ENVIRONMENT & NATURAL RESOURCES PROGRAM

Climate Disasters in the Philippines:

A Case Study of Immediate Causes and Root Drivers from Cagayan de Oro, Mindanao and Tropical Storm Sendong/Washi

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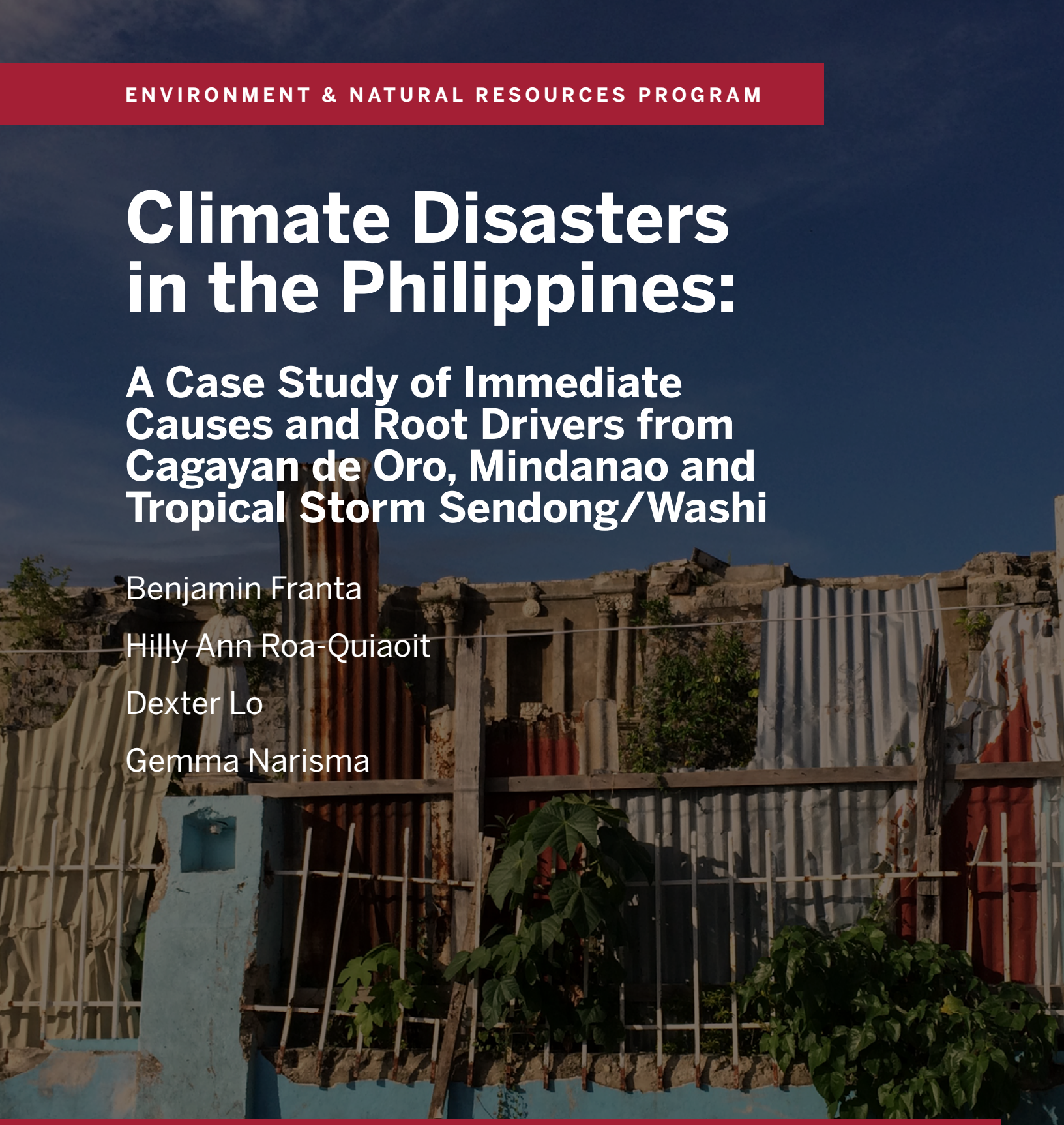

HARVARD Kennedy School
BELFER CENTER
for Science and International Affairs

REPORT
NOVEMBER 2016

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Cover photo: A destroyed church in Samar, Philippines, in the months following Typhoon Yolanda/ Haiyan. (Benjamin Franta)

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The Environment and Natural Resources Program (ENRP)

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Abstract

The impacts of climate change are beginning to be felt around the world. Case studies that identify the immediate causes of disasters as well as their root drivers provide the empirical basis for strategies to increase resilience to climate impacts. Here we present a case study of the city of Cagayan de Oro, Mindanao in the Philippines and its experience with Tropical Storm Sendong (international name Washi) in 2011. We use local key informant interviews from 2014 and secondary sources to identify both the local, immediate causes as well as the more widespread root drivers of the disaster. We focus on two root drivers in particular: informal settlements in hazardous areas and political dynamics based on patronage, which can present risks both pre- and post-disaster. Addressing these root drivers will be important for increasing climate resilience in the Philippines and other countries.

Preface

Working to increase resilience to climate change globally will be an important task in the 21st century. There are numerous reasons for this: humanitarian (reducing the incidence of death, harm, and poverty resulting from climate change), economic (avoiding shocks and losses incurred through climate change in a globally connected economy), political (guarding against political destabilization, state disintegration, and mass displacement due to climate effects), and even cultural (safeguarding the myriad cultures and heritage traditions of the human species so that future people can experience and learn from them).

One of the acute effects of climate change is changing weather conditions—such as increased incidence of heavy precipitation in some locales—that can lead to disasters. In the Philippines, heavy precipitation from tropical storms is a perennial and increasing concern. Why do some tropical storms lead to disaster, while others don't? What can be done to reduce the loss of life and economic resources? These are central (though by no means the only) questions in working to increase climate resilience in the Philippines.

Here, we drive toward these questions with a case study of a major city in the Philippines that experienced a disaster in 2011 from Tropical Storm Sendong (international name Washi), with major loss of life and damage to built infrastructure. What can a case study of such a specific event teach us? First, a case study, by virtue of its specificity, can provide us with a grounded understanding of how climate disasters actually unfold and what the important factors affecting them actually are. Second, case studies can illustrate general trends that are widely applicable. In that sense, case studies are documentations and analyses of natural experiments of social systems interacting with their environments. They form the empirical backbone of general social inferences used to plan and formulate policy.

In formulating case studies, two common pitfalls can limit their use. The first is to focus on granular details of the case that are of limited use outside

of the specific time and place being considered. The second is to assume a general theoretical framework as a starting point and to use that framework to interpret the case, rather than using the case (the specific details) to test the theoretical framework (the generalization). The problem with this second pitfall is that the terminology and concepts used to describe reality can quickly become tautological (*e.g.*, "A disaster occurred due to a lack of resilience." "How do we know there was a lack of resilience?" "Because a disaster occurred.") At that point, general theory becomes merely descriptive rather than predictive (*e.g.*, the concept of "resilience" simply becomes a relabeling of the fact that a disaster occurred).

In this case study, we seek to avoid these two pitfalls through a three-layer approach. First, we seek to describe the dominant factors pertaining to the case with a minimum of theoretical interpretation: What happened and where? What are the major characteristics of the location socially, economically, politically, environmentally? What is distinct about the context and what is typical? Obviously, not every detail of the case can be described; not every detail needs to be in order for the case to be useful. Second, we seek to identify the immediate causes of the disaster. Given that there was a tropical storm, for example, what was specific about that time and place that led to a disaster? What is frequently mentioned by those who experienced it? Were there many factors that led to disaster in that time and place or a few? We seek to identify these factors with a minimum of abstraction. Finally, we consider *why* these immediate causes were present. If the local government was unresponsive, then why? If local people did not evacuate, then why? For each immediate cause, a causal chain can be considered. Precisely which items on the causal chain one should label as ultimate causes or "root drivers" depends on interpretation and purpose (people rightly debate about ultimate causes). However, if a large number of the immediate causes appear to be related to a small number of recurring root drivers, then it is sensible to focus on those drivers. Identifying root drivers is useful because they point toward areas for reform or policy change, and they are often

systemically applicable over large areas. For example, in this case, we focus on two root drivers: informal settlements in hazardous areas and political dynamics based on patronage, which can present risks both pre- and post-disaster. It is useful to analyze these root drivers in the context of this case, because the same root drivers are present in many other contexts as well. This three-layer approach takes empirical observation (not theory) as its starting point while also offering the generalizability needed to draw useful conclusions that may be applicable elsewhere.

Formulating a case study is an interpretive exercise: among the vast pool of information pertaining to an event that is available or potentially available, what is important, and what lessons can be drawn? What is deemed "important" is a matter of interpretation. Thus it is natural to ask, "How do we know this case study is definitive? Won't my case study of the same event be different from yours?" The answer is that two case studies of the same event may very well be different, or they may not. Indeed it is useful to consider *why* they are the same or different, and in what respects and to what degree. Replication and comparison is how confidence is built and consensus is developed within science in general. Case studies of climate-related disasters—which are analyses of complex natural experiments—are no different. In the case of the particular event analyzed in this study, an independent study with independent methods was carried out by the Overseas Development Institute based in London[1]. The conclusions of that study and this are consistent with each other and similar in many respects, which lends confidence to both. Indeed, those who fund case studies may wish to consider using multiple independent teams to study a single event (as is sometimes practiced in investigative journalism). Often it is very useful to "trust, but verify."

At the same time, to attempt to capture immutable laws of human or system behavior through case studies—even many of them—somewhat misses the mark. First, human systems are highly complex, not always predictable, and change over time and space. Moreover,

though, the purpose of case studies pertaining to climate-related disasters is to be useful: to reduce death, harm, and loss, and to increase prosperity and life (and justice) in a prospective century of climate change. Such studies need not be perfect in order to be useful for that important purpose; indeed, non-scholarly criteria such as the accessibility of conclusions for a wide audience, the ability to spark further discussion and investigation, and the transference of lessons learned to policy and civil society are also highly important for a study's potential usefulness for improving human well-being.

Benjamin Franta
September 2016

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A destroyed church in Samar, Philippines, in the months following Typhoon Yolanda/ Haiyan. (Benjamin Franta)

1. Introduction

The Philippines, an island archipelago nation in Southeast Asia, is thought to be one of the countries most at risk to harms from anthropogenic climate change [2]. This high risk comes primarily from the country's high exposure to extreme weather events, such as tropical cyclones, as well as socioeconomic vulnerability arising from high poverty rates and overstressed public infrastructure and services [3].

Extreme storms represent one of the most prominent climate-related hazards in the Philippines [4]. Extreme rainfall intensity and frequency have both increased since the mid-20th century in the country [5], and in the last decade, tropical storms and cyclones—often accompanied by storm surges [6 7], high winds, flooding [8], and landslides [9]—have caused deadly and costly disasters [4]. Climate models predict that precipitation will (continue to) decrease in the dry season and increase in the wet season at least through mid-century, further increasing the risk of flooding and landslides [5]. Additionally, there is concern that rising ocean temperatures and changing atmospheric conditions could cause tropical cyclones to increase in strength, produce more precipitation [10], or change track [11], which could further increase hazard exposure. Thus, both current and projected future conditions in the Philippines illustrate a need to develop strategies for reducing the risks associated with climate change.

The risks associated with climate change are diverse, consisting of both rapid-onset events (*e.g.*, intense storms, heat waves, and droughts) and gradual changes in conditions (*e.g.*, sea level rise, changing agricultural conditions, and changes in infectious disease vectors). The wide range of impacts complicates the construction of general models of climate-related risk. Abstract concepts such as "resilience", commonly in use, can suffer from tautological usage and difficulties in definition and measurement (and thus lack of predictive power) [12 13 14], but they can nonetheless be useful as a shorthand method for expressing perceived levels of risk or performance [15 16]. In practice, much of the discussion of climate-related risk in the Philippines centers on the concept and rhetoric of resilience.

Climate change preparedness and resilience efforts are currently ongoing in the Philippines. Many of these efforts are organized by international aid organizations [17] [18] [19], civil society organizations, academic institutions, and government agencies [20] [21]. A common approach for reducing climate-related risks is "capacity-building", which often consists of meetings and workshops for decision-makers, community members, and experts to raise awareness of risk, find local solutions that may be present (including those derived from local knowledge, funds, or other resources), disseminate technical information, and mobilize participants to carry out actions expected to reduce risk [22]. Other risk-reduction activities include infrastructural projects and research for developing hazard-related information [20].

Here, we analyze climate-related risk through a case study of a climate-related disaster, using a three-layer approach of first describing the case, then identifying immediate causes of the disaster, and then identifying root drivers underlying the immediate causes (Table 1). We focus on the city of Cagayan de Oro in the Philippines, a regional urban center that experienced a flash flood triggered by Tropical Storm Sendong (known internationally as Tropical Storm Washi) in December, 2011 [23]. Our study is based on semi-structured interviews of 31 individuals in Cagayan de Oro, part of larger set of 94 interviews carried out in 2014 in climate-disaster-affected areas throughout the Philippines (including Panay, Samar, and Leyte). Interviewees represented a range of organizations, including local governments, national government line agencies, disaster aid agencies, international non-governmental organizations, local civil society organizations, grassroots organizations, academia, and businesses. We asked interviewees to describe the disaster event and the response, to characterize the damage and recovery, to describe the adaptations resulting from the disaster and the current resilience strategy, to analyze preparedness for future prospective disasters, and to discuss prospective strategies for reducing climate-related risks. Interviews were typically 60—90 minutes in duration. Our findings were corroborated against published literature, news reports, government documents, and independent researchers.

Using the case description, we identify the immediate causes of the disaster, which are typically context-specific (*e.g.*, increased rates of runoff from the local watershed, lack of evacuation on the part of local people, and so on).

We seek to identify these factors with a minimum of abstraction and expect that they may be useful for local climate resilience and reform efforts from government and civil society. We then seek to identify the root drivers that underlie these immediate causes, which are typically persistent, systemic factors that are widespread in the broader social context (*e.g.*, patterns of illegal land use, poor access to affordable mobility options, and so on). We focus in particular on root drivers that underlie many immediate causes. We expect that identifying and analyzing these root drivers may be useful for more general, system-wide climate resilience efforts. We emphasize that our purpose is not to identify a definitive, exclusive set of root drivers. The identification of root drivers is a matter of interpretation of a complex scenario and is and should be a matter of debate. Rather, our purpose is to glean information from the case that is useful for both *local* and *general* resilience efforts. Understanding how local experiences and systemic risk factors interact with each other is important for addressing either and could help to connect bottom-up and top-down approaches [2 24].

Component of analysis	**Characteristics**	**Relevant applications**
1: Case description	Based on on-site interviews (range of stakeholders) and secondary sources; minimum of interpretation	Empirical basis of analysis; could be used in case databases
2: Immediate causes	Local factors, often specific to case	Provides specific understanding of how disasters occur; could be used in local resilience efforts
3: Root drivers	Persistent, systemic factors, often relevant to large areas (*e.g.*, whole countries)	Provides understanding of how local experiences are connected to larger, more widespread factors; could be used in large-scale general resilience efforts

Table 1: Method of analysis. First, the case description was developed using on-site interviews and secondary sources (*e.g.*, news reports, published literature). Then, immediate causes of the disaster were identified, and from those, root drivers were identified. Both immediate causes and root drivers may be important factors in climate-related risk reduction.

2. Case description

2.1 Before the flood: The City of Cagayan de Oro

The city of Cagayan de Oro, with a population of 600,000 as of 2013 [25], is one of the largest cities in the Philippines. It is located on a flat plain on the northern coast of Mindanao, the large southern island of the country, and is the capital city of the province of Misamis Oriental. The city has an area of 412 square kilometers [26], about one-third of which is used for agriculture, and six major rivers flow through the city and into the ocean at the city's northern coast. The largest of these—the Cagayan River—is fed by a mountainous, 1500-square-kilometer watershed located in Bukidnon, a province adjacent to the city [27] (Figure 1). Land in Bukidnon is used largely for mining, forestry, and family-scale and plantation-scale agriculture [28]. Even though the watersheds of Bukidnon drain through Cagayan de Oro, the city does not have political jurisdiction over the province.

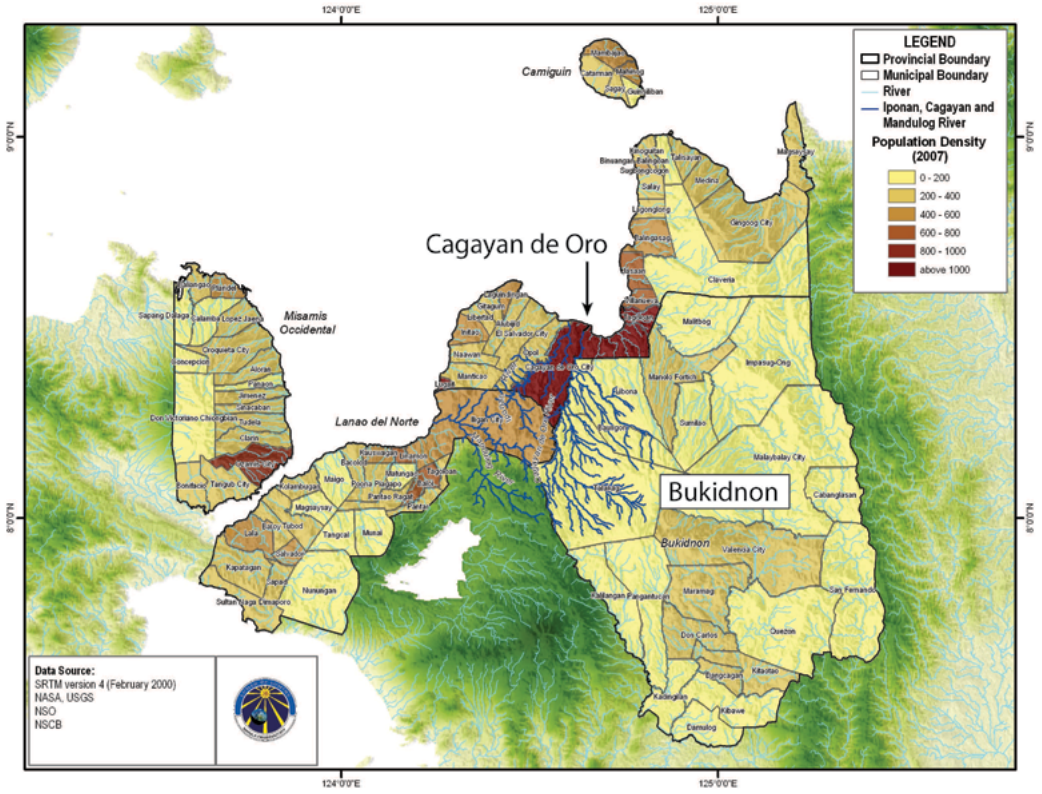

Figure 1: Map of the Cagayan de Oro area, including the relevant watersheds in the adjacent province of Bukidnon. Data Sources: SRTM version 4 (February 2000), NASA, USGS, NSO, NSCB. GIS data: MO, NAMRIA, NSO. Map Production: Geomatics for Environment and Development.

Economically, the city is one of the fastest growing in the Philippines and was named one of the country's most competitive cities in 2014 by the Philippine National Competitiveness Council [29]. Major areas of investment include malls, hotels, real estate, and business process outsourcing [1 30], and foreign investment has played a large role in the city's growth [31]. Tourism is another important industry, with 300,000 visitors per year, most of them domestic [32].

Numerous institutions are based in Cagayan de Oro. Four major private universities and one state-run university, along with other post-secondary educational institutions, operate within the city. The region's Roman Catholic archdiocese, covering eight provinces in northern Mindanao, is also based in the city. A range of non-governmental and civil society organizations also operate in and around

the city, organized around issues such as rural economic security, environmental management, and informal settler interests [33] [34] [35].

Wealth inequality and poverty are longstanding issues in the Philippines (with about one-quarter of the population living under the poverty line nationally), and Cagayan de Oro is no different [36]. Poverty estimates in the city vary widely [1]; government officials we interviewed estimated that 15—20% of the city's population, or about 100,000 people, reside in informal settlements (*i.e.*, shantytowns). These informal settlements are located along the banks of the Cagayan River in particular and constitute some of the most densely populated districts of the city, with more than 373 people per hectare (37,000 people per sq. km), similar to population densities in Manhattan, Hong Kong, and Mumbai (Figure 2) [37]. In the region surrounding Cagayan de Oro, the poverty rate is even higher than in the city, at about 40% in 2012 [38].

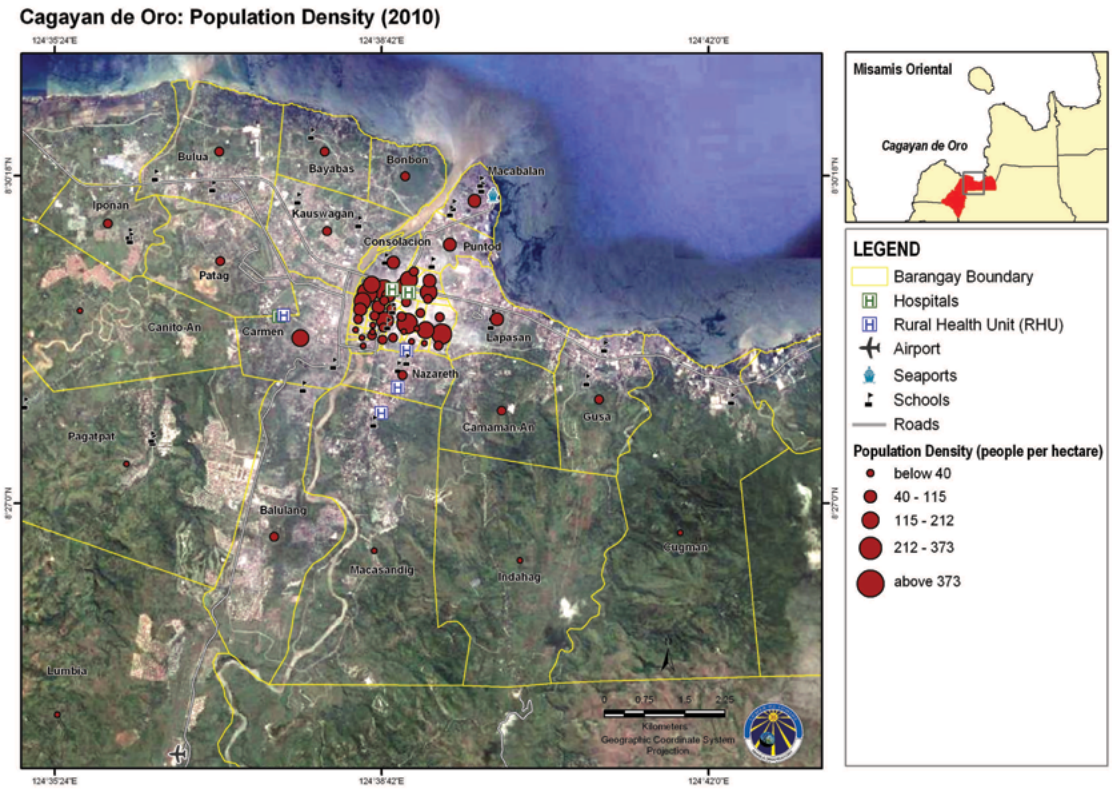

Figure 2: Map of Cagayan de Oro city showing densely populated areas next to the Cagayan River. Data sources: NSO, NAMRIA, Google Earth. Map Production: Geomatics for Environment and Development.

Politically, when Tropical Storm Sendong occurred in 2011, the city was governed by Mayor Vicente Emano, who had been prominent in regional politics since the early 1980s, first as the mayor of nearby Tagoloan city, then as governor of the surrounding province of Misamis Oriental, and finally as mayor, vice-mayor, and mayor again of Cagayan de Oro [39]. Long-term political dominance by a single politician is not infrequent within the various regions of the Philippines and has been documented and studied elsewhere [40] [41] [42]. One of the city's major initiatives under Emano was a socialized housing program begun in 2010 (known as the "piso-piso" program) under which the city government would purchase parcels of land and sell certificates of occupancy to low-income beneficiaries for one Philippine peso per day [43] [44] [45].

Even before Tropical Storm Sendong, the city had prior experiences with floods and other natural hazards. In 2009, the city experienced a series of floods that affected around 50,000 people [46] [47]. Deforestation in the upland watersheds from logging and mining was identified as a contributor to heavy runoff during rainfall, and a ban on logging was passed in 2010 to discourage further deforestation. Additionally, a consortium of civil society organizations in partnership with government agencies called the Cagayan de Oro Riverbasin Management Council (CDORMC) was formed, focusing on decreasing risks from natural hazards, conserving natural resources, and protecting cultural assets (*e.g.*, indigenous groups) within the Cagayan River watershed [34].

The city also had access to hazard maps developed by the Philippine Mines and Geosciences Bureau, which indicated that much of Cagayan de Oro existed in a flood zone (Figure 3) [48]. Some of the areas most at risk, such as the neighborhoods of Isla de Oro and Cala-Cala, had been populated through the city's socialized housing ("piso-piso") program [1] [49]. Thus, although hazard risk information was available at the time of Tropical Storm Sendong, it was not necessarily used in city planning.

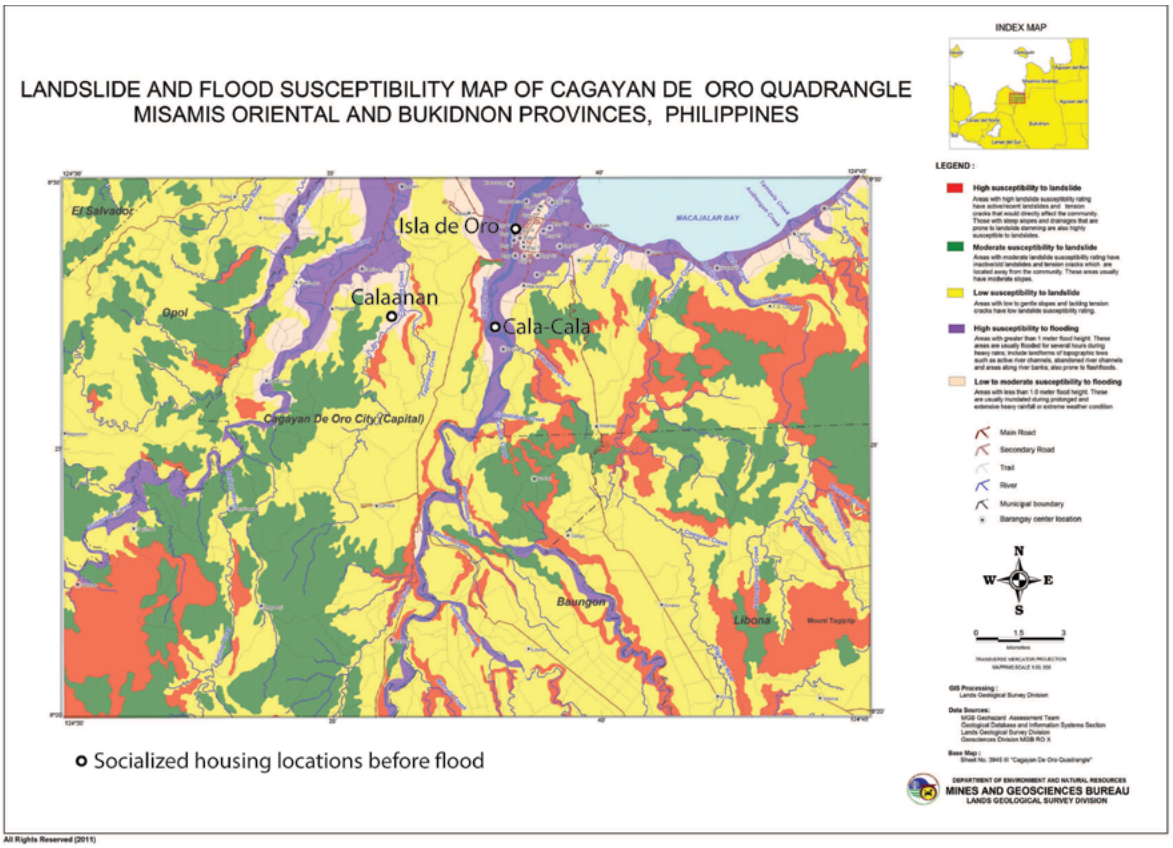

Figure 3: Hazard map of the Cagayan de Oro area from 2011 (before Tropical Storm Sendong occurred) showing areas with high susceptibility to flooding and landslides (purple and red, respectively) [48]. Socialized housing locations also indicated.

2.2 **Tropical Storm Sendong**

On December 15, 2011, Tropical Storm Sendong entered the Philippine Area of Responsibility, a tropical cyclone monitoring zone that surrounds the country, and PAGASA (the Philippine Atmospheric, Geophysical and Astronomical Services Administration), a governmental organization tasked with providing typhoon and flood warnings, began issuing advisories to at-risk areas [50]. At 5 p.m., the province of Misamis Oriental, where Cagayan de Oro is located, was put under Public Storm Warning Signal No. 1 (out of a 4-signal warning system, with 4 corresponding to the worst expected impacts [51]). At 11 p.m., the storm still had not made landfall, but the province was put under Public Storm Warning Signal No. 2, indicating that the storm's effects would be felt within 24 hours and that disaster preparedness personnel should alert communities within the province.

The next day, December 16, the storm approached the island of Mindanao. At 9 a.m., a general flood advisory was issued, indicating that waterways in Misamis Oriental would be affected. At 4 p.m., Sendong made landfall in Mindanao. The National Disaster Risk Reduction and Management Council, a collection of government and non-government agencies and groups operating under the Department of National Defense, was advised throughout the day to take preparatory action and to focus on pre-emptive evacuation rather than rescue operations. At 11 p.m., the storm had not yet hit Cagayan de Oro, and PAGASA issued its last advisory for the day. The city remained at Public Storm Warning Signal No. 2 and had not yet carried out evacuations [50].

The next morning, at 5 a.m. on December 17, PAGASA issued its next bulletin. Sendong had passed over the city overnight and the Cagayan River had flooded, increasing in depth from 2 meters, its normal level, to 10 meters [52] (Figure 4). The floodwater flowed at high speeds and carried debris from the watershed, such as logged trees, boulders, and mud, further increasing the damage [53].

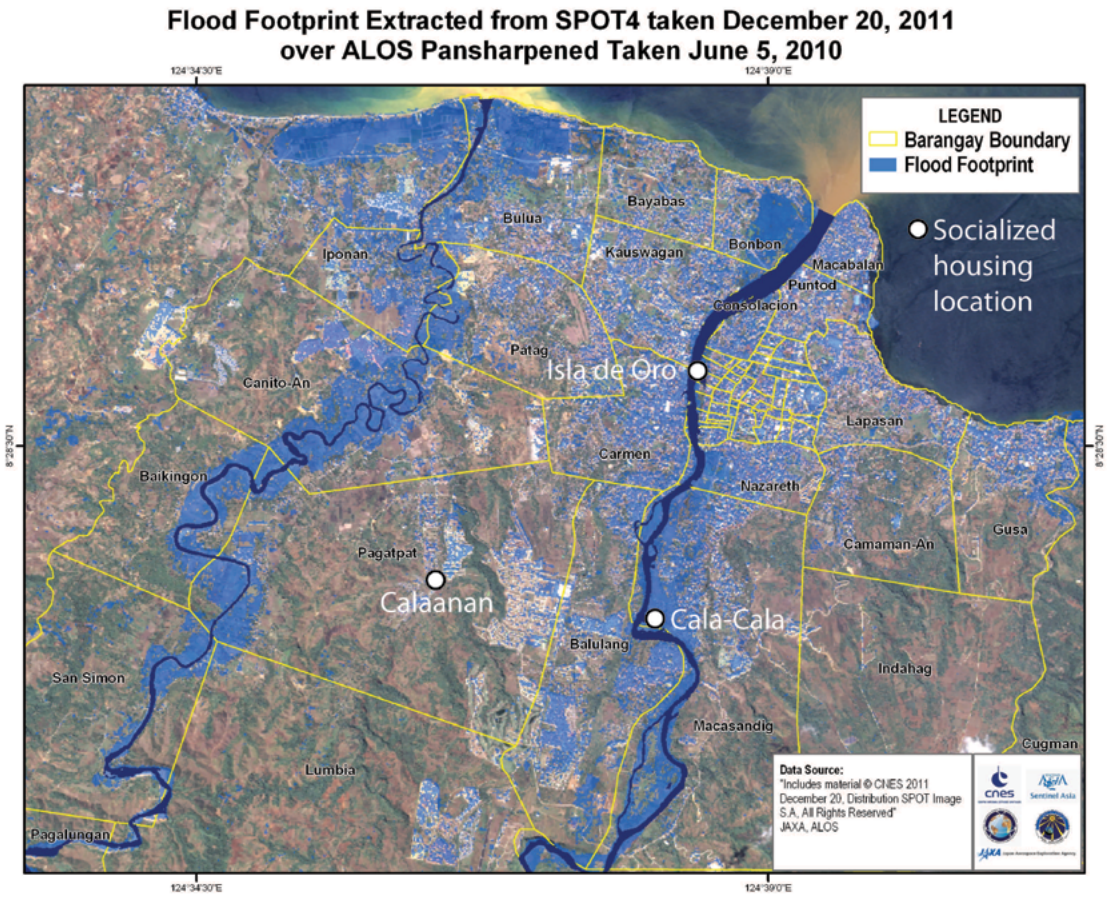

Figure 4: Flood footprint map showing Cagayan de Oro (right) and nearby Iligan city (left), along with socialized housing locations. Data sources: JAXA, ALOS, includes material (c) CNES 2011, December 20. Distribution SPOT Image S.A. All Rights Reserved. Map Production: Geomatics for Environment and Development.

The immediate damage from the flood was extensive [54]. According to interviewees and official records, overnight at least 1000 people died in Cagayan de Oro and nearby Iligan City, and about 70,000 families (300,000—400,000 people) had been displaced or made homeless [55]. Direct damages and expected recovery costs were estimated at over USD 100 million and USD 500 million, respectively [56] [52] [57]. Those near the banks of the Cagayan River were most affected, including informal settlements and neighborhoods that were part of the city's socialized housing program. Many of the victims had been sleeping when the flood occurred. Among those who had an opportunity to escape, many stayed in their homes in order to keep watch over their belongings and were killed, according to interviewees.

The local government was unprepared for the disaster, according to interviewees and news reports [58] [59]. A city disaster risk reduction and management council (DRRMC) had not been formed before Sendong despite being required by law; the city also lacked a disaster incident command system [52]. The majority of interviewees mentioned the local government's lack of preparedness or inability to respond to the disaster.

The city's ability to respond to the damage was also limited. Some of the city's health centers were in the flood zone and were rendered unusable [60]. Medical personnel we interviewed mentioned their lack of training in emergency medicine. Within days, poor sanitation produced a range of health problems including diarrhea, leptospirosis, and respiratory and skin problems. Much of the city lacked water, electricity, and telecommunication, and a food shortage developed within days. Psychosocial (mental and emotional) health care was often improvised, and many response personnel lacked professional training. Three days after the flood, the national government declared a state of national calamity, allowing international aid to enter the city [52].

In response to the lack of organized relief from the local government, various local leaders formed a partnership of governmental and non-governmental organizations called the Multisectoral Relief Response Operations Center in order to organize relief efforts. Major members of the partnership from the non-governmental sector included the local office of the Roman Catholic archdiocese, the Cagayan de Oro Riverbasin Management Council, and a local university (Xavier University), which served as a base of operations for aid distribution and the relief effort in general. This *ad hoc* partnership led relief efforts until the national government assumed control a few weeks later. After a few months, control reverted back to the local government. In May, 2012—about five months after the flood—efforts shifted from disaster relief to long-term rehabilitation.

2.3 **After the flood: Response and recovery**

One of the immediate impacts of Sendong was the destruction of homes adjacent to the Cagayan River, where some of the most densely populated areas of the city were located (Figure 6). According to interviewees, by the end of December (two weeks after the flood), about 14,000 families (about 100,000 people) remained in evacuation shelters, a large fraction of them informal settlers. Some areas near the Cagayan River that had previously been occupied by informal settlements were declared to be "no-build" zones, although some reoccupation occurred nonetheless.

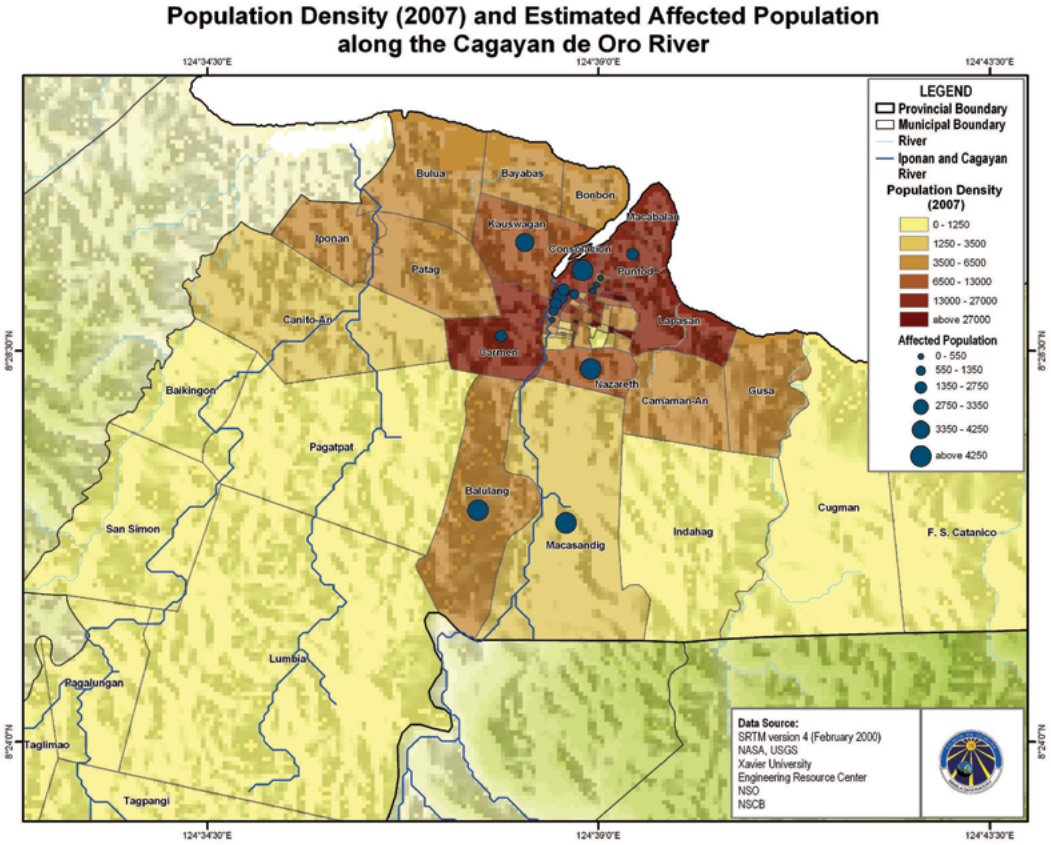

Figure 5: Estimated population densities and flood-affected populations near the Cagayan River. Data sources: SRTM version 4 (February 2000), NASA, USGS, Xavier University Engineering Resource Center, NSO, NSCB. GIS data: MO, NAMRIA, NSO. Map Production: Geomatics for Environment and Development.

To address the large-scale homelessness caused by Sendong, the city adopted a strategy of relocation. Empty parcels of land were bought by the city and relief organizations, and new communities were constructed and populated with flood victims [61]. These communities,

typically known as "relocation", "resettlement", or "IDP" (internally displaced persons) sites, ranged in size from a few thousand people to tens of thousands of people and were typically located outside of the city's central urban area (Figure 6). The largest site, Calaanan, was already a part of the city's socialized housing "piso-piso" program before the flood and is about an hour away from the city center by public transport; it is intended to accommodate about 6000 families (about 40,000 people). Two other major relocation sites, Pagatpat and Ecoville (the latter of which was established by Xavier University rather than the city), have capacities of about 1000 and 500 families, respectively. Calaanan and Pagatpat are located in regions susceptible to flooding, while Ecoville is located relatively far from the city center (which increases commuting time and costs for residents) (Figure 6). In July, 2014 (31 months after the flood), about 8000 of the 14,000 permanently displaced families had been relocated to 14 different relocation sites (implying that about 6000 families, or about 40,000 people, had not yet been relocated).

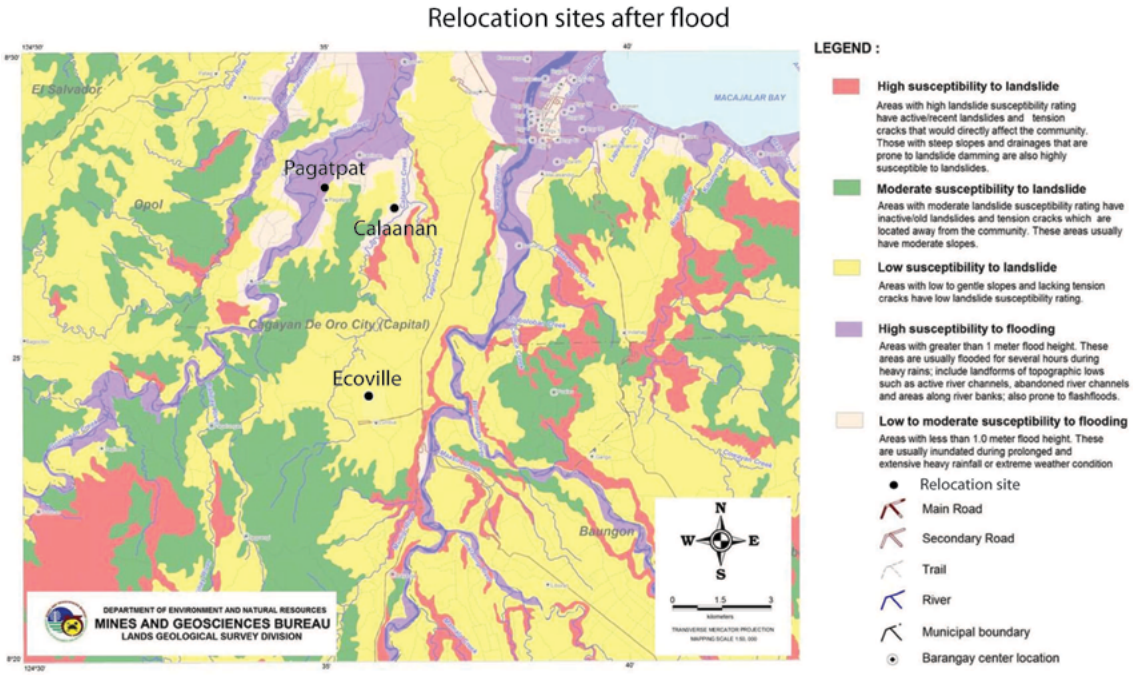

Figure 6: Location of major relocation sites superimposed on hazard map showing areas with high susceptibility to flooding or landslides (purple and red, respectively). Adapted from Philippine Mines and Geosciences Bureau, 2011.

Government agencies also carried out local meetings and workshops to identify factors that contributed to the disaster [52]. One factor commonly cited by interviewees was increased runoff from the watershed area, which

was believed to be the result of intensive land use such as logging, mining, and plantation agriculture. Before the flood, these practices had produced noticeable sedimentation in the city [27], causing the Cagayan River to become shallower. High rates of erosion occurred during the flood, and the floodwater debris seemed to indicate illegal logging activity in the watershed [62]. Other factors contributing to the disaster frequently cited by interviewees included the local government's lack of preparedness and response, political turfing (in which local government authorities would not cede control to other local or outside groups), patronage-based relief (in which relief was provided preferentially to political supporters) [52], the large number of people, especially informal settlers, living in flood zones along the banks of the Cagayan River (including those in government-sanctioned socialized housing), the widespread assumption that Sendong would not cause serious flooding (resulting in a lack of evacuation and other preparatory action by the local population and city government), and the fact that when flooding did occur, it progressed rapidly in the middle of the night when people were sleeping.

Since the flood, much attention has been placed on preventing future disasters in Cagayan de Oro, motivated by local experience, other high-profile disasters in the Philippines (such as Typhoon Yolanda/Haiyan in 2013) [6], and a widespread belief that climate change is presently increasing the unpredictability of weather conditions. When interviews were carried out in 2014, the city government (under a new mayor) was promoting a range of climate resilience strategies: special farming techniques for reducing runoff, using mangroves and bamboo to reduce riverbank erosion, planning construction of a large dike for flood control, and the development of a disaster contingency plan for up to 160,000 people. In addition, civil society organizations, such as the Cagayan de Oro Riverbasin Management Council, were studying the relationship between watershed land use and flood risk to the city [27], and an integrated riverbasin master plan was in development.

The city has also received attention in national disaster risk reduction efforts. The Climate Change Commission of the Philippines, an office of the national government, included Cagayan de Oro in its "Project Climate Twin Phoenix", which operated from 2012—2014 and

provided tools for local governments to reduce climate-change-related risks, particularly in regions that had recently experienced storm-related disasters [20]. The outputs of the project included high-resolution flood maps for present and projected future conditions, a mobile computer application for collecting household survey data, and government guidelines for incorporating hazard data into land-use planning.

Despite all this attention, Cagayan de Oro still faces significant challenges. Years after the flood, tens of thousands of people still wait for relocation, and only about half of the city's informal settlers have been relocated. According to city government officials, an estimated 10,000 people remain in high-risk zones. And according to interviewees, some informal settlements in the flood zone are being re-established.

Even for those already living in relocation communities, life is uncertain. Sources of income are scarce. Those who travel to the urban core of the city to make a living, often through informal day labor or street vending, lose a significant fraction (often about half) of their income to daily transportation costs. According to city officials, finding suitable and adequate land for relocation sites is difficult, and some of the sites that have already been established are located in hazardous areas or lack basic services such as potable water. Many opt to remain in high-risk areas of the city even if given the opportunity to move to a relocation community. As one interviewee described, for many, it is better to face the probability of death or homelessness from a disaster in the city than to be guaranteed decades of living in a relocation site.

3. Immediate causes of the disaster

What can we learn from the experience of Cagayan de Oro? Perhaps most striking is that, in retrospect, the potential for disaster seems clear: A city located in a flood plain, a history of worsening flooding due to land use outside of the city's political jurisdiction, socialized housing and tens of thousands of informal settlers near the riverbanks, a local government that had not fulfilled even mandatory disaster preparedness duties, and the potential for increasingly unpredictable weather due to climate change. Yet equally striking is that, at the time, few people saw the potential for disaster. Even as Sendong approached, evacuations were not carried out; a widespread belief persisted that Cagayan de Oro was a city that simply did not flood. How can we make sense of this?

The causes of the disaster in Cagayan de Oro were particular to that place, yet they reflect larger challenges that are widespread throughout the country and even throughout the world. In other words, there were local, immediate causes at play as well as more systemic root drivers. While addressing root drivers offers the attractive prospect of large-scale solutions, it is also important to consider the immediate causes, because they inform us what the *actual* causes of the disaster were. For example, the national government responded to the disaster in Cagayan de Oro largely by creating high-resolution flood maps of the city using LIDAR and a mobile app for taking demographic surveys. These are no doubt useful, but do they really address the causes of the disaster in Cagayan de Oro? Before the flood, the local government already had access to hazard data; the problem was not the resolution—the problem was that the data were not used. And even without granular demographic information, it was clear that tens of thousands of poor informal settlers were living near the riverbanks. If the cause of the disaster was not a lack of information, then what was it?

Multiple factors led to the disaster triggered by Tropical Storm Sendong. On the night of the storm, the factors that combined to cause disaster were:

- The presence of formal settlements and infrastructure, including socialized housing, in flood-prone areas.
- The presence of informal settlements in flood-prone areas.
- Land use practices in the upland watershed (potentially including illegal practices) that increased runoff rates.
- The lack of preparedness by the city government.
- Widespread complacency about the potential for a tropical storm to produce disastrous flooding in the city.
- The sudden, nighttime onset of the flood.

If *any one* of these factors had been different, then the flood might not have been so disastrous, which illustrates an important point: A disaster can be caused by multiple risk factors (not just one) that become extremely dangerous only in the presence of other risk factors. Furthermore, nearly all of the immediate causes are related to governance—in particular, a governance structure that relies upon political patronage in order to sustain itself, which is a broad trend in the Philippines. Another broad trend of particular importance in the case of Cagayan de Oro is the persistence and growth of informal settlements, which is itself related to governance and political patronage. These two trends—governance based on political patronage and the extensive presence of informal settlements in hazardous areas—are root drivers that underlie all of the immediate causes (with the exception of the timing of the flood). In the next section, we analyze these two root drivers in greater detail.

In the remainder of this section, we briefly discuss possible strategies for addressing the immediate causes. Attention on these factors is often focused immediately after disasters, when awareness is high [63]. Yet if awareness is not converted into tangible policy changes, resilience may not be increased in the long term. For example, consider that only two years after the Sendong disaster, Typhoon Yolanda caused an even larger set of disasters throughout the Philippines, in which

inadequate pre-emptive action was again an immediate cause. Thus, awareness of the potential for disaster is not sufficient to prevent it.

The presence of formal settlements and infrastructure, including socialized housing, in flood-prone areas. Geohazard maps and other hazard data can be used in urban planning to reduce climate-related risks. However, the availability of hazard data does not guarantee their use (as illustrated by the present case), and hazard information based solely on past experience may become inadequate as climatic conditions change. Strategies for incorporating hazard data into urban planning include technical experts working closely with or within local governments, policies to monetize and internalize risks incurred through building in hazard zones, and disseminating hazard information to local occupants and potential investors.

The presence of informal settlements in flood-prone areas. Even with knowledge of hazards, informal settlers often move to hazardous areas such as riverbanks, steep hillsides, and exposed coastlines due to a lack of more attractive options. After the flood in Cagayan de Oro, for example, some informal settlers moved back onto hazardous riverbanks. Elsewhere in the Philippines, informal settlers have returned to the areas devastated by 2013's Typhoon Haiyan. Local governments sometimes discourage informal settlement through the use of eviction, neglect, or the construction of infrastructure to block occupation, but these strategies leave the fundamental drivers of informal settlement unaddressed. Investing in rural and suburban economies and developing affordable and convenient transport to and from the city may help to alleviate demand for informal settlement in the urban core. In the short term, helping informal settlement households to move to less hazardous areas while maintaining sources of income could help to reduce risk.

Land use practices in the upland watershed (potentially including illegal practices) that produced increased rates of runoff. Watershed management is a major challenge in the Philippines, as many cities are located on flat plains between the coast and upland water catchment areas. Such watersheds often extend through multiple political jurisdictions, making comprehensive management policies difficult to

develop and enforce. Civil society organizations can play an important role by acting as a platform for cross-boundary coordination. For example, the Cagayan de Oro Riverbasin Management Council coordinates between rural upland communities and urban lowland communities in efforts to prevent deforestation and reduce flood risk.

The lack of preparedness by the city government. After a disaster, it is common to hear sentiments from local leaders of "never again". However, heightened awareness alone—without tangible changes in disaster preparedness policy and practice—is insufficient. Consider, for example, that only two years after the Sendong disaster, Typhoon Yolanda/Haiyan caused an even more severe set of disasters throughout the Philippines for which inadequate pre-emptive action across multiple levels of government was again an immediate cause. When possible, no-build zones and protective infrastructure should be established pre-emptively rather than reactively. For a country as exposed to tropical storms as the Philippines is, *barangay* (community) storm shelters and pre-emptive evacuation should be standard rather an exception [64] [65]. New policies should be regularly revisited and compared to norms on the ground, however, as gaps between laws on the books and practices in reality can lead to complacency and corruption. Regular review by an independent disaster preparedness agency—whether governmental or non-governmental—may improve disaster preparedness and local government accountability.

Widespread complacency about the potential for a tropical storm to produce disastrous flooding in the city. When awareness is low and policies are lacking, then complacency becomes dangerous. The key is to have effective policies in place so that disaster risk is reduced even when popular awareness is low. Procedural reforms for disaster preparedness and continual education and outreach are both important. Evacuation effectiveness should also be improved by ensuring adequate evacuation and storm shelter infrastructure and improving security for unattended property during evacuations.

The sudden, nighttime onset of the flood. The lack of evacuation and warning to local people made this factor disastrous. In the absence of local government preparedness, non-governmental

organizations communicating up-to-date hazard information to local people and organizations may be helpful.

4. Root drivers of the disaster

Two root drivers that contributed to the disaster in Cagayan de Oro were patronage politics and informal settlements in hazardous areas. These factors are widespread throughout the Philippines and in other countries. The systemic nature of these factors makes them both important and challenging to address.

Although these drivers are not new topics in the policy or research worlds—both have been studied extensively—their importance for climate change resilience is not often addressed directly. Most resilience efforts focus on immediate causes of disaster rather than the larger socioeconomic factors that underlie them. Yet it may be important to address both immediate *and* root factors in order to increase resilience to climate impacts meaningfully. Furthermore, considering root drivers provides an opportunity to include a wider range of expertise in addressing the hazards of climate change.

Addressing root drivers is a major challenge, because they can be entrenched social, economic, and political issues that change on long timescales (*e.g.*, decades), and they can have causes of their own that may not be well understood (*e.g.*, the game theory of political patronage systems [66], the socioeconomic forces driving the growth of informal settlements worldwide [67] [68], and so on). Root drivers can also be coupled to each other. For example, the selective enforcement of property and zoning laws can be used as a form of political patronage for informal settler demographics, and the support that politicians receive in return can keep them in power, so that political patronage and informal settlements can reinforce and entrench each other.

In the following sections, we discuss and analyze two root drivers: patronage politics and informal settlements. Both are highly complex

issues that require long-term attention to address and are highly relevant to climate impacts. Our purpose is not to imply that these are the *only* widespread drivers of climate risk in the Philippines or in Cagayan de Oro (watershed land use and management is another widespread driver of flood risk in the country, for example); rather, we focus on these two drivers because they are highly important and receive relatively little attention in the world of climate impacts.

4.1 **Patronage politics**

One root driver of the disaster in Cagayan de Oro was a governance system that allowed the presence of formal and informal settlements in flood-prone areas, promoted the occupation of flood-prone areas through socialized housing, neglected to establish a pre-emptive disaster management plan, and failed to carry out evacuations, all despite the availability of hazard information in the days and years prior to the flood. Many of these problems can be traced, directly or indirectly, to the dynamics of political patronage.

In patronage politics, sometimes referred as the *padrino* system in the Philippines, political power is used in a discretionary sense, with little oversight, to dispense favors (*e.g.*, construction contracts, business permits, funding from congressional pork barrels) in order to obtain support from allies or constituents, disadvantage or neutralize political opponents, and accumulate economic assets for family and other allies. The art of patronage requires not only judicious dispensation of favors, but also utilization of patronage from others, including those with greater political power. The logic of patronage (which rests on discretionary and wide-ranging obligations rather than contractual and limited obligations) is a common professional and personal dynamic in the Philippines, from day-to-day employment of normal people to interactions between government officials [69]. At times, patronage politics can become similar to bossism, in which individuals exercise unchecked and sometimes extralegal power in the control of a region or political group [70], and patronage dynamics can also contribute to the development and entrenchment of political dynasties [40] [41]. Although patronage

dynamics—and the problems that can arise from them—are common topics of conversation in the Philippines (often private), such extensive patronage systems are not unique to the Philippines, nor are they unique to the present. Other cases of entrenched patronage politics include "Old Corruption" in 18th-century Britain [71], political machines in the 19th-century United States, the Christian Democracy party in 20th-century Italy [72], and modern politics in Indonesia and Malaysia [73] [74] [75], for example.

Patronage politics manifests in various ways. For example, politicians may promise gifts (*e.g.*, livestock, a motor bike, and so on) to households conditional on electoral victory, or political authority may be used to give business permits or contracts to family and friends. Discretionary law enforcement is another form of patronage that is exacerbated by the mismatch between law and social norms [66]. Despite the fact that patronage is often (but not always) associated with corruption in the Philippines, those who do not participate generally put themselves at a disadvantage [76], making patronage dynamics difficult to avoid or reform. Some policies actively encourage or require engagement in patronage, such as the Philippines' longstanding pork barrel system, which provides politicians with an automatic lump sum that can be distributed at their discretion [77].

In our interviews in Cagayan de Oro and throughout the Philippines, we observed various specific mechanisms through which patronage politics increases disaster risk, including nepotism, selective law enforcement, political turfing, and obfuscation. We consider these in turn.

The highly personal and favor-based nature of patronage politics makes nepotism in the appointment of public officials frequent. This reduces the competence of public servants and the capacity of governments to prepare for and respond to disasters. Sometimes those placed in charge of disaster preparedness—even for large cities—lack any training or experience in their new public duties. Consider the difficulty (or impossibility) of organizing and executing disaster logistics if it were your "first day", so to speak. Increased formal standards for political appointments in disaster risk reduction and management may be useful in increasing the capacity of local governments, competition for such appointments, and public confidence in local governments.

Selective law enforcement is another problem that can be exacerbated by patronage politics. Illegal activities that increase disaster risks can enjoy protection as a form of patronage from local politicians or other power brokers. Allowing illegal settlements to persist in hazard-prone areas (or directly promoting the settlement of such areas) is one example of selective enforcement as a form of patronage. Another is turning a blind eye to illegal land use, such as the apparent illegal logging and mining in the Cagayan River watershed, which in turn increased the severity and destructive power of the flood in Cagayan de Oro. Some illegal activities—such as illegal logging—are so highly visible that their persistence without challenge suggests some form of political protection.

Political turfing is an extremely prominent characteristic of patronage politics with harmful results both pre- and post-disaster. Simply put, those within a patron's sphere of supporters tend to receive help, and those who are outside of it tend not to. Conversely, aid can be used as a way to buy support. Thus, what a family receives by way of aid or other resources can depend heavily on whose political turf they live. Those with strong patrons receive much, those with weak patrons receive little, and some communities get left out entirely. For example, some *barangays* (communities) we interviewed did not possess even a single basic storm shelter, because they did not have access to a political patron who was both able and willing to connect them to funding. Such scenarios vastly increase the vulnerability of some communities to extreme weather impacts. Furthermore, after a disaster occurs, politicians often use aid as a form of patronage for expanding (or preserving) their political turf; incursions by political adversaries are often resisted, even if this means keeping aid out. Interviewees in Cagayan de Oro frequently noted that they did not trust the local government because relief was "political". And when Typhoon Yolanda/Haiyan struck the city of Tacloban in 2013, political turfing between the city's mayor, the Philippine president, and local politicians led to a highly uncoordinated response [78]. As harmful as political turfing is in disaster situations, the incentives for it are clear: in an environment where patronage is a primary form of obtaining electoral support and aid is scarce, available resources are used to reward supporters and buy political support—and those who do not use patronage wisely may not last long. Even politicians we interviewed who are considered highly

adept at the patronage system pointed to the problems it produces in disaster situations. Decoupling disaster preparedness and response from patronage will require various strategies and time. Basic preparedness resources—such as storm shelters—should be supported in each *barangay* as a standard policy, rather than being contingent on special support. Furthermore, disaster aid should be depersonalized so that it cannot as easily be used for political turfing—perhaps by pooling aid resources and having distribution be administered by a standard government agency.

Finally, patronage politics leads to post-disaster obfuscation. Identifying or discussing errors made by patrons (whether employers, local power brokers, or politicians) is risky, because it can jeopardize future patronage. Thus, many different versions of the same event can emerge depending on what is convenient for a given person's relationships. Even relatively straightforward pieces of information—such as what event caused the disaster, when and where the disaster occurred, when and how much aid was received (and from whom), and what information was available prior to the disaster—can become difficult to establish. This makes post-disaster assessment, learning, and policy reform difficult. It may be difficult to avoid this factor as long as patronage dynamics are dominant in the public and private sectors.

Addressing patronage politics in the Philippines will likely take decades. However, in the shorter term, reforms can be implemented to address the most severe ways in which patronage politics increase disaster risk. Discouraging nepotism in public safety appointments, more consistently enforcing laws affecting disaster risk and public safety, establishing minimum government supports for disaster preparedness, and depersonalizing aid to avoid political turfing are all potentially feasible steps toward decreasing the negative effects of political patronage in disaster situations.

4.2 **Informal settlements in hazardous areas**

Anoother core factor of the disaster in Cagayan de Oro was the widespread presence of informal settlements on the banks of the Cagayan River. Not only were many of those killed residents of informal settlements,

but the flood and subsequent "no-build zones" permanently displaced tens of thousands of informal settlers, creating a long-term resettlement problem. Informal settlements are not unique to Cagayan de Oro; they are common in the Philippines as well as in many other countries. Given the vulnerability of informal settlement communities to extreme weather events and changes in environmental conditions, such communities could constitute a major topic in climate resilience efforts.

The term "informal settlement" is loosely defined. Typical definitions include long-term illegal occupation of private or public land, insecurity of tenure, and a lack of basic services such as water and sanitation. The terms squatter settlements, irregular settlements, shantytowns, and slums are also used, though distinctions exist between them (the term "slum", for example, often refers to conditions of poverty and the lack of basic services regardless of whether occupation is legal or illegal).

Widespread informal settlement has been a feature of modern states for hundreds of years [68]. Since the mid-20th century, however, such settlements have grown quickly around the globe alongside rapid urbanization processes [67]. For example, the urban population of Sub-Saharan Africa is currently estimated as growing at a rate of about 10 million people per year, with half of those people moving permanently into informal settlements [79]. In the urban zones of developing countries, it is typical for about 1/3 of the population to live in informal settlements.

Today, it is estimated that about 1 billion people (about 15% of the global population) live in informal settlements. This is expected to grow to 2 billion by 2030 [80]. Some settlements contain tens or hundreds of thousands of people (as in Cagayan de Oro), while others contain millions (as in the urban zones of Mexico City, Nairobi, and Mumbai) [67].

In the Philippines, estimates of informal settlement vary widely. A 2007 government census estimated that 3% of the national population were informal settlers (defined as those who inhabited land without permission and without paying rent) [81]. However, this estimate is much lower than the rates of informal settlement observed regularly in cities throughout the country. For example, informal settlement estimates in the Philippine

National Capital Region (which had a population of 12 million in 2010 [82]) are typically in range of 25—40% of the population (which alone would meet the government estimate for the entire country) [83] [84]. Estimates in Cagayan de Oro were slightly lower (15—20% of the population).

Informal settlements constitute a core topic for climate resilience for multiple reasons. First, they are often located in hazardous areas (such as areas prone to flooding and landslides) due to the fact that safer (higher-value) land is typically developed in the formal sector and faces higher competition for use. Furthermore, those living in informal settlements are typically poor, with *ad hoc* dwellings, low incomes, lack of work security, and lack of secure property. These factors further increase risk to extreme weather events. For example, in Cagayan de Oro, many of the deceased were those who stayed behind—even as the water rose and their families fled—to watch over their property (recall that informal settlers typically would not have insurance or other formal mechanisms for protecting themselves themselves from theft). Thus, informal settlements represent a population globally that is large and growing, highly exposed, and highly vulnerable to natural disasters. The potential for humanitarian crises and large-scale displacement is high.

The formation and persistence of informal settlements are active areas of research [85] [86] [87]. One driver of their growth appears to be a reduction in economic opportunities in rural areas and an increase in the concentration of such activities in urban centers, generating a demand for urban settlement that can overwhelm formal housing stocks and job markets (as well as the capacity of administrative systems to accommodate growth). A lack of convenient and affordable transportation produces further incentives to live close to sites of income (*e.g.*, urban markets, busy streets for vending), which increases demand for urban settlement further. Some public policies encourage the growth of informal settlements. For example, a proportion of city revenue in the Philippines comes directly from the national government, with the amount partly dependent on the city population [88] [89], which incentivizes the population boost that cities get from informal settlements. Nationally, focusing investment on cities to the exclusion of smaller-town and rural locations—though a

strategy for building international, "champion" cities and attracting foreign investment—can lead to an unmanageable flight to urban zones.

In the Philippine context, informal settlements are entwined with the issue of patronage politics [70] [69] [66]. Informal settlers have few legal protections from eviction or loss of property, so they may be more dependent than other citizens on protection from local politicians. Such protection is often traded for electoral support. Thus, politicians often face a difficult choice: support the informal settlements as they are and be seen as irresponsible and incompetent if disaster strikes, or remove the informal settlements and be seen immediately as unsympathetic and inhumane (and potentially lose office). The politics of informal settlements can become highly personalized, but their prevalence and growth worldwide indicates that structural socioeconomic factors are at play, and addressing informal settlements may require more than just local reforms.

What strategies could reduce disaster risk to informal settlements? Relocation, such as in Cagayan de Oro, is one strategy [61]. Upgrading, in which basic services such as water and sewage are extended to informal settlements, is another [80] [90]. Providing occupants with formal security of occupation (intended to promote home capital investments) has also been tried [87]. Macroeconomically, some have proposed that stronger property laws could make living in the formal economy more attractive [68], while others have suggested that economic dislocations arising from international investment and trade policies must be addressed [67]. And some argue that informal settlements should be accepted as a normal part of "semi-planned" urbanization [91].

The drivers of informal settlement will not be addressed overnight. However, a core question from the perspective of climate resilience is: how can exposure and vulnerability to climate hazards be reduced? To reduce exposure, informal settlers need safe, affordable places to live near sites of income. Investing in economic development in the urban periphery, in small towns, and in rural settings may alleviate the unmanageable demand to live in urban cores. Transportation infrastructure is another key piece—if living on safe land requires a commute to daily work, then transportation must be affordable

and convenient. The use of trusted organizations—whether state or non-state—to provide informal settlements with timely disaster information, facilitate evacuation, and secure property may help to reduce vulnerability when extreme weather events do occur.

5. Conclusions

In this case study of climate change impacts, we analyzed a flood caused in 2011 by Tropical Storm Sendong (international name Washi) in Cagayan de Oro, one of the main urban centers of the Philippines, which displaced approximately 100,000 people and killed over 1000. Efforts to increase both local and general resilience to climate change in the Philippines are of interest due to the country's exposure and vulnerability to extreme weather events and the increasing frequency of such events due to climate change.

We utilized a three-part approach to our analysis: first describing the case, then identifying immediate causes of the disaster, and then identifying root drivers of the disaster. Increasing both local and general resilience to climate impacts may require addressing both immediate causes and root drivers of climate risk.

Numerous immediate causes combined in order to produce the disaster in Cagayan de Oro, including the establishment of formal settlements and infrastructure in flood-prone areas, the presence of informal settlements in flood-prone areas, land use practices in the upland watershed (potentially including illegal practices) that produced increased rates of runoff, the lack of preparedness by the city government, widespread complacency about the potential for a tropical storm to produce disastrous flooding in the city, and the sudden, nighttime onset of the flood. Thus, the disaster was caused not by a single factor, but by a confluence of factors. Focusing on addressing these immediate causes may be useful for local resilience efforts.

Nearly all of the immediate factors in the case could be traced to two root drivers of risk: patronage politics and informal settlements. These are prominent issues in the Philippines and in other parts of the world, but

their connections to climate change resilience efforts have not often been addressed directly. Specifically, patronage politics can produce nepotism, selective law enforcement, political turfing, and obfuscation that increase disaster risk. Informal settlements represent large populations with high exposure and vulnerability to climate-related hazards. Policy reform and organizational efforts to address these risk factors could increase general resilience to climate impacts in the Philippines and elsewhere.

We expect the need for climate change resilience studies to become increasingly great as climatic change progresses throughout the century. The reasons for increasing climate resilience are many, including humanitarian (reducing the incidence of death, harm, and poverty resulting from climate change), economic (avoiding shocks and losses incurred through climate change in a globally connected economy), political (guarding against political destabilization, state disintegration, and mass displacement due to climate effects), and cultural (safeguarding cultures and heritage traditions so that future people can experience and learn from them).

Case studies of climate-related risk, as analyses of natural experiments of social and environmental interactions, can provide us with a grounded understanding of how climate disasters unfold and what factors underlie them. The specific and general lessons they impart can form the empirical backbone of the social inferences needed to plan and formulate policy. Going forward, databases of climate risk case studies (with identification of immediate causes, root drivers, and strategies to address those factors) may be useful in formalizing and advancing climate resilience efforts around the globe.

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