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INSTITUTE FOR SOCIAL AND ENVIRONMENTAL TRANSITION-INTERNATIONAL

POLICY BRIEF

Da Nang, Vietnam

DA NANG: TYPHOON INTENSITY AND CLIMATE CHANGE

March 2012–March2014 | Lead Author: Dr. Sarah Opitz-Stapleton, Staplets Consulting
Supporting Author: Kate Hawley, ISET-International

KEY FINDINGS

- The overall number of typhoons forming in the East Sea decreased slightly between 1990–2008, as part of the natural, multi-decadal cycle.
- Projections from multiple climate models indicate that the total number of typhoons in the East Sea may continue to decrease in the future.
- It is still too early to tell whether the number of strong (winds 119–156 km/hr) to violent typhoons (winds greater than 194 km/hr) will decrease or increase in the future.
- Typhoon Xangsane was a strong typhoon when it made landfall in Da Nang in 2006. While we do not know how many storms like Xangsane might happen in the future, we do know that they will happen again.
- Infrastructure should be able to withstand storms like Xangsane with minimal damage, while protecting people and assets.

Da Nang's Context

Da Nang, located along the central Vietnamese coast, is experiencing rapid development in response to a growing population and diversifying economy. The city and the central Vietnam coastline experience tropical storms and typhoons. Significant damage to infrastructure, such as housing and office buildings, can occur during tropical storms due to high, sustained winds and post-storm due to flooding. As more people migrate to Da Nang, those who can afford to are constructing or purchasing new homes. Current housing, particularly homes built by the poor to middle income households, often cannot withstand tropical storms with winds higher than 89–102 km/hr, which are not even typhoon strength winds.

Rating Typhoon Intensity

The Institute of Meteorology, Hydrology, and Environment and the Central Committee for Flood and Storm Control uses the extended Beaufort scale with 17 levels to designate the severity of wind speeds accompanying storms and their infrastructure damage potential. Tropical storms have wind speeds of 62–117 km/hr (level 6–11). Typhoons are storms with wind speeds above 118 km/hr, or level 12 on the scale, and can cause significant damage to typical infrastructure found in Da Nang. Vietnam's categorization compares with international designations such as those of the Hong Kong Observatory in the following way:

TABLE 1

A TROPICAL CYCLONE INTENSITY SCALE

Extended Beaufort Scale Category	Wind Speed (km/hr)	Typhoon Category
12	**118 KM/HR**	**TYPHOON**
13-14	**119-156 KM/HR**	**STRONG TYPHOON**
15-16	**157-193 KM/HR**	**VERY STRONG TYPHOON**
17	**>194 KM/HR**	**VIOLENT TYPHOON**

RECENT TYPHOON TRENDS

Tropical storms tend be larger and more intense in the Western North Pacific (WNP) basin than in any other ocean basin (Chavas and Emanuel, 2010). The typhoons that make landfall on the coasts of Vietnam or southern China originate near the Philippines in the East Sea. A number of different agencies, such as the Hong Kong Observatory and the Regional Specialized Meteorological Center in Tokyo, monitor the development, movement, and strength of typhoons in the WNP, and keep historical records of past typhoons. There are differences in the records—called best track data—between the agencies. Records only extend back to the 1950s, and early records are not as reliable as those from the more recent period.

Depending on which dataset is used, some researchers have detected a small decreasing trend in the overall number of tropical storms and typhoons between ~1990–2008 for central to south Vietnam, and no trend in storms making landfall in north to central Vietnam (Chen and Lin, 2013; Yokoi and Takayabu, 2013). However, this small decreasing trend is part of natural multi-decadal variability. There is no observable trend in the number of very strong or violent typhoons between 1977–2007 (Tong et al., 2010). Frequency analysis of tropical storm and typhoon data provided by the Vietnam Central Committee for Flood and Storm Control confirms that there is no trend in the number or severity of tropical storms and typhoons impacting Da Nang or the central Vietnam coastline near Da Nang.

Possible Future Changes in Typhoon Intensity

Preliminary studies project the following possible changes to typhoons impacting Vietnam:

- The overall number of typhoons forming in the East Sea and making landfall in Vietnam is likely to decrease according to multiple climate models (Yokoi, Takayabu, and Murakami, 2012; Tong et al., 2010).
- Climate models do not consistently project whether the number of very strong and violent typhoons will increase or decrease. Some multi-model studies show a potential increase in these types of typhoons, while others show a decrease (Tong et al., 2010).

General circulation models (GCMs) are used to project broad changes in a region's climate. Such models have a spatial resolution of approximately 90–300 km. The processes governing typhoon formation and movement occur at much smaller scales; GCMs have a difficult time reproducing typhoons, particularly very strong typhoons with wind speeds greater than 178 km/hr. Due to these difficulties, projections of future changes in typhoon frequency and wind intensity in the WNP should be interpreted with caution.

Broad Implications for Housing in Da Nang

Initial projections do show that the overall number of typhoons and tropical storms impacting Vietnam might decrease. However, it is still too early to tell whether the number of strong to violent typhoons will increase. Though there is the potential for fewer storms, it is important that the public, city planners, developers, and the department of construction do not relax building standards. Typhoons like Xangsane will still occur, some will be very strong or violent, and can cause significant damage if people are not prepared. While the models are not yet clear whether the intensity of wind speeds in typhoons in the WNP will decrease or increase, most models are showing an increase in the intensity of heavy rainfall events (due to tropical storm/typhoons or the monsoon) that contribute to flooding and infrastructure damage. It is therefore important that buildings adopt multi-hazard resilient construction, and offer homeowners and businesses safe places to store their assets. Improved early warning and communication systems can also help homeowners relocate their families and assets to safer locations (DiGregorio & Huynh, 2012).

Resilient Housing in Da Nang

To address these issues of typhoons, ISET–International and Hue University, with the support of the Climate Development and Knowledge Network, have announced a design competition specifically focused on climate resilient shelters that will be built to withstand typhoons with up to category 15 on the Beaufort scale, and that are also flood resistant. The design competition was launched March 1, 2013.

Further Reading

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EXTREME RAINFALL, CLIMATE CHANGE, AND FLOODING IN DA NANG, VIETNAM

March 2012–March 2014 | Lead Author: Dr. Sarah Opitz-Stapleton, Staplets Consulting
Supporting Author: Kate Hawley, ISET-International

KEY FINDINGS

- Rapid development in Da Nang's urban and peri-urban areas is increasing flood frequency and severity in the city during extreme rain events (e.g. typhoons), and storm surges during high tides.
- Climate change will increase the intensity (mm/hr) of extreme rainfall events in and around Da Nang.
- In 2007, a moderate rainfall storm not influenced by climate change caused significant flooding in the city because of the rapid development. By the end of the 2020s, climate change could increase the rainfall intensity of events like 2007 storms by 3 to 24%.
- Construction standards based on historical experience, even of rare extreme events such as the 1999 storm, will not prepare houses and infrastructure for future events.
- If the city continues to expand into low-lying areas without taking a multi-activity flood risk reduction approach and multi-hazard resilient construction, damage and possible loss of life may be severe even in areas of new construction.

Extreme Rainfall, Climate Change, and Flooding in Da Nang, Vietnam

Da Nang's Context

Da Nang, located along the central Vietnamese coast, is experiencing rapid development in response to a growing population and diversifying economy. Much of the new and planned growth, as outlined in the city Master Plan, is in the low-lying floodplain to the south of the city center. In these areas, developers are infilling lands to protect new development from flooding, yet this infilling constricts drainage and eliminates floodwater retention zones, increasing the risk in adjoining areas. Poor communities upstream or adjacent to new development are likely to be heavily impacted.

These urbanization processes have changed the nature of flooding hazards for the city. As they accelerate, so too will the changes in flood hazards. Yet, flood hazards will also increase due to climate change. Current flooding is often triggered by rainfall events associated with the monsoon or typhoons either in the city or upstream of the city in the Vu Gia—Thu Bon river basin. Storm surges and high tides during rain events can exacerbate flooding. Climate change will increase sea levels and is likely to alter the intensity of rainfall events that contribute to Da Nang's flooding.

Climate Change and Da Nang's Extreme Rainfall by the 2020s and 2050s

Our analysis indicates that climate change is likely to increase the intensity of moderate to severe rain events in and around Da Nang. More common rainfall events that happen on average, every 10 years or less, might not change that much. Flooding in the city occurs because of land-use, the orientation of buildings, roads, and other infrastructure, which interact

with heavy rainfall. The diagram below depicts how urban flood events will be magnified with increased urbanization and more intense rainfall events in the future.

Extreme rainfall is described by how frequently it occurs on average (*Return Period)*, how intense the event was (mm/hr), and how long the event lasted (Duration). Tables 2 and 3 (on the next page) show how, for storms of a certain return period and duration, the intensity may change as a result of climate change. Over the period of 1961-2005, Da Nang's extreme rainfall events had the characteristics shown in Table 1 below.

Climate change will alter the intensity and frequency of Da Nang's extreme rainfall events. Table 2, on the following page, shows the percentage change in intensity by the 2020s as compared to the 1961–2005 historical period. For instance, from Table 1, the 24-hr duration, 10-year rainfall intensity is 12 mm/hr. According to Table 2, this rainfall intensity might change to 10.8 to 16.3 mm/hr by the end of the 2020s.

According to the projections, in Da Nang the intensity of severe rainfall events (those with a return period of 50 years or more) is likely to increase. More moderate events (those with a return period of 10 years or less) will not increase as much in intensity. No clear trends (increasing or decreasing) in intensity can be determined for the 2020s for minor events (very short duration and return period), although by the 2050s it does appear such types of events also might increase in intensity. There is greater uncertainty (larger spread in the model projections and/or unclear trend) in how climate change might alter events lasting less than 24 hours as well as short return periods (10 years or less).

Resilience Activities in Da Nang

Flooding already occurs in many of the low-lying districts of Da Nang, often after only minor amounts of rain. Flood risk in the city has greatly increased over the past few years due to the rapid pace of development. Climate change will likely increase the intensity of moderate to severe rainfall events by the end of the 2020s and definitely by the 2050s. In parallel, sea levels are rising and will continue to rise for decades even if climate emissions were stabilized today. Taken together, this implies that climate change will intensify flood risk in the future. Coupled with continued development, it is possible that Da Nang could experience unprecedented levels of flooding in the future.

In response, Da Nang stakeholders, including the People's Committee, government departments, mass organizations, and international NGOs, are taking action to build resilience of physical systems, agents, and institutions in the city. With support from the Asian Cities Climate Change Resilience Network (ACCCRN) program, stakeholders are working to:

- Understand how vulnerabilities result from and may be exacerbated by climate change and urbanization, and plan for building resilience;

FIGURE 1

INCREASES IN URBAN DENSITY (URBANIZATION) AND THE INTENSITY OF EXTREME RAINFALL EVENTS CAN LEAD TO MORE SEVERE FLOODS IN URBAN AREAS.

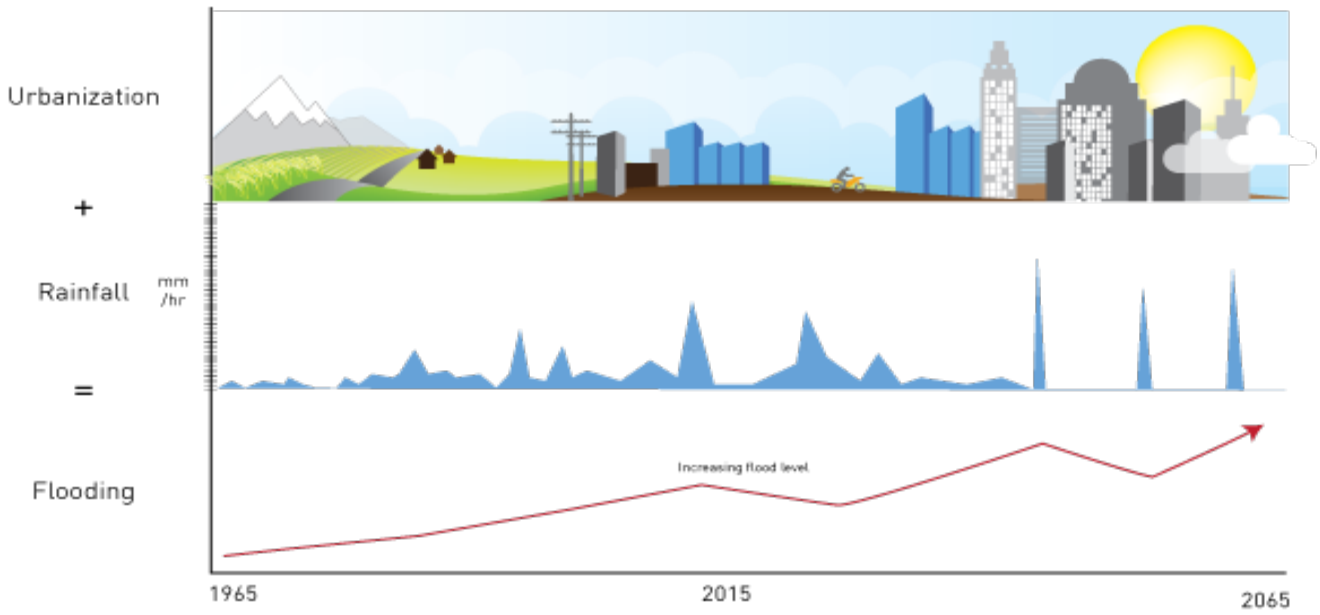

TABLE 1

RAINFALL INTENSITY 1961–2005

Average rainfall intensities (mm/hr) for select durations and return periods based on Da Nang's historical record of 1961–2005.

	RETURN PERIOD (YEARS)		
DURATION (HRS)	2	10	50
24	**6.6 MM/HR**	**12 MM/HR**	**16.7MM/H**
48	**4.8 MM/HR**	**8.5 MM/HR**	**11.7MM/H**
96	**3.5 MM/HR**	**6 MM/HR**	**8.2 MM/H**

TABLE 2

PROJECTED CHANGES IN RAINFALL INTENSITY

Range of percent change in Da Nang rainfall by the 2020s, derived by comparing projected intensities from multiple models to the past intensities.

	RETURN PERIOD (YEARS)		
DURATION (HRS)	2	10	50
24	**-15 TO 30%**	**-10 TO 36%**	**-8 TO 40%**
48	**-6 TO 18%**	**1 TO 27%**	**4 TO 33%**
96	**-5 TO 11%**	**1 TO 21%**	**3 TO 25%**

- Establish a Climate Change Coordination Office within the city government;
- Pilot a new "boat winch" technology to assist local fishermen to come safely to shore during storms;
- Build the Women's Union's capacity and provide loans to vulnerable households to build storm resistant housing;
- Develop a hydrological model to help planners make decisions based on possible future flood patterns, using a variety of climate change and urban development scenarios;
- Incorporate urban climate resilience into local school curriculums, to build knowledge, skills, and capacity of students, teachers, and community members; and,
- Assess options for increasing the resilience of Da Nang's clean water supply to stresses from urbanization and climate change, rising demands, and changes in the hydrological regime within and outside the city's boundaries.

About the Project

Additionally, The Da Nang Department of Construction (DOT), Da Nang Technical University (DUT), Southern Institute of Water Resources Research, and ISET–International, have been working together to explore the factors that lead to endemic flooding within Da Nang and identify resilience options that can reduce immediate disaster risk while building climate resilience. With support from the Rockefeller Foundation and Climate Development and Knowledge Network, ISET–International conducted extreme rainfall event analysis of historical and projected rainfall to generate plausible storm intensity profiles for two time periods, the 2020s and the 2050s, to inform flood modeling efforts. The rainfall analysis supports two current research projects. The first research project, funded by the Climate Development and Knowledge Network, hypothesizes that climate-adapted shelter has a positive benefit cost ratio accruing to vulnerable populations. The second research project, funded by the Rockefeller Foundation, aims to add substantive new insights on the economic and other returns to investment in climate resilience that go substantially beyond the costs and benefits of individual interventions.