the global GDP, 49% of world trade (APEC website) and the East Asia and the Pacific region accounts for approximately two-fifths of the global economic growth (World Bank 2017). The region is also the hub of many of the Global Value Chains (GVCs), in for instance the apparel and footwear, agro-food, electronics and automotive industries. In 2013, the region accounted for approximately 45% of the global GVC-related exports of final products (UNESCAP 2012). Moreover, small and medium size enterprises (SMEs) from the region are important suppliers of many critical components and are increasingly important providers of IT and other services. The Mekong river subregion, for instance, is a critical production base for the global automotive industry and the provinces around Bangkok in Thailand are critical hubs for the global electronics industry, in particular in relation to semiconductors and hard disk drives.

2.1 The World's Most Disaster-Prone Region

However, as indicated in the introduction to this chapter, the Asia-Pacific is also the world's most disaster-prone region, in terms of disaster frequency, number of people affected and economic impact. Indeed, the region accounts for roughly 70% of natural disasters in the world and between 1970 and 2014 accounted for approximately 56% of the disaster related fatalities (Melkunaite 2016). The main reasons for this lie in the geographical destiny of the region, climate change and demographics. First of all, the region is engulfed by the Pacific Ring of Fire, which accounts for 75% of world's volcanoes and 90% of the world's earthquakes (Jha and Brecht 2011). Consequently, the region is not only the most active region in terms of earthquakes, but it also has experienced many of the largest earthquakes in the world. Some of the most famous examples of such "mega-earthquakes" are the magnitude 7.3 Kobe earthquake (the Great Hanshin earthquake) of 1995, the magnitude 8.0 Sichuan earthquake in 2008 and the magnitude 9.0 Great East Japan Earthquake in

2011 (the Tōhoku earthquake). The 1995 Kobe earthquake caused the loss of life of 6434 persons, devastated immediately 150,000 buildings and caused economic damage equalling to 2.5% of Japan's GDP at the time, whilst the 2008 Sichuan earthquake killed 70,000 people, injured 374,000 and caused approximately $US 85 billion in damages (Jha and Brecht 2011). The Great East Japan Earthquake of 2011, on the other hand, was the most powerful earthquake ever recorded in Japan and caused a cascading disaster of unprecedented proportion when it created a massive tsunami, which in turn damaged the reactors of Fukushima Daiichi Nuclear Power Plant. The cascading disaster cost 16,000 lives, 100,000 residents had to be evacuated from impacted areas and the country suffered a total economic damage of USD$ 212 billion, making it the costliest natural disaster in world history (World Bank 2014). Besides the devastating local impact, however, the cascading effects of the 2011 disaster echoed well beyond the immediate area of the disaster and Japan as a whole, disrupting global supply chains across industries. For instance, Shin-Etsu Handotai, one of the world's leading producers of silicon wafers and ingots, that are used in the manufacturing of semiconductors, had its factory in Fukushima and the disruption of production there caused a 22% drop in the global supply of silicon wafers and ingots (Jha and Brecht 2011). The disaster also caused extensive disruptions in other electrical components and the automotive industry, causing cascading effects in those supply chains across Asia and indeed, the world (Asian Development Bank 2009).

In addition to being prone to earthquakes, the region is also vulnerable to other natural hazards, such as tropical typhoons, floods and drought. One of the major factors influencing climate patterns in the region is the *El Niño South Oscillation* (ENSO) phenomena, which causes irregular and periodical variation of sea surface temperatures and wind patterns over the eastern Pacific Ocean, which in turn influence temperature and precipitation variations. ENSO in fact has two distinct phases, of which *El Niño* is the warming and *La Niña* the cooling phase. The warming phase essentially refers to the warming of the ocean surface, which influences wind and rainfall patterns, direction and strength. During the warming phase rainfall tends to become reduced over Indonesia and increase over the eastern tropical Pacific Ocean. It also weakens the low-level surface winds from east to west along the equator, whilst in some cases changes the direction to the opposite. The cooling of the ocean surface, on the other hand, tends to increase rainfall over Indonesia and reduce it over the central tropical Pacific Ocean. It also has the tendency to strengthen the easterly winds along the equator. The two phases could thus, be used to predict seasonal weather pattern changes in advance. However, the timing, intensity and duration of the two phases vary and the element of surprises in regardless of the potential significant (L'Heureux 2014). Asia is also subject to circular monsoon seasons, which affect the level of precipitation and winds, but these are by default regular and thus, predictable.

Whilst ENSO and monsoon seasons are a natural phenomenon and thus, somewhat predictable in their occurrence, the unpredictability of extreme weather events seems to be nonetheless increasing, in particular in terms of flooding and tropical cyclones. The primary recent examples include the massive and extended flooding in Thailand in 2011 and the massive tropical storms in the Philippines in 2013. The 2011 floods in Thailand are a particularly pertinent example of the challenges for risk reduction and resilience strategies. Whilst flooding in Thailand is not unheard of in the monsoon season, the tropical storms in July 2011 started a catastrophic cycle that continued almost to the end of the year and produced extraordinary heavy rainfall in parts of the country. In particular the northern and central regions of Thailand suffered enormously, experiencing 40% above normal precipitation that caused the Chao Phraya Rivers system to flood downstream. Consequently, the flooding inundated parts of Bangkok and surrounding industrial areas, bringing the water levels up to three to five meters above normal, rendering flood barriers at river banks and the flood preparedness measures useless. The several months long floods not only caused over 800 deaths, enormous impact on the environment and approximately USD$ 46.5 million in damages, but also disrupted important industries and global supply chains, when manufacturing plants seven industrial parks with hundreds of factories in the Ayutthaya, Nonthaburi and Pathum Thani provinces in Bangkok's neighbourhood were inundated under the masses of water and had to close down.

The factory closures hit two industries particularly bad; the automotive and electronics industries. The electronics industry manufacturers were particularly severely hit. Besides causing a major blow to the companies and the local workforce, the global supply chains of semiconductors and hard disk drives were severely impacted when major manufacturers, such as Western Digital, Seagate Technology, Sony and Samsung Electronics, had to close production. Seagate and Western Digital, for instance, are two of the largest hard disk drives manufacturers in the world and the shortage of supply shock caused by the disruption of their production causes prices to double world-wide. Moreover, the recovery of the global hard disk drives market took over 2 years. Also the automotive industry was hit bad when major manufacturers such as Honda Motor, Toyota Motor and Nissan Thailand had to close down. Much like in the case of the electronics industry, the local disruption causes a global impact for the automotive supply chain.

3 The Increasing Number of Vulnerable Populations as a Future Challenge

Whilst the fact that the Asia-Pacific is especially prone to a variety of natural disasters, another major reason for this continuous tragedy is that the region is also the home of the largest and fastest growing number of vulnerable populations. For instance, East Asia is currently the home to four of the top ten most vulnerable cities in terms of populations exposed to natural disasters; Guangzhou, Shanghai, Ho Chi Minh City and Osaka-Kobe. When you add South Asia's two top ten cities – Mumbai and Kolkata – on the list, Asia accounts for 6 out of 10 most vulnerable urban populations in the world (World Bank 2014). Moreover, in East Asia the number of urban population is expected to double from 1994 to 2025, putting enormous strain on the environment, infrastructures and resources, even under normal circumstances (Melkunaite 2016). Perhaps more concerning, however, is that the fastest rates of urbanisation in Asia are in the earthquake and tropical cyclone vulnerable areas of China and Southeast Asia, risking the doubling of the number of people in large cities potentially exposed to such natural hazards (World Bank 2014). Between 1970 and 2010 the number of people exposed to flooding more than doubled from 29.5 to 63.8 million and the number of people living in areas vulnerable to tropical cyclones grew from 71.8 million to 120.7 million (UNESCAP 2012). Whilst the population growth in the region has peaked, the concentration of populations in vulnerable areas is a considerable challenge for the future and, places a great strain on risk reduction and resilience building measures. The likely total impact of these factors is that the frequency and impact of disasters is more likely to grow than become reduced. Given that the resulting loss of lives, livelihoods and assets in the region is not only a human tragedy on its own, but also represents potentially a significant diversion of funds and resources from economic and socio-economic development towards disaster relief and recovery, the call for risk reduction and resilience building has a strong base. As the global value and supply chains are vulnerable to cascading effects from localised disasters and Asia has major concentrations of critical production and services for them, risk and resilience building in Asia should be a global priority.

4 The Terror of the Unexpected: Compound Disasters and Black Swans

Yet another factor driving the increasing focus on resilience is the inherent unpredictability of disasters. Even though natural sciences have made leaps in understanding the root causes and dynamics of natural disasters, they, in particular earthquakes and tsunamis, are nonetheless hard to predict in terms of occurrence and severity. Such levels of uncertainty make effective preparedness very difficult, regardless of the competences and resources available. The Great East Japan Earthquake is a demonstrative example of this. Japan, an advanced and prosperous nation, was in fact well prepared for earthquakes, as well as tsunamis, prior to the disaster. However, a magnitude 9.0 earthquake was deemed so improbable on basis of historical data that magnitude 8.0 was used as the worst-case scenario for planning. In a similar manner, cities along the coastlines had constructed breakwaters to fend off the impacts of possible tsunamis, but against waves up to 8 meters high. Both worst-case estimates proved to be underestimates. There was, however, nothing wrong with the estimates in the context of well accepted risk management principles. The estimates should have been adequate, taking into consideration data from past experiences. Moreover, there rarely are rewards available for planners that use once-in-a-thousand-years events as basis for their planning assumptions. Moreover, if the occurrence and impact of one individual event are hard to predict, predicting potential cascading effects from multiple events is practically impossible. This problem of "compound disasters" – multiple sequential disaster events that cause more catastrophic impact than any single individual disaster – was embodied in the 2011 Great East Japan Earthquake (Kawata 2011). One can prepare for an earthquake, a tsunami and a nuclear plant accident, but preparing for multiple events with no advanced knowledge of the potential causalities is not within the parameters of our capabilities. Furthermore, individual events may gain differing importance in different contexts, or cause cascading impacts that are more critical than the initial event. Hence, a potential event could be deemed as not catastrophic on its own merits, but may prove to cause a catastrophic event when combined with other coinciding events, whether these are related or not (Melkunaite 2016). The increased occurrence of such disasters and the concentration of vulnerable populations due to urbanisation would seriously challenge any measures taken for risk reduction, but also strengthens the call for resilience building as a complementary strategy.

Finally, a triggering event might not originate in the region, but nonetheless have catastrophic cascading impacts in the region. One example of such a possibility was the Eyjafjallajökull volcanic eruption in 2010, which despite its notable remoteness from the Asia-Pacific, nonetheless caused cascading effects there. For instance, 5 days after the eruption Nissan Motor had to shut down three auto assembly lines in Japan due to the inability to acquire the required tire-pressure sensors from Ireland, as flights in Europe were grounded on basis of safety concerns (Jha and Brecht 2011).

The idea of compound disasters and the problem dealing with them highlights the problem of high impact – low probability events, as proposed by Nassim Nicholas Taleb in the context of his black swan event theory (discussed in more depth in the theory section of this chapter). Albeit by default extremely rare, such events pose a significant challenge to disaster risk management. Not only are such event hard to value with any reasonable accuracy in terms of probability and impact, but there are few convincing policy arguments towards directing or reserving adequate resources to deal with them. Moreover, even if resources could be secured, it would be extremely difficult to distribute their use in an optimal manner due to the inherent complexity of such events. Whereas events fitting in the framework of the" normal accidents" theory, root-causes and dynamics of disaster events can be at least to a degree predicted through historical experiences, those of "black swan" events are simply not known. Consequently, such considerations would appear to support the use of strategies that focus on reducing risk exposure (as reducing the probability and impact are not an available option), whilst simultaneously building resilience capabilities to survive such extreme events and improve the society's resilience against any and all disaster events, regardless of their root-cause, origin or dynamics.

Some past examples from the region that could be categorised as black swans were for instance the 1997 financial crisis, SARS, bird flu and the 2004 Boxing Day tsunami that caused 350,000 deaths. Whilst predicting and naming potential "black swan" events goes against the very essence of the concept, one can speculate on the relevant categories, as well as the potential sources of such events. In terms of the relevant categories, a black swan that would have a serious impact on the region would most likely fall either into the category of a political, economic, social, environmental, technological or space originated event. One potential source for a black swan could be a compound result of the tensions created by the rising economic protectionism, leading potentially to trade wars, and when combined with a random triggering event (such as a North Korean missile test gone bad, or an accident between naval vessels in the South China Sea), could further escalate into a full blown geopolitical crisis (major war, or even nuclear war) between major powers (such as the United States and China). Another potential is a large-scale pandemic that could not only kill millions, but also, depending on its nature could alter social, economic and political structures in countries and areas affected. Technological risks are equally hard to predict, but given the development of deepening dependency on the Internet in constantly broadening fields of life, the collapse of the global Internet would have devastating impact. Whilst the global Internet could be considered quite resilient due to its distributed structure, such an eventuality is not impossible, but could be caused by for instance a massive cyberattack. As demonstrated by the October 2016 Dyn cyberattack, such an eventuality cannot be ruled out. Also, whilst Asia has already experienced more than its fair share of natural disasters that could be categorised as black swans (e.g. the Great Eastern Japan Earthquake and the 2004 Boxing Day tsunami), a massive volcanic eruption, for instance in Krakatoa Indonesia would certainly qualify as one. After all, last time Krakatoa erupted in 1815, it caused global average temperatures to drop 5 degrees and crops failing worldwide. Should Krakatoa erupt again, the ash clouds could result in worldwide food shortages, that would be particularly catastrophic to the vulnerable populations in Asia. Finally, the possibility of massive solar geomagnetic storms could disrupt satellites, electricity grids and a variety of critical electronic devices and systems, causing a potential compounding disaster beyond current imagination.

5 Risk Reduction and Resilience Building in the Asia-Pacific

Considering the disaster proneness of the region, the increasing number of vulnerable population concentrations and the fear of compound disasters, it is hardly a surprise that disaster risk reduction and resilience building have gained growing attention in the regional agenda. Consequently, the region has no shortage of such initiatives. In fact, most of the regional cooperation organisations have DRR on their agendas, if not on their own regard, then at least in the framework of the international DRR cooperation, such as the Hyogo Framework for Action (HFA 2005–2015) in past, or currently the Sendai Framework for Disaster Risk (2015–2030). The United Nations (UN) Office for Disaster Risk Reduction (UNISDR) coordinates the implementation of the Sendai Framework for Disaster Risk Reduction in the region through its regional structure and country presence. The Sendai Framework is a voluntary programme that recognises that the primary responsibility for disaster risk is with the state, but with a proposition that the responsibility should be shared with the local governments, businesses and other relevant stakeholders. The Sendai Framework's goal is: *The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries* (UNISDR website). The primary platform for the action plan and regional cooperation in implementing the framework is the Asian Ministerial Conferences on Risk Reduction (AMCDRR). The AMCDRR was established in 2005 and is organised biennially jointly by the United Nations Office for Disaster Risk Reduction (UNISDR) and a rotating Asian host country. The AMCDRR is intended as serving the regional states as a forum for agreeing on shared responsibilities and actionable commitments for DRR in the region. Altogether seven AMCDRR conferences have been arranged since 2005, the latest being the 2016 conference in India, which adopted the 'Asian Regional Plan for Implementation of the Sendai Framework' (UNISDR 2016a). Another important UNISDR platform supporting the implementation of the Sendai Framework is the ISDR Asia Partnership (IAP) forum. The IAP forum is intended as the operational arm of the UNISDR regional platform and focuses on providing a regional mechanism for consultation and technical support for the implementation of the regional plan (UNISDR 2015).

Other international organisations that have DRR related initiatives concerning the region include a variety of United Nations (UN) agencies, international financial institutions and bilateral assistance organisations. The World Bank's East Asia and the Pacific Disaster Risk programme, for instance, provides DRR related support in the form of "lending, technical assistance, institutional strengthening and capacity building, and provision of knowledge in the form of best practice, on-demand analytics and just-in-time assistance" (World Bank 2017). The Asian Development Bank (ADB), on the other hand, links DRR with climate change adaptation (CCA) in the context of its flagship DRR project the *Regional Partnerships for Climate Change Adaptation and Disaster Preparedness*. The focus of ADB is to provide tools and methodologies to integrate DRR and CCA approaches in the region (ADB 2013). The ADB also runs a fund supporting such initiatives. The Integrated Disaster Risk Management (IDRM) Fund was established by ADB in 2013 and is supported by the Government of Canada (ADB website).

The Asia-Pacific Economic Cooperation (APEC) Disaster Reduction Framework, on the other hand, is a call for action to the APEC member countries to strengthen DRR in all policy areas. It focuses on risk reduction and disaster resilience in a variety of areas in order to secure sustainable economic development regardless of the frequent disasters in the region (APEC 2016).

In Southeast Asia, the Association of Southeast Asian Nations (ASEAN) created the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) in December 2009 in order to increase regional and national capabilities in disaster response through regional cooperation, coordination, technical assistance and resource mobilization. Moreover, the 2015 Declaration of Resilience envisions a disaster resilient ASEAN Community, whilst the ASEAN Vision 2025 on Disaster Management provides a strategic framework for the implementation of AADMER over the coming decade (ASEAN website).

Oceania is another important sub-region in the Asia-Pacific, both in terms of its disaster occurrence and vulnerability and the number of leading DRR initiatives. According to the World Bank's index the sub-region's exposure to natural disasters and its vulnerability to them tops the list; five out of ten of the registered natural disasters have indeed occurred in Oceania. Just during the past 20 years, Oceania has experienced a total of 156 disasters, which have claimed over 2300 lives, affected another 4.3 million people and caused economic damage worth of USD$ 58 billion (UNISDR 2016b).

Australia, for example, is one of the world's most vulnerable countries to climate change related disasters, such as drought, flooding and bushfires. The recent examples of climate related natural disasters include the 2009 Black Saturday bushfires in Victoria, which killed 173 and injured 414, and the 2010–11 Queensland floods, which killed 38 people, impacted three quarters of the state and ravaged the agricultural industry. The concern is, however, much broader and the exposure to natural disasters is expected to multiply in the future. For instance, the cost of natural disasters in Australia exceeded AUD$ 9 billion in 2015 alone. However, according to estimates, without any mitigating actions, the total cost of natural disasters could amount to AUD$ 33 billion by year by 2050 (Slezak 2016). On the other hand, following a sharp focus on the topic, Australia is currently considered one of the world leaders in DRR and an important regional partner. DRR has indeed been on the top of the Australian government's agenda in the recent years. The government, for instance, released a National Strategy for Disaster Resilience in 2011. The strategy called for a shared responsibility of DRR between governments (Commonwealth, States and Territories), business and communities, and instigated the importance of improved understanding of risks and communicating information about them. The strategy aimed at reducing risks in built environments in Australia and improving national capabilities in disaster resilience by bringing together the various levels of government; State and Territory governments, local governments and the Commonwealth government. The strategy also had a strong emphasis on partnering between different stakeholder groups and empowering individuals and communities. The Australian government has also established important funding mechanisms for DRR. For instance, the National Emergency Management Projects (NEMP) program allocated AUD$ 3.7 million funding to 22 nationally significant projects in the 2015–2016 period. The Natural Disaster Resilience Program, on the other hand, includes AUD$ 26.1 million each year by the Commonwealth Government and matched by state and territory governments, in order to support disaster resilience in local communities across the country. The National Bushfire Mitigation Program, in its turn, includes funding worth AUD$ 15 million over 3 years (2014–2017) to support initiatives with an aim to reduce long-term bushfire risks and disaster resilience against them. In addition to the Commonwealth Government, the state governments also have developed DRR strategies, plans and assessments. For instance, the Queensland state government released the *Queensland Strategy for Disaster*

Resilience in 2014. In addition to natural disaster focused DRR, Australia has addressed the risks to critical infrastructures. For instance, the Australian Government Critical Infrastructure Resilience Strategy was released in 2015 with a strategic goal of improving the resilience of critical infrastructures against all hazards. The partnership between business and government in critical infrastructure resilience, on the other hand, has been a central strategic already for quite long. The Trusted Information Sharing Network (TISN) for Critical Infrastructure Resilience was established by the Australian Government in 2003 as the primary engagement mechanism for such cooperation. The TISN provides a secure environment for critical infrastructure owners and operators across eight sector groups to regularly share information and cooperate within and across sectors to address security and business continuity challenges (TISN 2015). The focus on critical infrastructure resilience is well founded, taking into considerations that the biggest economic costs of natural disasters are associated with critical infrastructure damage (Slezak 2016). However, research commissioned by the Australian Business Roundtable for Disaster Resilience and Safer Communities found that economic costs and social impacts of natural disasters are even more costly than tangible impacts (Slezak 2016).

New Zealand, with a relatively isolated location in the South Pacific Ocean and in the middle of the Pacific Ring of Fire, sitting on top of two tectonic plates, is particularly prone to multiple natural hazards, including (but not excluding); flooding, high wind storms, drought, cyclones, snow storms, earthquakes, volcanic eruptions, geothermal events, tsunamis and landslides (IFRC 2014). The most pertinent examples of recent major disasters are the two massive earthquakes in the Canterbury region in 2010 and 2011. The 2010 earthquake reached magnitude 7.1 and caused significant physical damage, but no casualties. The February 2011 earthquake, on the other hand, whilst weaker at magnitude 6.2 earthquake, had its epicentre in the built areas and caused massive damage in the city of Christchurch, killing 185 people and injuring thousands. Whilst the earthquakes were tragic, they also triggered reviews of legislation concerning risk and disaster management and the state of preparedness in the country. Consequently, the dramatic experiences of the earthquakes motivated New Zealand to establish a particularly sharp focus on DRR. The sharpened focus on DRR proved its utility when the magnitude 6.5 earthquake hit the south of Wellington in August 2013 and later in November 2016 a magnitude 7.8 stroke North Canterbury, causing also a tsunami 2 h later.

In addition to being particularly vulnerable to major earthquakes, being part of the Pacific Ring of Fire, New Zealand is also vulnerable to volcanic eruptions. Albeit the majority of volcanoes are either inactive or dormant, there are also many active volcanoes and relatively frequent eruptions. For instance, the Taupo Volcanic Zone consists of three frequently active volcanoes, of which the Mount Ruapehu is the largest, and two of the world's most productive calderas. The Auckland Volcanic Field, on the other hand, is an area of roughly 360 km^2 situated around the city of Auckland, consisting of 50 separate volcanoes. Whilst the individual volcanoes are unlikely to become active again, the field itself is young and quite possibly active.

Moreover, the potential locations of eruptions are much harder to predict than with individual volcanoes, as the field can erupt anywhere (www.info.geonet.org.nz).

Perhaps also because of its exposure to a wide variety of natural disaster risks, New Zealand is another world leader in DRR and important regional thought leader in the topic, particularly known for its progressive approach to DRR law and regulations and engaging local communities in disaster resilience. In terms of regional cooperation and assistance, New Zealand is a major player. The New Zealand Disaster Response Partnership (NZDRP), for example, offers immediate assistance following a disaster, in forms of for instance, provision of initial emergency supplies, such as water, food and shelter, other humanitarian assistance and the provision of technical expertise. According to the scheme, accredited NGOs may apply funding granted by the Minister for Foreign Affairs on basis of their merit (www.mfat.govt.nz). New Zealand has also pledged strong support for the Sendai Framework for Disaster Risk Reduction and is one of the most active framework partners in the region. New Zealand is also well regarded for DRR and organisational resilience research, local universities offering both Masters and PhD degrees in the topics.

The Pacific Islands have also experienced more than their fair share of natural disasters. The best known recent examples were the category 5 cyclone Pam in March 2015 and the category 5 tropical cyclone Winston in February 2016. The tropical cyclone Pam hit Vanuatu with wind speeds up to 320 km/h, killing at least 15 and leaving 70,000 homeless. Tropical cyclone Winston, on the other hand, was the most powerful storm that has ever hit Fiji, claiming 44 lives and causing economic impact equalling to 20% of Fiji's GDP. The efforts to improve DRR in the sub-region mainly take place in the framework provided by the UNISDR Pacific Platform, which comprises; Australia, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Nauru, New Zealand, Niue, Palau, Papua New Guinea, Samoa, Solomon Islands, Timor-Leste, Tonga, Tuvalu and Vanuatu (UNISDR website). The focus of DRR in the Pacific Platform is distinctively strong in its coupling between climate change and disaster risk due to the Pacific islands' particularly high exposure to the negative impacts of climate change, e.g. rising of sea levels tropical storms, flooding and drought.

Also non-governmental organisations have turned their focus to risk reduction and community resilience in their work for strengthening civil societies against disasters. For instance, the International Federation of Red Cross and Red Crescent Societies (IFRC) established the *Asia-Pacific Reference Centre on Disaster Risk Reduction and Community Resilience* in order to support its national committees in the region in such capabilities. In fact, non-governmental organisations play an increasingly important role in regional DRR. Another important example of such efforts is the Global Resilience Partnership, a joint initiative by the Rockefeller Foundation, U.S. Agency for International Development and the Swedish International Development Cooperation Agency (Sida) seeks to "to identify and scale locally driven, high-impact, innovative solutions that will build the resilience of hundreds of millions of people in the Sahel, Horn of Africa, and South and Southeast Asia (Rockefeller Foundation 2017). Moreover, the Asian Cities Climate

Change Resilience Network (ACCCRN), a partnership led by the Rockefeller Foundation, focuses on coupling climate change and resilience and supporting South and Southeast Asian cities in identifying their vulnerabilities to climate change impacts and building resilience against them. The core countries in its focus are Bangladesh, India, Indonesia, Thailand and Vietnam (ACCCRN 2017).

The multiple regional initiatives, albeit partially overlapping, are important for developing solidarity and actionable commitments towards advancing DRR in the region. What is critical, however, is to ensure that appropriate linkages are built between the different vertical levels of commitments from local, national, regional and international initiatives.

6 The Expected Versus the Unexpected: Theories of Risk, Uncertainty and Resilience

The idea of risk reduction and resilience building complementing each other is a result of evolving practice in particular in the context of hazards and disaster management. In principle, such approaches are pragmatic and in the simplest of terms rely on the notion that *risk reduction* is a practice aimed at responding to the expected (based on the information gained from the observation of risk events that have taken place in the past), whilst *resilience* is primarily focused on the ability to survive the unexpected. There are, however, some notable differences between practice and theory in how the relationship between risk and resilience are perceived (Melkunaite 2016). Whilst the practices and theories are supposed to complement each other and contribute to each other's development, there is a danger of science and practice not being optimally aligned and enriching each other. The problem exists in particular with regard to the appropriate balance between *risk reduction* and *resilience* building in the preparedness for disasters and the ongoing practices of learning from them in order to enhance the capabilities required to guard in particular vulnerable populations against *all hazards*. Reaching such an optimal balance, hence, requires a firm understanding of central concepts of *risk*, *uncertainty* and *resilience*.

7 The Practices and Theories of *Risk, Uncertainty* and *Resilience*

The practices of Disaster Risk Resilience are largely based on a collection of experiences gained through the past disaster events and the lessons learned from them, as well as from the conceptual and technical development of methods and best practices established with international organisations working in the region. The practice of risk reduction largely derives from a notion that it is both possible and advantageous to attempt to reduce the expose of vulnerable populations to risks observed based on past events by a variety of planning efforts. The idea of risk reduction in the context of DRR has thus a strong coupling with sustainable development and involves a collection of practices of community planning and development that improve the structural condition of the community to withstand and reduce the impact of disaster events, in particular natural disasters, but in principle also human-made risks.

Resilience, on the other hand, has in recent years become a ubiquitous term that features in continuously expanding selection of contexts, ranging from engineering, ecology and psychology to economics and business. The definitions of the concept of *resilience* vary depending on the point of view and field of science in question. The most common and colloquial use of the term *resilience,* however, derives from material sciences, in which the term is used towards engineering design, and in particular towards understanding the behaviour and properties of specific materials in relation to their purpose; for example in the design of structures, such as support beams and bridges (Martin-Breen and Anderies, 2011). Resilience in complex adaptive systems, on the other hand, such as the ecosystem and social systems, is understood as a combination of an ability to **resist**, **recover** from and **reorganize** in response to a shock or a crisis. The key to resilience is thus **adaptability**, which is enabled by the non-linear nature of relationship between constituent parts of the system. Consequently, the definition of 'normal' in complex adaptive systems adapts to match the new circumstances and focuses on the ability to maintain the core function/s of the system, even if the system structure may change, or even collapse in the process (*Ibid.)*.

The concept of *resilience* has emerged particularly strongly in the recent years as a critical element of DRR in the region. Perhaps the most commonly referred to definition of resilience in the context of DRR is that of the United Nations Office for Disaster Risk Reduction (UNISDR). UNISDR defines resilience as "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions (UNISDR 2017). According to UNISDR a resilient community is thus, one that has the ability to have the necessary resources and capabilities to organise itself both prior and during the disaster in a manner that minimised the impact to the community and recover from them (Melkunaite 2016). Other definitions by international organisations are somewhat more technical and emphasise a systems approach to resilience. The Asian Development Bank (ADB), for instance, defines *resilience* as follows: "the magnitude of a disturbance that a system can withstand without crossing a threshold into a new structure or dynamic" (ADB 2009). Such "human systems" approaches to resilience emphasise the systemic ability of communities to withstand or recover from stress, whether it is a result of natural disasters, environmental or climate change or economic, societal or political upheaval (Melkunaite 2016). The ADB, however, has also a more practical definition for resilience, stressing the adaptive capabilities of human systems and organisations for surviving crises; "the ability of countries, communities, businesses, and individual households to resist, absorb, recover from, and reorganize in response to natural hazard events, without jeopardizing their sustained socioeconomic advancement and development" (ADB). Such practice oriented definitions differ from more technical and theoretical definitions in a sense of stressing the adaptive capabilities of autonomous components of human systems, which then as a collective improve the system's ability to do the same. The coupling between the two approaches, however, may cause confusion in practitioners about the choices between top-down and bottom-up approaches and the merits of such alternative strategies. At least a partial reason for such divergence can be explained by the evolving understanding of resilience in DRR over the recent years. In particular over the recent years the thinking about resilience in DRR has been influenced by general trends in resilience in other fields, specifically in reference to the objectives of resilience and what they tell us about the fundamental nature of resilience a concept. In this context, the current literature has been dominated by a debate whether resilience should be thought of as primarily a process (or a strategy, approach) or rather as the desired outcome. Hence, resilience has been described both as the entity's ability to return to its predefined and pre-crisis state, which could be described as the "business as usual" or "*status quo*" state as quickly and efficiently as possible, as well as the entity's ability to absorb and adapt to shocks, so that the system continues to perform the same functions and provide the same services during the shock as under normal conditions, despite whether the system itself may have been altered as a result of the shock. The significance to vulnerable populations of the choice between the two can be significant, as the first could be seen as emphasising the ability to preserve the "normal" without any particular emphasis on the continuous development aspects at the cost of securing the continuity of the achieved minimum living conditions also after a disaster, whilst the second approach could be seen as emphasising the focus on the essential at the cost of the non-essential, but also the continuous development of the human system to improve (Melkunaite 2016). This suggests a value based choice, which has significant repercussions to the populations involved. Significantly, it also suggests that such a choice is essential in terms of coupling of risk reduction and resilience building in order to avoid situations where the two approaches that are meant as complimentary, do not proceed with expense of one another. After all, risk reduction primarily supports the first approach, whilst the sustainable development ideology would primarily support the latter understanding of resilience. As will be pointed out later on, this dilemma is directly connected to the understanding of resilience in DRR context is primarily deriving of its origins in ecology or the more recent emphasis on societal resilience.

Albeit the particular emphasis on resilience in the recent years and the increasing coupling between it and risk reduction as a holistic strategy of DRR are relatively recent, the concept of resilience in the context of DRR is not entirely new. The first was primarily influenced by the works of a Canadian ecologist Crawford Stanley Holling in the early 1970s, in particular by his article *Resilience and Stability of Ecological Systems* (1973), in which Holling emphasised the system's ability to adapt and improve cope with shocks in relation to a dynamic equilibrium, thus contrasting the systems stability and its ability to return to an equilibrium (*status quo*).

As opposed to the *status quo* approach, Holling argued that a resilient system may actually be inherently relatively unstable and fluctuate between different states of equilibrium. Such approach, whilst influential in the development of DRR from the 1970s onwards and more recently in the context of the Hyogo and Sendai Frameworks, it has also been strongly influenced by community and societal resilience approaches. The community resilience approach focuses on how communities as social systems react to crises, not so much in terms of how the physical infrastructures in the community can withstand and recover from them. Consequently, community resilience emphasises the adaptive and learning capabilities of communities to self-organise in the event of a crisis and maintain their critical functions and services despite a disaster (see for instance Boon et al. 2012; Cutter et al. 2008). Whilst the definitions for such resilience vary somewhat in the literature, researchers have put forward suggestions for what the elements of community resilience are. Cutter et al. (2008), for instance, refer to six elements of community resilience; ecological, social, economic, institutional, infrastructure, and community competence, whilst Bruneau et al.(2003) refer to four interrelated dimensions as elements of community resilience; technical, organisational, social and economic (leading to an acronym TOSE). Whilst community resilience approaches emphasise a "bounce back" aspect of resilience, it does not exclude transformative resilience entirely, as it acknowledges that returning to the pre-crisis equilibrium may not be possible, or even desirable, due to the changes in the community's environment. Due to the changes in the environment, it may be more prudent to adapt to the altered environment, rather than persistently aiming at "bouncing back" to the pre-crisis "normal" state (Melkunaite 2016).

Societal resilience approaches, on the other hand, focus on how human systems respond to and recover from external and internal shocks, regardless of whether they are natural or human-made in origin. Consequently, whilst it considers natural hazards, the scope can just as well be economic, societal and political upheaval, or in principle any endogenous or exogenous shock. Moreover, it does not limit itself to "bounce back" effects, but instead many accounts of societal resilience emphasise the transformative aspects of resilience, whether they are marginal or radical. Philippe Bourbeau (2013), for instance, refers to three types of (societal) resilience, each representing a different ontology: (1) **resilience as maintenance**, emphasizing utilizing the capability for adaptation towards the maintenance of the status quo, (2) **resilience as marginality**, aiming at keeping the changes produced by a crisis or shock as marginal in order to safeguard against changes to existing structures or policies and, (3) **resilience as renewal**, with an aim to transform, even potentially remodel, the existing structure and policies, relying on diversification between multiple structures and institutions acting as fullbacks (Bourbeau 2013). The maintenance, or *status quo*, type of resilience refers to the capability to return to the normal state as quickly and efficiently as possible, whilst preserving the system as closely as possible to its "normal state". This type of resilience would see the altering environment as a given state and focuses simply on guarding the society and its institutions and structures against it. The second type, on the other hand, would acknowledge the importance of adapting to the altering environment, but would seek to keep the changes in the societal structures and institutions as marginal as possible. The third, and most radical, type focuses on adaptive capabilities that allow for not only absorbing exogenous shocks, but the utilisation of multiple structures and institutions or policies in order to shape or alter them in a manner that minimises the negative impact to the society. Hence, whilst the two first types have preventive focus, the transformative approaches would involve a broader societal processes of change that stretch beyond the crises at hand. Such divergence in theoretical approaches to resilience, in particular between the robustness and continuity emphasising preventive strategies and those that emphasise more adaptive, or even transformative aspects, influence what objectives, resources and methods will be used for DRR. Whilst all these approaches have their merits, the choice between the different available emphasis has a particular importance for the coupling between risk reduction and resilience building; whilst preventive approaches to resilience are probably more compatible to risk reduction, they are also less complimentary. The closer resilience is to the preventive, *status quo* type of resilience, the more rewarded it becomes to question whether risk reduction and resilience building are in reality more synonyms to the one and same method or strategy, rather than two complimentary ones. The transformative approaches on the other hand, can work against the objectives of risk reduction and may in effect nullify some of the positive impacts of risk reduction. For example, if risk reduction includes urban planning measures that aim at reducing the risk in flooding exposed areas to critical infrastructure or function in order to maintain their functionality as close as possible to the normal state and, a transformative type of resilience building approach is chosen, a possibility exists that in more extreme disaster events these functions would be subject to moving, changing or even become abandoned altogether.

In order to avoid such potential contradictions, it is not only important to understand the theories of resilience, but also the theories of *risk* and *uncertainty*. For instance, the Bayes' theorem states that agents utilize probabilistic assessments about the likelihood of events based on observations on their past occurrence to understand their operational environment. Frank Knight (1921), on the other hand, distinguished the differences between "risk" and "uncertainty" in his seminal book *Risk, Uncertainty and Profit*, by arguing that whilst" risk" is observable and measurable, "uncertainty" operates in the limits of our knowledge, making assigning probabilities impossible. Risk is thus referring to situations where probability and impact of an undesirable event can be determined because the possible outcomes can be identified and the past frequency of their occurrence can be determined through observations of past events (Jarvis 2011). Uncertainty, on the other hand, suggests that possible outcomes are not known or decision-makers do not hold adequate knowledge or experience concerning the situation, or event at hand, to assign probabilities for the possible outcomes or to understand their possible impacts. This in turn leads to the inability to determine the appropriate response within the range of different courses of action. This problem was made famous by Nassim Nicholas Taleb, the author of the best-selling book -" The Black Swans", who used the metaphor of black swans to the propensity of trying to forecast hard to predict extreme events, i.e. low probability – extreme impact events, or assigning probabilities to rare events using scientific methods. Attempts to utilize scientific methods to measure such extreme outliers thus, creates false hope of prediction on events that are genuinely explainable only in the hindsight (Taleb 2007). Another, somewhat related, concept Is Charles Perrow's Normal Accidents Theory (NAT), which explores the social aspects of technological risk. NAT was largely motivated by the Three Mile Island nuclear power plant accident in 1979 and argues that in complex systems accidents are inevitable and "natural" consequence of complexity (Perrow 1984).

Consequently, ontological differences exist between the concepts of *risk* and *resilience* with significant consequences to the choice of available strategies, methods and practices in DRR. In general, risk management is exclusively a preventive approach and risk assessments are carried out in order to identify and quantify the negative impacts of potential events to the entity, measure its exposure to them and determine the appropriate mitigation measures to protect the entity against negative impact either by attempting to lower its exposure to the risk or lower the impacts of such events. The priorities of potential risks and hence, the scope and extent of mitigation measures are generally determined by the magnitude of individual risks, measured by their likelihood and impact. Whilst in principle exogenous risks cannot be terminated, the entity has the opportunity to determine whether to accept certain amount of risk left after mitigation efforts have been implemented (residual risk) or attempt to transfer it (principally to insurance). Resilience, on the other hand, can be generalised as an approach that emphasises the capability to absorb, adapt and/or recover from disaster events. Resilience can thus compliment risk reduction by providing the entity the capability to withstand, adapt to or recover from unforeseen risk events (uncertainty, black swans) that are not identified by risk assessments, or risk events of such magnitudes that required resources for their mitigation are simply not available, or events of such complexity that risk mitigation cannot capture adequately (compound disasters, NAT).

8 Conclusion

The Asia-Pacific is not only the world's most disaster prone region, but it is also of paramount importance to the world economy and the home of the largest number of vulnerable populations. Consequently, the development of Disaster Risk Resilience in the region should be a top global priority that will not only benefit the region, but potentially the entire world. The Asia-Pacific can also be a major testing ground for DRR practices and an important source of lessons learned for other regions.

Whilst risk reduction and resilience building are indeed generally complimentary, care should be exercised in terms of clarity of concept when devising holistic strategies for DRR. Such clarity in turn requires an advanced understanding of the theoretical concepts of risk, uncertainty and resilience, in particular in terms of the concept of *resilience.*

Resilience differentiates from the traditional risk-based approaches in a sense that it is based on the underlining notion that preventive strategies do not work under the conditions of extreme uncertainty due to the actors' inability to forecast and assess threats to a relevant extent. Consequently, the proponents of resilience would argue that preparedness towards unpredictable catastrophic events, the likes of the" Black Swans", requires an" all hazards" approach in preparedness and a strategy of survival, rather than mitigation. The underlining assumption behind this position is that since there can be no credible ability to prevent events from taking place, one should focus to manage their consequences towards survival and perhaps, renewal through learning. In an essence, one could argue that resilience is a" post risk" strategy (security after risk).

In sum, risk and resilience are a hot topic in the Asia-Pacific region with a number of institutions and policy frameworks increasingly focusing on the issue. The regional approaches, however, highlight the difference between risk management and resilience approaches; risk management (and reduction) is primarily focused on dealing with the expected, whilst resilience building is primarily focusing on capabilities required for dealing with the unexpected "Black Swans", (once in a thousand years events). Consequently, in theory, risk reduction would focus on frequent and seasonal events with fairly localised impact, whilst resilience building would address low probability – high impact risks, as well as to adapting to long-term risks, such as those brought about by global climate change and their wide-ranging cross-border implications. Likewise, the shift from reactive to proactive approach to disaster management would appear to make sense. There are, however, difficulties associated with determining the distinction between uncertainty and risk and consequently, the appropriate balance between risk reduction and resilience.

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