Technical Report

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Interconnected Disaster Risks
2020/2021

Floods in Central Viet Nam

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Table of Contents

1. Event

From the beginning of October to mid-November 2020, Central Viet Nam was hit by nine consecutive high magnitude storms and typhoons (DMPTC, 2021; UNICEF, 2020). Typhoon Linfa, Typhoon Nangka, a tropical depression in the East Sea (also called Storm Ofel in some event reports), Typhoon Saudel, Typhoon Molave, Super Typhoon Goni, Storm Astani, Typhoon Etau and Typhoon Vamco caused heavy rains, strong winds, storm surges, widespread flooding and, in some instances, deadly landslides across ten provinces in the central region[1] (DMPTC, 2021; van Tien and others, 2021a and 2021b; Office of United Nations Resident Coordinator, 2020c).

The nine storms and typhoons caused high waves and surges, together with high wind speeds and intense and continuous rainfall (Office of United Nations Resident Coordinator, 2020a, 2020b and 2020c). The continuous torrential rain left insufficient time for the water to infiltrate or drain, causing riverine floods, flash floods and in some areas also landslides (Office of United Nations Resident Coordinator, 2020c; IFRC, 2020b; VRC, 2020; World Bank, 2020). As this happened repeatedly in a short time frame of only seven weeks, new historic high levels were recorded in rivers including the Hieu (Quang Tri Province), Bo (Thuan Thien Hue Province), Gianh and Kien Giang (Quang Binh Province) in some affected areas (IFRC, 2021; World Bank, 2020).

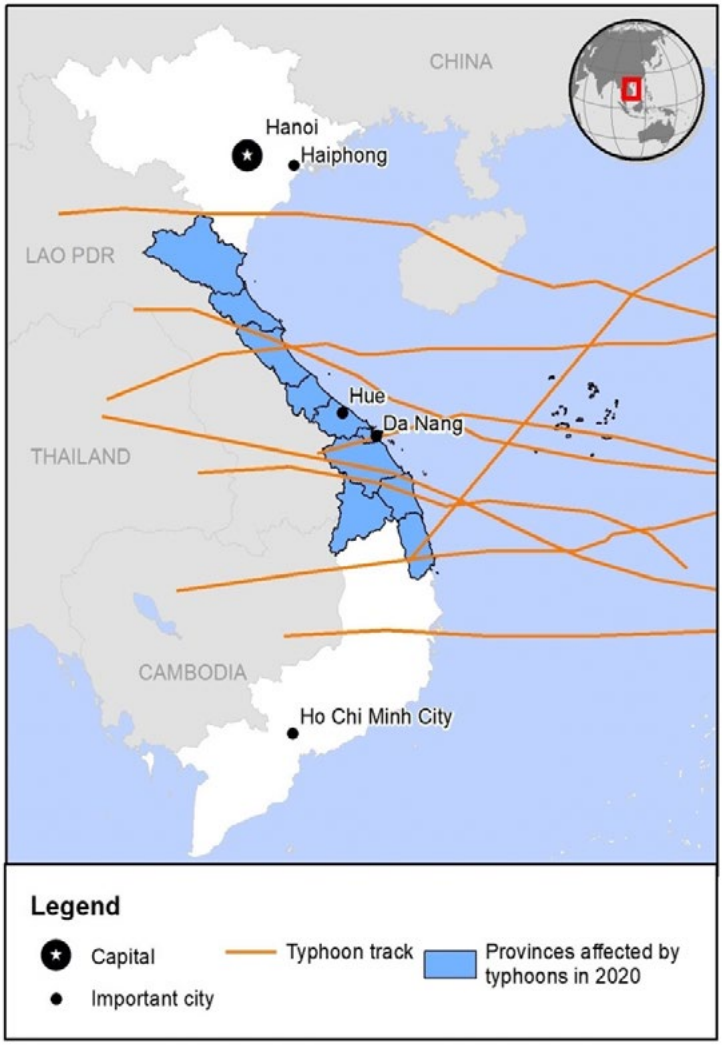


Figure 1: Typhoon tracks affecting VietNam in 2020

1 The provinces affected were Ha Tinh, Quang Binh, Quang Nam, Quang Ngai, Quang Tri, Thua Thien Hue, Da Nang, Nghe An, Binh Dinh and Kon Tum (UNICEF, 2020).

When different hazards that might not always be extreme events individually manifest or co-occur in the same space and time, they can exacerbate the impacts and event duration, extent and damage, resulting in a compound event requiring different types of and integrated responses (Zscheischler and others, 2018; Sadegh and others, 2018; Mehran and others, 2017). This happened in Central Viet Nam, as the series of storms, typhoons and consequent different floods co-occurred with the COVID-19 pandemic and the situation developed into a compound event.

2. Impact

Direct impacts

In the aftermath of the floods, there were 291 fatalities and 66 missing people; around 7.7 million people were affected, many of whom also suffered physical damage such as injuries or infections related to waterborne diseases (UNICEF, 2020; IFRC, 2020b; IFRC, 2020a). Crops and livestock were lost, which directly and indirectly affected the livelihoods of the affected communities and the availability of food commodities in the market (FAO, 2021). Overall, the Government reported around US$1.3 billion in damages (VDMA, 2020a). Losses in key economic sectors, such as tourism, agriculture, aquaculture and industry also impacted the incomes of people in those sectors (AHA CENTRE, 2020; FAO, 2021).

Figure 2: Houses destroyed and submerged in flood waters in Le Thuy District, Quang Binh Province, Central Viet Nam, SOURCE: UNICEF/Pham/AFP-Services

Not only did local communities suffer physical harm and economic losses, but they also suffered from the disruption of their basic services, such as electricity, communication, transport, roads, water, health, education and nutrition (IFRC, 2020b; UNICEF, 2020; Office of United Nations Resident Coordinator, 2020a).

The magnitude of the consecutive storms and typhoons challenged the capacity of the emergency response teams (United Nations News, 2020; Bruess, 2020; World Bank, 2020). The constant rains flooded evacuation centres and damaged roads, all of which disrupted the work of the response teams and the delivery of aid relief (Office of United Nations Resident Coordinator, 2020a; IFRC, 2020b; VDMA, 2020b). The situation was so critical that after the event, the Government of Viet Nam decided to introduce a new level of classification for heavy rain in its warning system (Thu Viên Pháp Luát, 2021).

As the floods co-occurred with the COVID-19 pandemic, the capacities of the Viet Nam Government were strained. Furthermore, disaster response teams from other countries were not allowed to go to the country to help with disaster response efforts (Bohane, 2020; Hutton, 2020).

Indirect impacts

Vulnerable households struggled with inflated prices of food as their purchasing power was reduced, forcing many of them to deplete their savings and/or employ eroding coping strategies such as reducing meals, resorting to less nutritious food and/or saving food for children (FAO, 2021). Although such coping strategies can help to withstand the immediate impacts of the disaster, they actually increase people's vulnerability to recurring floods in the long run (Opondo, 2013).

Emerging risks

The nine storms and typhoons and consequent floods also resulted in several emerging risks that may develop in the future from the disaster, or from similar disasters occurring again. The floods in Central Viet Nam resulted in a number of social and health problems among the affected population, which in turn could increase vulnerability (Lee and others, 2021; Thanh Thi Pham and others, 2020). Furthermore, floods inflict significant financial losses, exacerbating poverty and, consequently, increasing the propensity of people to suffer harm (Bangalore and others, 2019; World Bank & Asian Development Bank, 2020). Social inequalities may emerge or deepen as a consequence of the floods (Hudson and others, 2021; Lassailly-Jacob & Peyraut, 2016). According to the United Nations International Children's Fund (UNICEF) the loss of livelihoods resulting from the floods in Central Viet Nam could translate into an increased risk of child labour (UNICEF, 2020). Furthermore, the emotional stress and traumatic experiences that children face during the floods could hinder children's appropriate development (Randeniya, 2018; Thiel and others, 2021; Simcock and others, 2018; Spratt & Kennedy, 2021). Additionally, gender-based violence is believed to increase in times of crisis and should be closely monitored (Office of United Nations Resident Coordinator, 2020a; Parkinson, 2019). This is also important considering that women in Viet Nam are slightly more affected than men after floods and could take longer to recover from the flood impacts (Hudson and others, 2021). To limit social inequalities and avoid exacerbated future risk, women and children should get particular attention in disaster recovery efforts.

Floods can also result in a lack of clean drinking water and unsanitary environments (FAO, 2021; UNDRR & ADPC, 2020), and can have negative long-term impacts on people's health (Zhong and others, 2018) and wellbeing (Walker-Springett and others, 2017). They may additionally damage, and thereby reduce, the number of hospitals available (FAO, 2021; UNDRR & ADPC, 2020). Furthermore, floods can affect nutrition levels as people may reduce the number of meals they eat or else turn to less nutritious foods as a result of flood impacts, with negative consequences on their health and wellbeing (FAO, 2021; UNDRR & ADPC, 2020).

The flood damages and losses to the private sector, as well as to household incomes, could further exacerbate the poverty levels in the country, especially as they coincided with the economic hardships caused by the COVID-19 pandemic (World Bank, 2020). Furthermore, households that experience recurring flood damages and spend money for recovery are less likely to put money aside to prepare their houses for the next floods (Lampard, 2020). These continuous costs of coping with the impacts of floods means households keep falling short during flood events. Also, they are at risk of falling into a cycle of extreme poverty and entering into a 'vulnerability loop' (World Bank & Asian Development Bank, 2020; Casse and others, 2015; Lampard, 2020). Poor households are especially prone to falling into extreme poverty after floods, as they are more likely to depend on the surrounding ecosystem for subsistence and income generation (Bangalore and others, 2019; CFE-DM, 2018). Additionally, poor households likely have fewer savings, limited borrowing capacity and less diversified income sources (Bangalore and others, 2019; World Bank & Asian Development Bank, 2020; Casse and others, 2015; CFE-DM, 2018). With floods being the most frequent hazard affecting almost all the provinces in the country (UNDRR & ADPC, 2020), the impacts of floods on the economy need attention and consideration.

The increasing magnitude of hydrometeorological hazards due to human-induced global warming is another emerging risk that should be critically considered (Hoegh-Guldberg and others, 2018). Viet Nam will likely face an increase in the frequency and destructive power of very intense tropical typhoons (Kieu-Thi and others, 2016; Nguyen and others, 2017; Lap, 2019), and will also suffer from severe consequences of above-average sea level rise (Clark and others, 2016; Tran and others, 2016).

Despite seeming distant, these emerging risks are critical as they could undo the progress and advances made in the country in terms of development (Ohno, 2013; Ho & Ho, 2021). In recent years, Viet Nam has had high and stable growth, with its GDP steadily growing for the last 20 years (World Bank, 2021). Viet Nam has also made progress in achieving the United Nations Sustainable Development Goals (Nguyen and others, 2021; Baum & Dabla-Norris, 2020). Even despite the economic impacts of COVID-19, the country's economy grew 2.9 per cent in 2020, reaching one of the highest growth rates in the world, and in 2021 it is projected to grow 6.5 per cent (IMF, 2021). Yet, both economic and societal development are being put at risk by the recurring and increasing magnitude of hazards the country faces, and chief among them are floods: at the national level flood damage represents around 97 per cent of average annual loss from all hazards (World Bank & Asian Development Bank, 2020). Key economic sectors like aquaculture, tourism and agriculture that are fundamental for the development and prosperity of Viet Nam are in fact facing significant risks (Rentschler and others, 2020).

3. Drivers

La Niña

La Niña is the cold phase of the El Niño Southern Oscillation (ENSO) phenomenon (Su and others, 2018). It refers to a large-scale cooling of the surface of the ocean in the eastern and central Equatorial Pacific Ocean, coupled with changes in the tropical atmospheric circulation (WMO, 2020; Cai and others, 2015). La Niña affects the temperature, precipitation and storm patterns in many places around the world (WMO, 2020). The phenomenon usually increases rainfall patterns in the South-East Asia region, including Viet Nam (Cornhouse, 2020; WMO, 2020; Su and others, 2018). It is likely that the La Niña formation in 2020–2021 played a key role in the onset of the storms in Viet Nam, as October to November presented its most intense months (Cornhouse, 2020; Hau, 2020; ASMC, 2020). The 2020–2021 La Niña event was considered 'moderate/strong', while the previous event in 2011–2012 was 'moderate' (WMO, 2020). The scientific community usually needs some time until the role of La Niña as driver of an event can be scientifically confirmed. For instance, Chen and others published in 2020 a paper about the important role that La Niña played in the onset of four consecutive high-magnitude tropical cyclones over the coastal areas of eastern China in 2018 (Chen and others, 2020).

Ocean warming

Ocean heat changes are driven by both natural forces, such as changes in solar irradiance, and anthropogenic forces, mainly human-induced greenhouse gas emissions (GHG) (Charles & Meyssignac, 2020; Swart and others, 2018). However, since 1993 the rate of ocean warming has doubled due to human-induced GHG emissions (IPCC, 2019). Warmer oceans are accelerators for tropical cyclones, with rising sea surface temperatures linked to more intense, and therefore destructive, storm formations (Sun and others, 2017b; Murakami and others, 2017; Trenberth and others, 2018) directly affecting the coastal regions of Viet Nam (Trinh and others, 2021; Thanh and others, 2020a; Sun and others, 2017a). Ocean warming and the resulting increase in tropical storms therefore represent a driver of the devastating situation in Central Viet Nam. Furthermore, in some areas of the world, ocean heat can act as a booster of cyclonic activities during La Niña events (Bhowmick and others, 2019).

Economic and development activities causing ecosystem degradation, which in turn decrease hazard-regulation services

Many ecosystems can provide hazard-regulation services besides their economic and biodiversity values (Sutton-Grier & Sandifer, 2019; Ellison and others, 2017). In the context of storms, forests can protect communities from landslides and flash floods, block winds and surges, and prevent soil erosion (Hairiah and others, 2020; Linh & Long, 2020; Chang & Mori, 2021). Coastal ecosystems like mangroves and sand dunes provide coastal protection against storm surges, waves, small tsunamis, coastal flooding, coastal erosion and the impacts of sea level rise (Nehren and others, 2017). Wetlands help to regulate floods reducing the peak water surge (Joy & Paul, 2021). Coral reefs and seagrasses help also with the attenuation of the water flow, wave size and the prevention of coastal erosion (Roelvink and others, 2021; James and others, 2021).

Central Viet Nam has all the above-mentioned ecosystems and many more that are capable of buffering the impacts of hazards (Nehren and others, 2017; Dang and others, 2018; Tu and others, 2021b; Le Dung, 2020; Huu Nguyen and others, 2016; Tu and others, 2021a; Hoang and others, 2018; Ho and others, 2010). However, to ensure the delivery of ecosystem services including those related to hazard regulation, these ecosystems should be in good health (MEA, 2005). Unfortunately, in Viet Nam many of these ecosystems are degraded, or have been lost already due to economic and development land pressures caused by agriculture, aquaculture, the construction of hydropower dams and roads, industry and urbanization (Nguyen, 2020; Tran and others, 2015; Rentschler and others, 2020; Funkenberg and others, 2014; Nguyen and others, 2018a; UNDRR & ADPC, 2020; Nehren and others, 2017; Tu and others, 2021b; Le Dung, 2020; Huu Nguyen and others, 2016). For instance, in the last 30 years Viet Nam has lost almost 50 per cent of its mangroves and, in the last 20 years, around 23 per cent of its primary forest cover (Rentschler and others, 2020; Global Forest Watch, 2021). Deforestation leads to an increase in surface runoff, which in turn worsens the flooding aspect of rainfall events (Rafiei Emam and others, 2017; Lim and others, 2019). In fact, deforestation of the mountain areas likely played a key role in the large floods and the onset of the landslides in Central Viet Nam (Costea,

2013; Mohammad Reza, 2017; Linh & Long, 2020). Furthermore, landslides occurred in areas with poor vegetation or that were covered with commercial trees with lower ecological value (van Tien and others, 2021a and 2021b). Additionally, evidence suggests that the loss or degradation of wetlands combined with the precipitation increase projected under climate change scenarios will increase the risk of more severe floods (Gulbin and others, 2019; UNDRR & ADPC, 2020; Rentschler and others, 2020). Also, the loss and degradation of mangroves could raise the storm surge elevation and increase the velocity of the flood wave (Deb & Ferreira, 2017).

The effects of climate change, land-use change and other economic and development activities have resulted in the degradation or loss of ecosystems critical for hazard regulation, putting Viet Nam at risk of suffering more intense floods in the future (Khoi & Thom, 2015; Bangalore and others, 2019; Clark and others, 2016).

Civil protection capacity at limit

The quick succession of storms provided little respite in the affected areas and stretched the disaster response capacities to the limit (World Bank, 2020; Bruess, 2020). The nine storms and typhoons flooded and damaged roads, while the constant rains disrupted both the work of the response teams and the delivery of relief aid to the communities in need, further aggravating the situation of the affected people (Office of United Nations Resident Coordinator, 2020a; IFRC, 2020b; VDMA, 2020b). There was a lack of response equipment, such as motorized boats, which made access to affected communities difficult (IFRC, 2020b). The magnitude of the floods and their cascading impacts, such as landslides and water-borne diseases, were a challenge for the civil protection capacity that exacerbated the flood impacts (van Tien and others, 2021a; IFRC, 2020a and 2020b; VRC, 2020; Office of United Nations Resident Coordinator, 2020a).

Furthermore, the efforts and capacities of the Viet Nam Government were strained by the COVID-19 pandemic, and disaster response teams from other countries were not allowed to go to the country to help with the situation due to the COVID-19 restrictions (Bohane, 2020; Hutton, 2020).

Deficiencies in early warning and flood protection

According to the International Federation of the Red Cross and Red Crescent Societies (IFRC), the use of loudspeakers for early warning during the floods was revealed to be ineffective in some places due to their limited coverage, pointing towards deficiencies in early warning (IFRC, 2021). Furthermore, previous studies had already pointed at some deficiencies in the effectiveness and suitability of certain methods for early warning of floods (Ngo and others, 2019; Rentschler and others, 2020). After the 2020 flood event the Viet Nam Disaster Management Agency (VDMA) recognized that there was a need to enhance warning capacities for flash floods and landslides (VDMA, 2021), especially pointing to the need to develop a system of warning maps, disaster maps, evacuation location maps and real-time monitoring and early warning systems (VDMA, 2021).

In Viet Nam, many sea dikes are not able to withstand the influx of seawater associated with storm events. (UNDRR & ADPC, 2020). Nationwide, around 65 per cent of the dikes do not meet the Government-prescribed safety standards (van Ledden and others, 2020). Furthermore, many hydropower dams and water reservoirs that are intended to prevent floods are in need of maintenance, do not comply with the regulations and lack properly-coordinated water discharge (Baogiothong, 2020; Giang & Bang, 2020). The lack of proper maintenance, synchronization and connection between drainage systems in urban settings is considered a contributing factor in flood risk, which needs addressing urgently (UNDRR & ADPC, 2020).

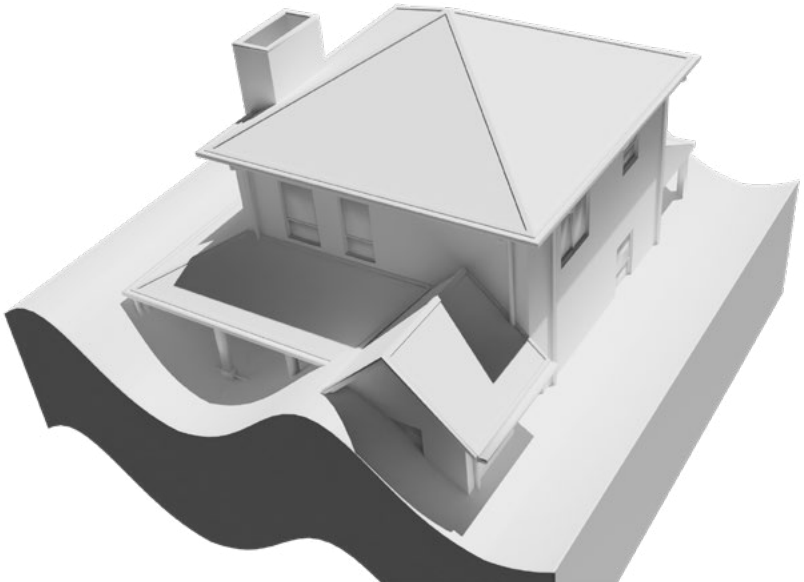
Uncontrolled urbanization in flood-prone areas and inadequate housing

The Viet Nam coastline is 3,200 km long and around 70 per cent of the Vietnamese population lives in coastal areas and low-lying deltas (GFDRR, 2015). Even though nearly two-thirds of Viet Nam´s total population lives in rural areas, the annual urbanization rate has grown seven per cent from 2009 to 2019 (STATISTA, 2021). This trend is expected to

continue, and by 2040 more people will be living in urban areas than in rural areas (URBANET, 2021). Rapid urbanization increases the flood risk of an area (UNDRR & ADPC, 2020; Huong & Pathirana, 2013).

Urban areas are particularly vulnerable to floods not only because of higher and faster runoff linked to the number of impermeable surfaces, but also due to challenges around appropriate drainage systems (Rentschler and others, 2020). Urban areas, additionally, present numerous other challenges in relation to disaster risk management, partly due to their higher level of demographic complexity, the difficulties in encouraging people to participate in disaster preparedness, the lack of tools, personal and resources to cover bigger areas, and the lack of space for applying disaster risk reduction measures (Nguyen & Tran, 2016; Sörensen and others, 2016; Ng and others, 2012). Central Viet Nam has many cities on the coast and development continues to concentrate along the coast in high-risk areas (Rentschler and others, 2020).

Furthermore, part of the new urban population is living in uncontrolled settlements, where housing conditions are susceptible to damage and destruction. Even though the share of people living in uncontrolled settlements has decreased significantly in recent years, around 14 per cent of the Vietnamese population still lives in these conditions (World Bank & United Nations Habitat, 2018). Uncontrolled settlements next to riverbanks can increase the exposure and vulnerability of people to floods (UNDRR & ADPC, 2020; CFE-DM, 2018). This issue is particularly acute for low-income people, who are more likely to reside in these dangerous locations due to unaffordable housing prices in the cities (UNDRR & ADPC, 2020; CFE-DM, 2018). Observing the materialized impacts of the floods in these areas, Phuong (2020) suggested it was clear that the communities living there were not prepared to face the consequences of living in those places.



Coping capacities eroded by COVID-19

The COVID-19 pandemic negatively influenced the impacts of the floods and contributed to the disastrous situation. At the household level, the COVID-19 pandemic significantly impacted the income and livelihoods of many households in Viet Nam. According to Tran and others (2020), around 66.9 per cent of households reported income loss due to the pandemic. This income loss reduced households' capacity to cope with the impacts of the floods and promoted the use of erosive coping mechanisms such as reducing meals, resorting to less nutritious food and/or saving food for children (AHA CENTRE, 2020; FAO, 2021; World Bank, 2020), which can have short-term benefits but in the long term severe implications on livelihood security and vulnerability (Opondo, 2013; Warner & van der Geest, 2013). The result was that households already affected by the economic impacts of the COVID-19 pandemic were in critical need of help during the floods (Office of United Nations Resident Coordinator, 2020a).

4. Root causes

Human-induced greenhouse gas emissions

Human-induced GHG emissions result in global warming and therefore in climate change (NASA, 2021). Sea level rise and changes in weather patterns play a role in the onset of more extreme hydro-meteorological hazard events around the world (Brysse and others, 2013; IPCC, 2018; Swart and others, 2018). Some of these changing weather patterns are already being experienced in Viet Nam (Nguyen and others, 2017; Schmidt-Thome and others, 2015), where the average temperatures in the country increased by 0.62°C from 1958 to 2014 (Tran and others, 2016). Furthermore, projections of different climate change scenarios suggest that this trend will keep increasing across all regions of Viet Nam (Tran and others, 2016).

Viet Nam has been and continues to be increasingly affected by the impacts of climatic change. The country will likely face an increase in the frequency and destructive power of hydro-meteorological hazards, as very intense tropical cyclones are expected to increase around the world (Tran and others, 2016; Patricola & Wehner, 2018; Tsuboki and others, 2015). Furthermore, sea level rise in the coastal regions of Viet Nam is expected to be high under different scenarios (1,280 Pg C, RCP2.6, RCP4.5, RCP6 and RCP8.5) (Clark and others, 2016; Tran and others, 2016).

Within Viet Nam, the central and coastal regions will likely face the most severe impacts of climate change compared to the rest of the country (VCCI and others, 2020; UNDRR & ADPC, 2020; Clark and others, 2016). Tropical cyclones are expected to increase in the northern and central part of Viet Nam (KIEU-Thi and others, 2016) and sea level rise projections suggest that coastal flooding could become more significant across the country (Rentschler and others, 2020). With the coastal region being particularly prone to the impacts of climate change, these risks are of special concern considering the region encompasses major economic sectors such as tourism, agriculture, aquaculture and industry (VCCI and others, 2020; Rentschler and others, 2020; Clark and others, 2016; Bangalore and others, 2019).

Environmental costs and benefits undervalued in decision making

One of the identified drivers of the floods is that ecosystems critical for hazard regulation have been increasingly degraded or lost as a result of land conversion driven by economic and development activities. Climate change poses an additional threat to ecosystems and contributes to ecosystem service losses (Trisurat and others, 2018; Moss and others, 2021). This is especially pronounced in the forestry sector, which has seen a loss of around 23 per cent of its primary forest cover in the last 20 years (Global Forest Watch, 2021). Viet Nam has a growing economy and development activities in its central and coastal regions such as urbanization, industrial development, dam and road construction, and deforestation are often blamed for the extreme floods (UNDRR & ADPC, 2020; Nguyen and others, 2018b; Nguyen, 2020). Although these activities do provide economic and development benefits to the country, when not planned appropriately they can have negative effects on ecosystems and decrease their capacity to regulate hazards (Rentschler and others, 2020; World Bank, 2020; UNDRR & ADPC, 2020). As the forest benefits are undervalued, decision makers are not fully accounting for the lost benefits caused by deforestation (Nguyen and others, 2020; Nguyen & Singh, 2020).

Insufficient disaster risk management

The disaster risk management mechanisms in Viet Nam fell short in the face of the extreme situation that the floods caused. Limited resources stretched the civil protection capacity to beyond its limit, as the response teams experienced a shortage of equipment to respond to the floods (IFRC, 2020b), proving that the disaster risk management plans were insufficient for such an extreme situation. Resource limitations are also considered as one of the main reasons behind the deficiencies in early warning and risk-informed spatial planning (VDMA, 2021). Sufficient human resources, team capacities and expertise, financial means and proper equipment are all aspects that are essential for the proper functioning of disaster risk management teams (VDMA, 2021; Rentschler and others, 2020; Chau and others, 2014). Additionally, these limitations have also led to shortcomings in the implementation of risk-informed spatial planning, building codes and safety standards (Rentschler and others, 2020), increasing the number of exposed houses and settlements in flood-prone areas.

5. Solutions

In the face of human-induced climate change, Viet Nam needs to prepare for more intense storms and floods (Rentschler and others, 2020). The unprecedented series of storms and flooding shows that disaster preparedness, response and coping mechanisms, which were designed based on historical experiences, need to be adapted to account for the new extreme scenarios that climate change could bring in the future (Remmits & Birkman, 2021). The situation was so complex that most countries would have struggled to respond adequately to it, and Viet Nam's experience indicates that countries across the globe need to climate-proof their urban development policies and plans, disaster preparedness plans and risk reduction approaches to better consider extreme scenarios (Rentschler and others, 2020).

Special attention needs to be paid to improve disaster risk management in urban areas, where exposure and potential impacts are high and governance options are often constrained (Nguyen & Tran, 2016; Garschagen, 2016). Solutions for urban flood risk reduction need to be combined with interventions in upstream areas such as reforestation of upstream, mountain areas – as in the case of Central Viet Nam (Kabeja and others, 2020; Rentschler and others, 2020).

Furthermore, awareness of the importance of ecosystems for disaster risk reduction and climate change adaptation should be increased. Increased awareness of the disaster risk reduction and climate change adaptation benefits of protecting ecosystems such as upstream forests will highlight their important value and promote the consideration of ecosystems in decision-making processes related to economic and development activities (Rentschler and others, 2020; World Bank, 2020; Everett and others, 2010). Increased awareness could also promote the consideration of ecosystems in disaster risk management plans as nature-based solutions (Rentschler and others, 2020).

It is, furthermore, critical to improve early warning – especially for fast-onset hazards. Previous reports have highlighted that Viet Nam could improve the effectiveness of its early warning system and channels in order to better respond to fast-onset hazards such as flash floods and landslides (Rentschler and others, 2020; UNDRR & ADPC, 2020). Flood risk assessments in Viet Nam could be improved by incorporating hazard-, exposure- and vulnerability-related elements (Nguyen and others, 2021a) and better hazard information that feeds into such risk assessments (Chinh and others, 2016). The equipment of disaster response teams and their ability to operate under such extreme conditions need to be evaluated and eventually upgraded (Rentschler and others, 2020; Chau and others, 2014).

Maintenance of flood-protection infrastructure and drainage systems is also critical and necessary (Rentschler and others, 2020). Additionally, urban growth should be monitored and controlled more rigorously in flood-prone areas and risk communicated to the people living there (Nguyen and others, 2018; Lee & Lee, 2017). If necessary, the relocation of industries and people needs to be considered while supporting respective finances and livelihoods (Bangalore and others, 2019). Ultimately, to ensure that these aspects can be properly addressed by disaster risk management agencies, there is an urgent need for additional funds and resources to implement necessary measures and improve Viet Nam's disaster risk management system (UNDRR & ADPC, 2020).

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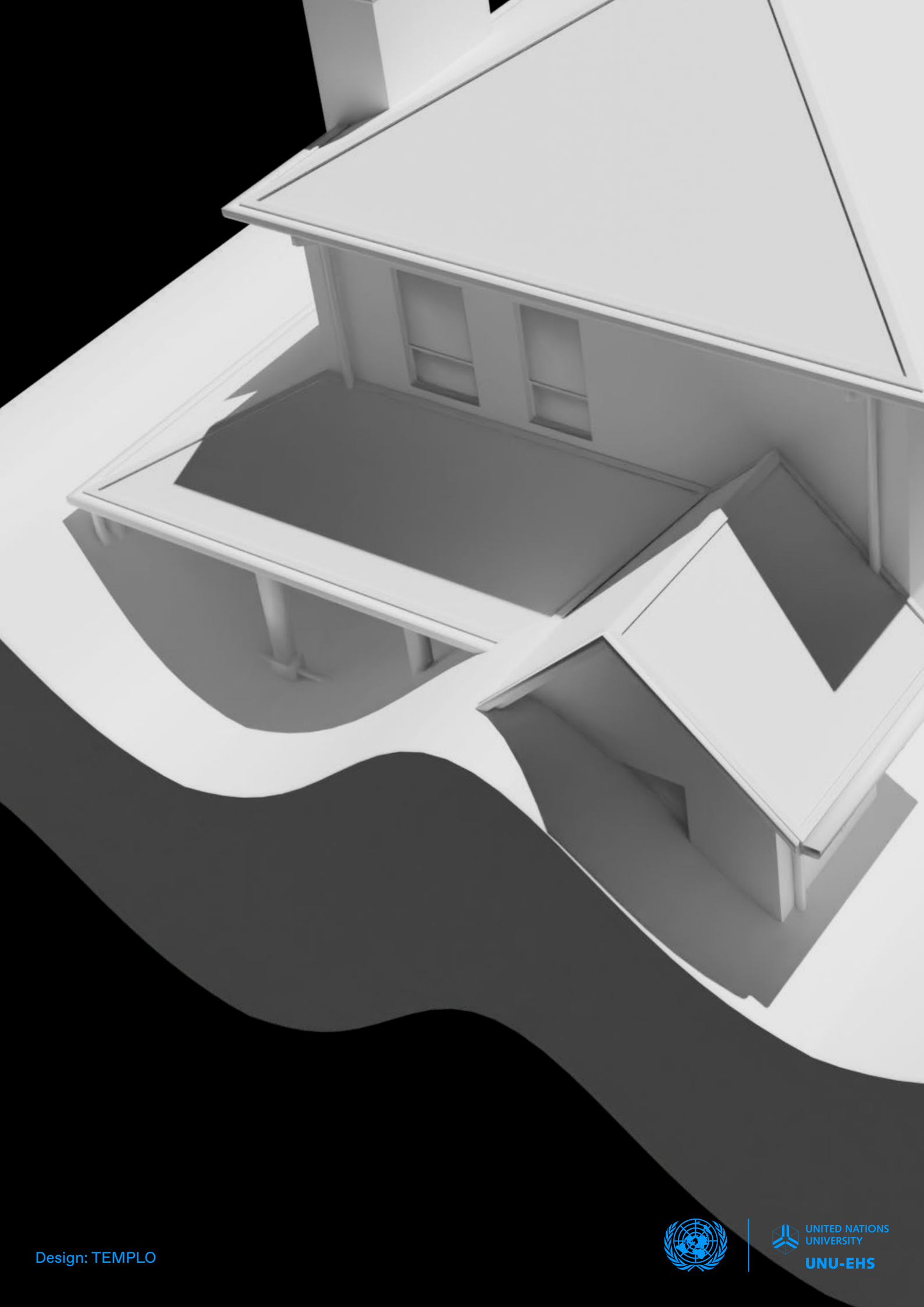

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