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POLICY BRIEF

Da Nang, Vietnam

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

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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.

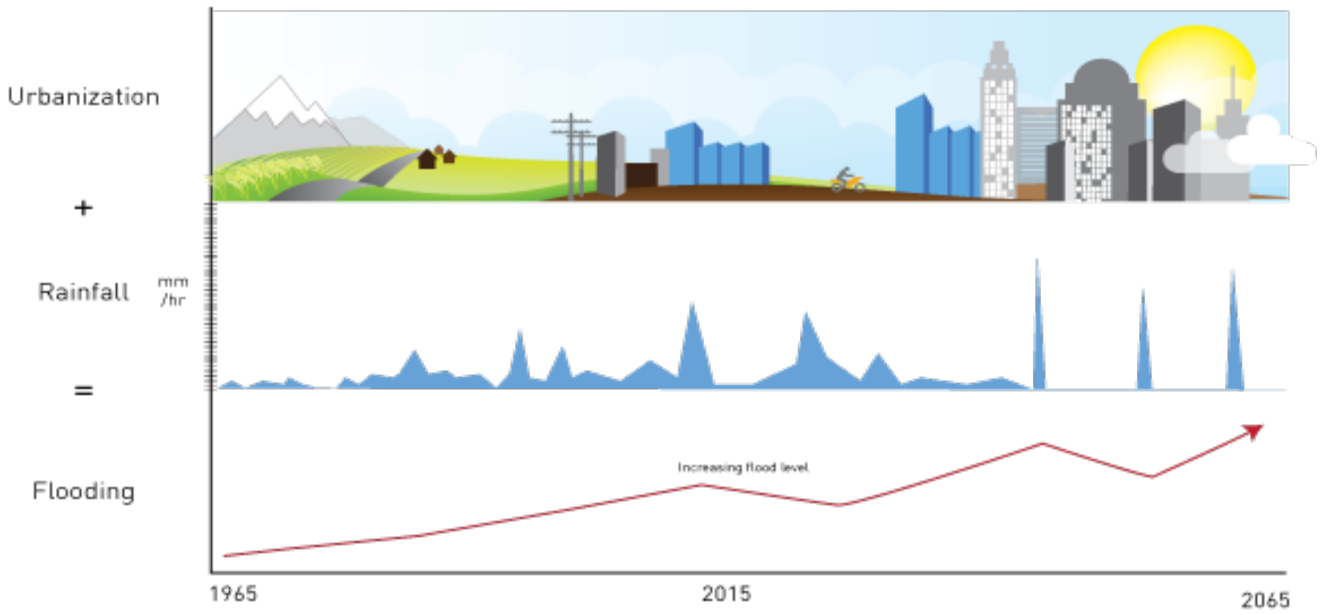

TABLE 1

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.

Uncertainty and Construction Planning

There is fairly large uncertainty in how much the intensity of Da Nang's extreme rainfall might change in the future according to multiple models. Some of this uncertainty is due to gaps in the historical observation records; this will get better with time through improved monitoring with automated weather stations along with coordination with the local IMHEN office. Other sources of uncertainty are due to natural climate variability (not influenced by climate change), the differences between climate models, and the fact that no one really knows what the world's population, energy use, greenhouse gas emissions, and land-use will look like in 2020 or 2050. All of these later factors will influence the severity and rate of climate change.

Resilient construction and infrastructure, however, can withstand multiple types of hazards and is energy efficient. People living within such resilient houses have more options for protecting their families and assets from flooding and storms. Truly resilient houses are able to withstand a wide range (uncertainty) of projected changes.

The attached technical brief provides a more comprehensive overview of possible changes for rainfall events of multiple durations and return periods for Da Nang, and displays the full IDF curves plus analysis.

Further Reading

This policy brief does not provide the technical details of the extreme rainfall event analysis for Da Nang. The technical brief gives greater detail about the methodology and findings discussed in this Policy Brief. The following are also good technical resources and/or provide more information on Da Nang and resilience activities:

IPCC (2012). Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. A Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change. In C. B. Field, et al. (Eds.), (pp. 582). Cambridge, UK.

Mailhot, A., Duchesne, S., Caya, D., & Talbot, G. (2007). Assessment of future change in intensity-duration-frequency (IDF) curves for Southern Quebec using the Canadian Regional Climate Model (CRCM). Journal of Hydrology, 347, 197-210.

DiGregorio, M., & Huynh, C. V. (2012). Living with Floods: A Grassroots Analysis of the Causes and Impacts of Typhoon Mirinae. Boulder: ISET–International.

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