Climate and Disaster Risk Assessment: Iloilo City

December 2020

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Disaster risk results from the interplay of the hazard, exposure, and vulnerability characteristics of a given community. To assess disaster risk, it is important to understand not only the occurrence of natural hazards, but the socio-economic issues of the affected communities as well. However, the risk framework of the Intergovernmental Panel on Climate Change Fifth Assessment Report (IPCC AR5 – WGII SPM, 2014, see Figure 1) also highlights that, while disaster risk is created locally, it may also be influenced by larger processes such as climate change and development trends. Changes in climatic drivers, in terms of averages and extremes, can intensify existing disaster risk, or create entirely new threats.

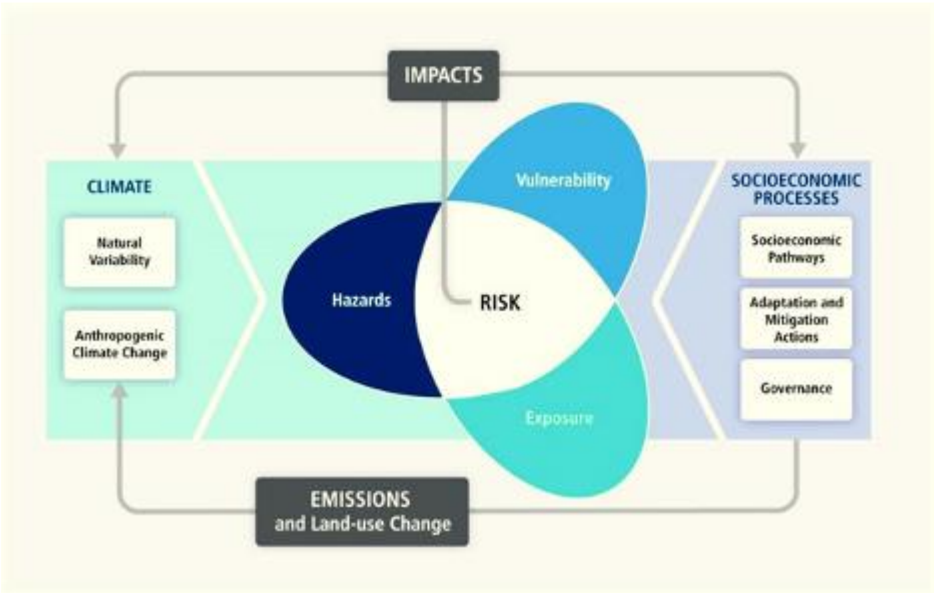

Figure 1. Climate and disaster risk conceptual framework (Source: IPCC AR5 – WGII SPM, 2014).

Through the Coastal Cities at Risk in the Philippines: Investing in Climate and Disaster Resilience (CCARPH) Project of Ateneo de Manila University, and the Resilient LGU Program of the National Resilience Council, Manila Observatory (MO) together with University of the Philippines - Visayas (UPV) and Iloilo City Government conducted a Climate and Disaster Risk Assessment (CDRA) of Iloilo City. Through a series of online meetings between MO and UPV-LGU, an Integrated Risk Analysis (IRA) based on hazard-exposure-vulnerability maps was conducted. Adopting a coaching and mentoring approach, MO facilitated various analysis activities that built on the key steps outlined in the Enhanced LGU Guidebook on the Formulation of LCCAP (2017) Book 4 by the Department of the Interior and Local Government (DILG).

Iloilo City

Located within the southern part of Panay Island, Iloilo City is a 1st income class highly urbanized city in the province of Iloilo. The city comprises six (6) districts, and serves as the center of commerce and industry in Western Visayas. Being a highly urbanized city with one hundred and eighty (180) barangays, majority of its land cover are built-up with some low to medium density tree cover sparsely located in the uplands (Manila Observatory, 2015).

Iloilo City has relatively low elevation, and is situated along the coast. Highly dense populations are located within the coastal areas and along the Iloilo River, making these communities highly susceptible to flooding and storm surge.

In recent years, Iloilo city has also experienced a number of major water shortage problems. In 2009 and 2007, the city experienced water crises due to the impacts of El Niño (Porio et al., 2019). Similarly, in 2015, the city declared a "state of imminent water crisis" again induced by El Niño (PNA, 2019). Over extraction of groundwater is also becoming a major concern for the city, as the Metro Iloilo Water District (MIWD) and many households mainly rely on groundwater for potable water (National Water Resources Board, 2013).

1 Climate profile

The average temperature in Iloilo City is about 27 °C. The warmest month is May with a mean temperature of 28.5 °C, while the coldest is January when the temperature goes down to 26 °C. The city has two pronounced seasons similar to a type I climate in the Modified Coronas classification: dry from November to April and rainy for the rest of the year. The mean monthly rainfall during the wet season is about 250 mm, with maximum rain of 300 mm around July and August. Tropical cyclones (TCs) are more frequent at the end of the year around November and less frequent in February. Most of these TCs affecting Iloilo City are tropical depressions (TD) and tropical storms (TS).

2 Climate projections

Average temperature is projected to significantly increase in Iloilo City (see Figure 2a). Under a medium emissions scenario, temperature is expected to increase by 1 °C in the near future to about 2.2 °C in the late 21st century. However, under a high emissions scenario where no mitigation measures are implemented, the rate of warming will be much faster and the average temperature can increase by up to about 4 °C in the late 21st century.

In contrast, there will be no significant changes in average rainfall (5% decrease in annual rainfall, see Figure 2b), as well as in extreme rainfall events (3% increase in contribution to total annual rainfall). However, projections show that there will be fewer but stronger typhoons (category 4 and 5) in the future, packing more destructive winds (DOST-PAGASA 2018).

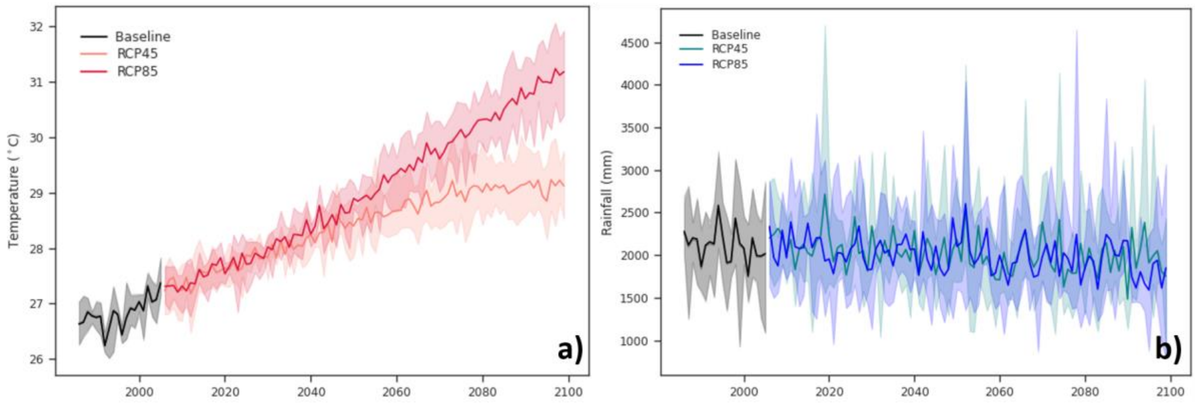

Figure 2. Annual trend of (a) Temperature and (b) Rainfall

Further analyses were done to look at the impact of climate change on drought events in Iloilo City. First, climate indices such as consecutive dry days (CDD) and consecutive wet days (CWD) were investigated. CDD is the maximum number of consecutive days where rainfall amount is less than 1 mm, and is used as an indicator of the maximum length of dry spells. In contrast, CWD is the maximum number of consecutive days where rainfall amount is greater than or equal to 1 mm, and a decrease in its value suggests that drought events are more likely to happen in the future. Results show that, in Iloilo City, CDD is projected to increase, while CWD is projected to decrease.

Second, the Standard Precipitation Index (SPI) values were calculated for Iloilo City, as shown in Table 1. SPI3 is used to describe agricultural drought, while SPI6 and SPI12 are often correlated with groundwater deficiency. Increases in SPI values suggest an increase in drought events in the future.

Table 1. SPI Values

Scenario	Period	SPI3	SPI6	SPI12
Baseline	1986 - 2005	2	2	2
RCP 4.5 (medium)	early (2016- 2035)	2	2	2
	mid (2046-2065)	3	3	4
	late (2080-2099)	3	4	4
RCP 8.5 (high)	early (2016- 2035)	3	3	3
	mid (2046-2065)	3	3	4
	late (2080-2099)	4	4	5

In Iloilo City, the number of agricultural drought events (SPI3) are expected to increase by 1 event compared to the baseline under the medium emissions scenario, and by 2 events under the high emissions scenario. More intense drought events related to groundwater deficiency (SPI12) will also increase in the late 21st century, as 4 events are detected in the medium emissions scenario, and 5 under the high emissions scenario -- compared to only 2 events in the baseline.

3 Climate risks and potential impacts in Iloilo City

Average temperature is projected to significantly increase in Iloilo City. In contrast, there will be no significant changes in **average rainfall** (5% decrease in annual rainfall), as well as in **extreme rainfall events** (3% increase in contribution to total annual rainfall). However, projections show that there will be fewer but stronger **typhoons** (category 4 and 5) in the future, packing more destructive winds. **Drought** is also more likely to happen as Consecutive dry days (CDD) are projected to increase, and consecutive wet days (CWD) to decrease. The potential impacts of these projected changes in the climate of Iloilo City are summarized in Table 2.

As climate change and extremes may also serve as a risk multiplier, the potential implications of climate-related disasters on **COVID-19** response are also summarized.

Flood and Typhoon

The rainiest months in Iloilo City fall between June and November, with many typhoons occurring at the end of the year. Given the low elevation and abundance of rivers and streams in the city, many of its barangays (up to 40%) have high to very high susceptibility to flooding (Figure 3).

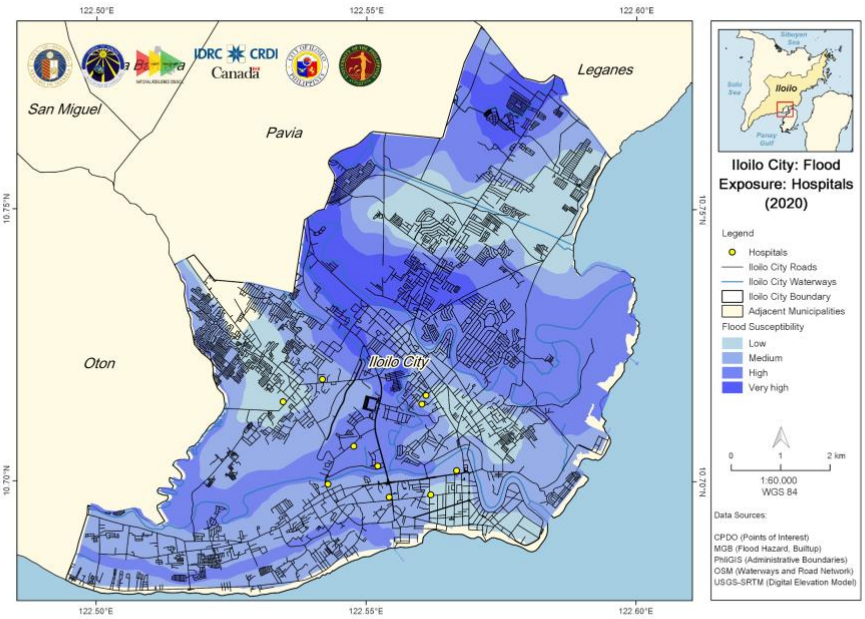

Figure 3. Flood exposure map of Iloilo City, overlaid with location of hospitals.

Table 2. Projected climate impacts in Iloilo City

<table>
<tr><th colspan="2">Climate projections</th></tr>
<tr><td colspan="2">
Average temperature is projected to significantly increase in Iloilo City.
No significant changes in average rainfall (5% decrease in annual rainfall), as well as in extreme rainfall events (3% increase in contribution to total annual rainfall).
Fewer but stronger typhoons (category 4 and 5) in the future, packing more destructive winds
Drought is also more likely to happen as Consecutive dry days (CDD) are projected to increase, and consecutive wet days (CWD) to decrease
Climate change and extremes serve as a risk multiplier, aggravating the impacts of the COVID-19 and potentially overwhelming capacity for response
</td></tr>
<tr><th>Projected Climate Impacts</th><th>Implications for COVID-19 response</th></tr>
<tr><td colspan="2">Flood</td></tr>
<tr><td>Loss of lives and properties especially in barangays with highly dense populations that are located along the coastal area and the Iloilo River

Interruption of economic activities in the larger Iloilo City:
commercial, industrial, institutional operations may stop
flooded city streets hamper mobility of both goods and services
Lower agricultural productivity

Suspension of classes

Increase in water-related diseases like dengue and diarrhea

Contamination of dug wells of households with water access level 1</td><td>Evacuation becomes more complicated due to need to observe social distancing especially in highly dense barangays

Flood-related diseases such as Dengue and Leptospirosis could add burden to hospitals responding to COVID-19

Crowding while fetching water from limited safe access points can increase likelihood of COVID-19 transmission</td></tr>
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Projected Climate Impacts	Implications for COVID-19 response
Typhoon / storm surge	
Widespread destruction of infrastructure especially within coastal areas Agricultural and livestock damages, decrease productivity in tertiary services ● Decrease in the volume of production of rice ● Increase in number of deaths of animals ● Decrease in fishpond aquaculture production	Evacuation becomes more complicated due to need to observe social distancing especially in highly dense barangay Power interruption due to typhoons could pose challenges to COVID-19 response in affected DOH facilities and hospitals such as limited ability to provide healthcare and services
Drought	
Lower agricultural productivity especially within cropland areas Competing use of already scarce water resource ● Water from Tigum River (Maasim) may drop to critical levels ● Drying of wells and acute shortage of tap water sources Increasing cost of water which further compromises urban poor communities' access to sanitation	Water shortage make it challenging to practice hygiene needed to combat COVID-19 Drought can dry out dug wells of households with water access level 1 prompting them to crowd around limited safe water access points. Crowding while fetching water can increase likelihood of COVID-19 transmission
Heatwave	
Increase in temperature could result in higher incidence of heat-related illnesses such as tiredness and stroke Greater demand for power Increase in number of grassfire incidence	Heat/brownout could induce people to stay outside, where they are more exposed to the virus Heat-related illnesses could add burden to hospitals responding to COVID-19

Flooding may lead to loss of lives and properties especially in barangays with highly dense populations that are located along the coastal area and the Iloilo River. During flooding events, economic and educational activities, as well as delivery of basic services (e.g. transportation and communication) within the city may also be disrupted. Continuous flooding may also bring about losses to local farmers, fisherfolk, and livestock raisers (FAO, 2017).

Flooding may also increase the risk of water-related diseases such as dengue, diarrhea and leptospirosis (WHO, n.d.), potentially adding burden to hospitals responding to COVID-19. Furthermore, where evacuation is necessary, the capacity of evacuation centers become significantly reduced due to the need to observe social distancing.

In the future, rainfall is *not* expected to significantly change in Iloilo City, both under the high and medium emissions scenario. With this, changes to existing flood risk would be determined more by future development decisions affecting exposure and vulnerability, rather than climate change per se. There is thus a strong need for Iloilo City to address persistent issues such as clogged drainages and unplanned urban development, especially along coastlines and rivers, in order to decrease flood risk.

Furthermore, given that many households in Iloilo City still rely on tubed or dug wells for cooking and drinking, special attention must be paid to preventing flood waters from contaminating the environment through increased sewage input. In the long-term, the city must work towards increasing these households' water access from Level 1 to Level 3 (Figure 4). Contamination of dug wells during flooding and lack of access to water in general may force households to crowd around limited safe water access points, increasing the risk of COVID-19 transmission.

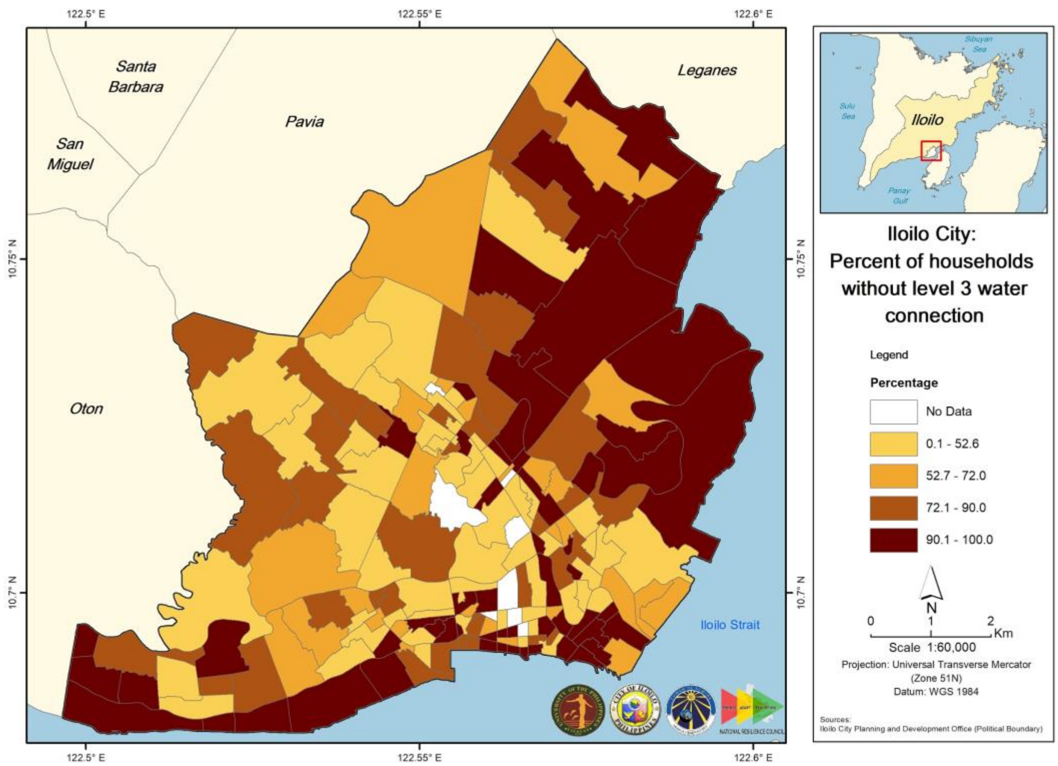


Figure 4. Households without level 3 water connection.

In addition to floods, strong typhoons can damage public facilities and infrastructure such as roads and bridges. In 2008, Typhoon Frank caused damages in agriculture and infrastructure that amounted to P1.6B in Western Visayas alone (ReliefWeb, 2008). In 2019, Iloilo Province was one of the worst hit by Typhoon Ursula, which caused thousands of people to evacuate on Christmas Day. Should another typhoon hit Iloilo City at the height of the pandemic, it could cause power interruptions that may limit the ability of affected DOH facilities and hospitals to carry out COVID-19 response activities.

In the future, climate change is expected to result in fewer but stronger typhoons in the Philippines (DOST-PAGASA 2018). Category 4 or 5 typhoons are particularly destructive because of strong winds, as well as storm surges. In Iloilo City, the coastal communities exposed to storm surge also comprise the most vulnerable sector of the population.

Drought and Heatwave

In the summer of 2019, Iloilo Province declared a state of calamity due to the El Niño-induced water crisis in the area. As early as 2015, Iloilo City has foreseen such challenge when it declared a "state of imminent water crisis." Unfortunately, climate analyses show that drought events are projected to further increase in the future.

Drought can lower agricultural productivity especially within cropland areas, putting the city's economy and food security at risk (FAO, 2017). Prolonged drought may also cause the water in Tigum River (Maasim) to drop to critical levels, and groundwater wells to dry up.

Currently, many households in Iloilo City rely on groundwater wells for potable water to be used for cooking (Figure 5) and even drinking (Figure 6).

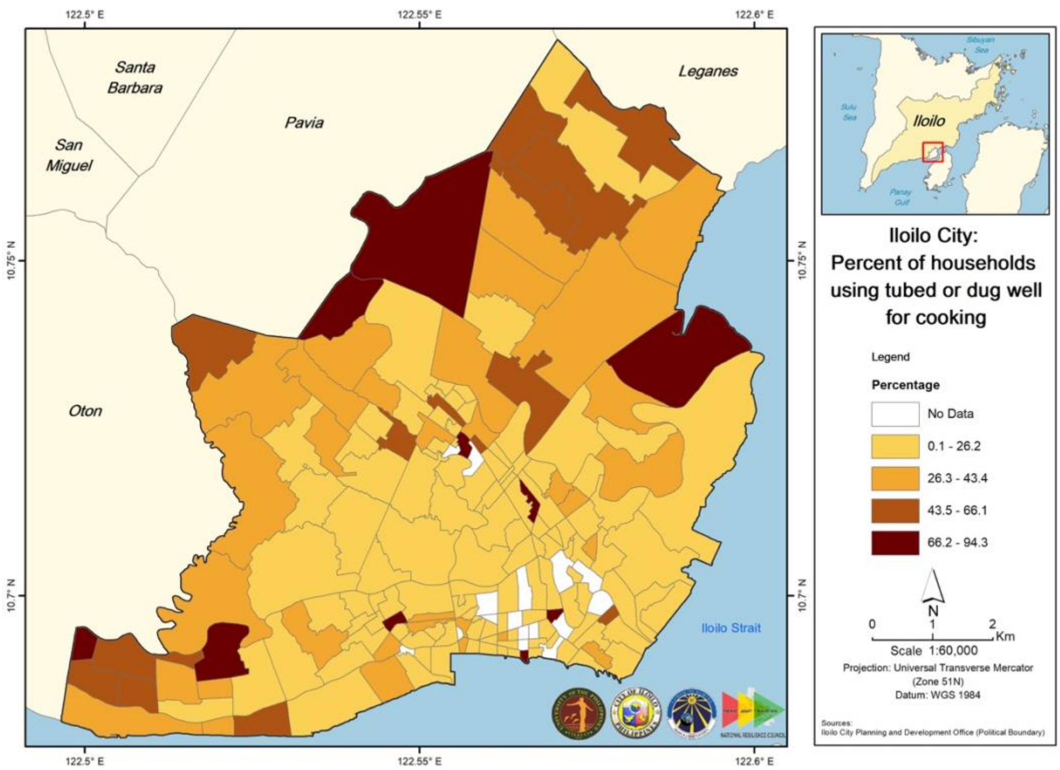


Figure 5. Map showing the percent of households in Iloilo City using tube or dug well for cooking.

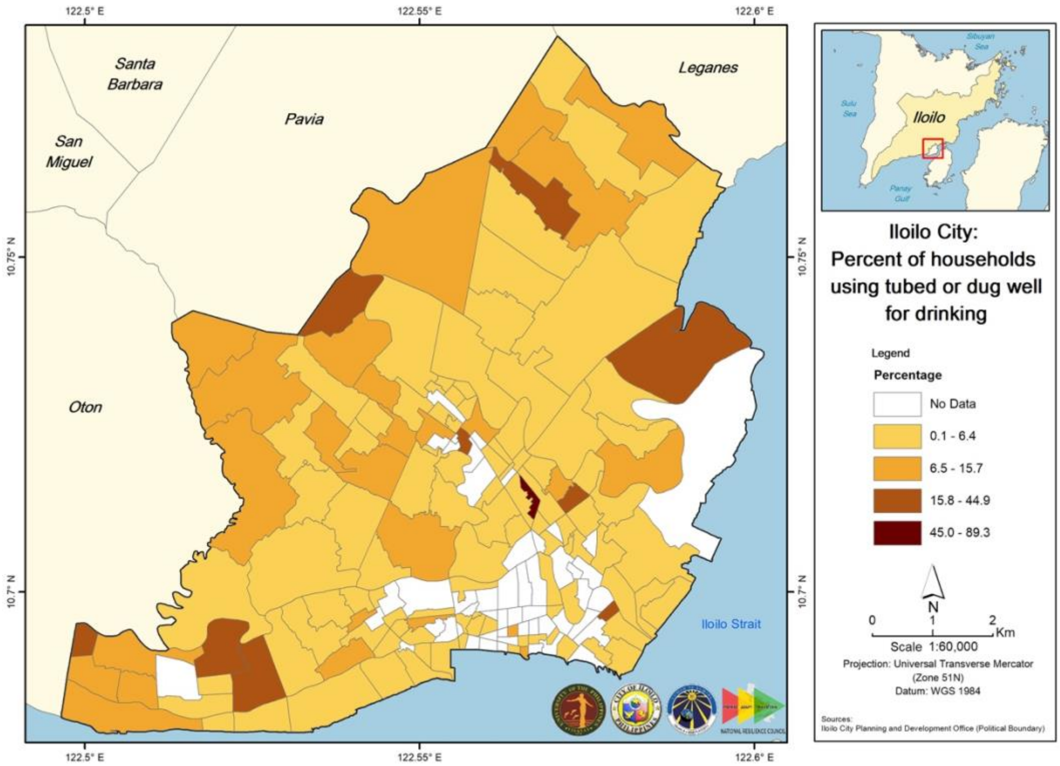


Figure 6. Map showing the percent of households in Iloilo City using tube or dug well for drinking.

Should a drought event occur at the height of the COVID-19 pandemic, it could pose additional challenges for Iloilo City. Droughts can make it challenging to practice hygiene needed to combat COVID-19, and even dry out dug wells of households with water access level 1. Water shortage can prompt households to crowd around limited safe water access points, increasing the likelihood of COVID-19 transmission.

Competing use of limited water resources for agriculture, domestic, and hygienic purposes can drive the cost of water up, further compromising the ability of urban poor communities to access safe water and proper sanitation.

Heatwaves or periods of excessively hot weather that often come along with drought events can also impact Iloilo City in many ways. Increase in temperature could result in greater demand for power with more houses using air conditioning units for longer periods, as well as a higher number of heat-related health cases such as tiredness and stroke especially among vulnerable groups (Margolis 2014).

Coupled with high humidity, heatwaves can further exasperate the city's COVID-19 situation. Indoor heat could induce people to go outside, where they are more exposed to the virus. Heat-related health cases could also add burden to hospitals responding to COVID-19.

It is worth noting that, especially in the built-up areas of Iloilo City, urban heat island effect can also exacerbate the impact of increasing average temperatures (Tan et al., 2010).

4 Social Vulnerability and the Iloilo City context

Hazards have differential impacts on individuals, people and communities due to various historical, social, economic and political circumstances operating in various scales (Thomas, K., et al., 2019). Social vulnerability is a preexisting condition or an inherent characteristic that weakens a community's ability to prevent financial loss or human suffering in disaster events. Thus understanding of social vulnerability of a community is crucial for effective intervention programs to reduce if not eliminate disaster risks.

An important component of the climate and disaster risk assessment (CDRA) conducted for Iloilo city was the social vulnerability analysis, which focuses on the inherent vulnerability of communities, social groups and individuals to environmental hazards. Thus, the social vulnerability assessment completes the CDRA of Iloilo city. It shows the socio-economic and demographic contexts in which hazards occur thus providing a comprehensive understanding of the disaster risks confronting the city.

Iloilo city is a coastal metropolis with a population of 447, 992 people (PSA, 2015). It has a total land area of 78.34 square kilometers and an aggregated coastline of 72 kilometers. Iloilo city is the capital of Iloilo province and the regional center of the Western Visayas region.

Like most coastal urban settlements around the world, Iloilo city is characterized by rapid population growth and urbanization accompanied by massive development in infrastructure, commerce and tourism that ushered in tremendous socio-economic and environmental changes. While this progress is beneficial to the economy, employment and business, it also increased disaster risks arising from climate-related hazards. The location and topography of the city makes it prone to storm surge, flooding and drought.

Methods, data sources

The concept of social vulnerability is the basic framework used in understanding the inherent vulnerability of Iloilo city to climate change and disasters. A context specific social vulnerability composite index was developed using indicators from various studies (See and Porio, 2015; Cutter, 2010). The unit of analysis were the barangay and the household. The data used were the 2016-2017 barangay situationer, the 2015 census, and the ecological profile of Iloilo city.

Eighteen variables which included socio-demographic indicators, housing characteristics, informal settling, disability, education and water access were considered to develop the social vulnerability index at the barangay level. Factor analysis (FA) with principal component method was used for the composite index. It is a statistical technique utilized to reduce a set of variables into a smaller number of factors that account for the variations in the data. This is done through the clustering of variables that measure the same themes and patterns. The factor analysis generated eight factors which were used to calculate the social vulnerability index score of each barangay.

To measure sampling adequacy and quality of data, the Kaiser-Meyer-Olkin (KMO) test was done. A score of 1.0 indicates optimal suitability for Factor Analysis and the lower limit is 0.60. For this study a score of 0.702 resulted from the analysis which indicates good quality of data and suitability for FA. Further, the Bartlett's Test of Sphericity was employed to test the null hypothesis that the correlation matrix is an identity matrix versus the alternative hypothesis that the correlation matrix is different from an identity matrix, an assumption that needs to be satisfied for FA. Since the p value is less than 0.001, the test rejects the null hypothesis at 5% level of significance implying that factor analysis is suitable for the data at hand.

Based on the data, scores for the eight factors were calculated then added to come up with the composite social vulnerability index score for each barangay. This additive model was employed so as not to make prior assumption on the importance of each factor in the vulnerability score. That is, each factor was considered to have the same contribution to the barangay's social vulnerability score.

Results of the social vulnerability assessment

The index score indicates the social vulnerability level of each barangay in comparison to the other barangays of the city. The scores were categorized into low, moderate and high social vulnerability based on the minimum and maximum values.

Majority or 121 (67%) out of the 180 of the barangays fall under the moderately vulnerable category, 20% are of low vulnerability while 13% are highly vulnerable (Table 3). The ones with high vulnerability scores are mostly located in the coastal zones (Figure 7). These are the most populous communities, with high dependency ratio, housing mostly made of light materials, they lack access to level three water system, and have relatively lower educational attainment.

Table 3. Barangays with low-moderate-high social vulnerability in Iloilo City.

Level	No of Barangays	%
Low	36	20
Moderate	121	67
High	23	13
Total	**180**	**100**

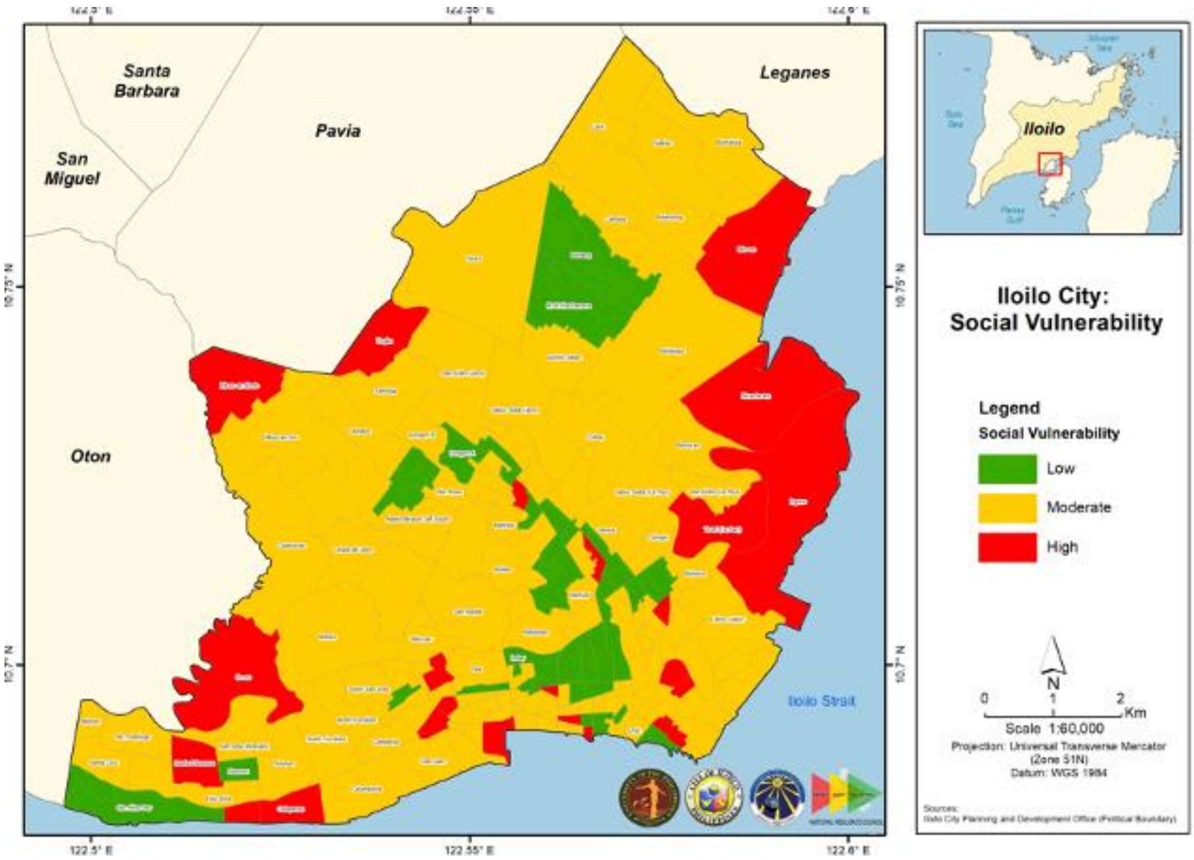


Figure 7. Social vulnerability of Iloilo City.

Integrated Vulnerability Analysis

An integrated vulnerability analysis was done by combining the social vulnerability index with specific hazards, particularly flooding, drought, storm surge and COVID-19. The city planning office identified the barangays/areas prone to these four hazards based on exposure data. Putting these together with the social vulnerability analysis, the overall vulnerability of each barangay were analyzed.

Among the four hazards, COVID-19 and flooding threaten the largest portion of the Iloilo city population at 65.8% and 53.65% respectively (Table 4). The barangays prone to these hazards have also the most number of vulnerable population such females, old dependents and persons with disability compared to the other barangays. For flooding, this simply implies that in areas where the hazard is highly likely to occur, we find a relatively higher number of people who will have difficulty evacuating on their own. Thus, the risk of injuries or even deaths is higher for these barangays during extreme flooding events.

Table 4. Social vulnerability of barangays at risk of flooding, drought, storm surge, and COVID-19 in Iloilo City.

	Flooding	Drought	Storm Surge	COVID-19
Barangays at risk	72	25	22	81
People exposed (2015 census)	240,360	97,969	107,894	294,947
% of total population of Iloilo City	53.65%	21.9%	24.08%	65.8%
Females	51.13%	50.30%	49.95%	51.2%
Young dependents (<5yo)	10.6%	11.55%	12.21%	10.8%
Old dependents (>65 yo)	6.2%	5.0%	4.7%	6.0%
Dependency ratio	47%	48%	50.05%	47.2%
Not literate	2%	2.4%	2.4%	2.06%
With elementary education	6.45%	22.1%	23.5%	21%
With high school education	20%	13.06%	13.7%	11.3%
In elementary occupations	11.14%	13.06%	13.7%	11.3%
Persons with disability	2%	1.3%	1.7%	1.8%

Note: Data on COVID-19 (as of Aug 9, 2020) obtained from Iloilo City Health Office.

Social Vulnerability of most at-risk barangays in Iloilo City

The integrated vulnerability analysis also enabled the identification of the top five barangays facing the highest risk to the four hazards (Table 5). The social vulnerability analysis showed the socio-economic characteristics and the inherent vulnerabilities of the population in these areas. Based on these, specific disaster risk reduction and management interventions can be put in place by the LGU.

Table 5. Most at-risk barangays in Iloilo City, considering Hazard - Exposure - Vulnerability.

	Top 5 at-risk barangays
Flooding	San Isidro,Tabuc Suba Jaro, Dungon A, Calubihan, Dungon B
Drought	Tacas, Lanit, Navais, Sooc, Hinactacan
Storm Surge	San Juan, Calumpang, Calaparan, Sto. Nino Norte, Sto. Nino Sur
COVID-19	San Juan, Rizal Pala Pala 2, Tanza Baybay, Bo. Obrero, Benedicto Pale

Flooding

The five most flood-prone barangays have a total population of 17,383 people or approximately 4,345 families (Figure 8). The population density in these areas is at 11,000 per square kilometers which is double compared to the 5,700 per square kilometer population density of Iloilo city. The two barangays in the list, San Isidro and Tabuc Suba, are among the most populous in the city. About 13% of the houses are made of non-durable materials hence prone to damage during floods.

More than half (60%) of the households do not have access to level three water system. Most of them rely on dug wells that are either owned by the family or shared by the whole community. Floodwaters can contaminate water sources that are less secure/safe thus there is a high possibility of increased incidence of water-borne illnesses in the area after a flood.

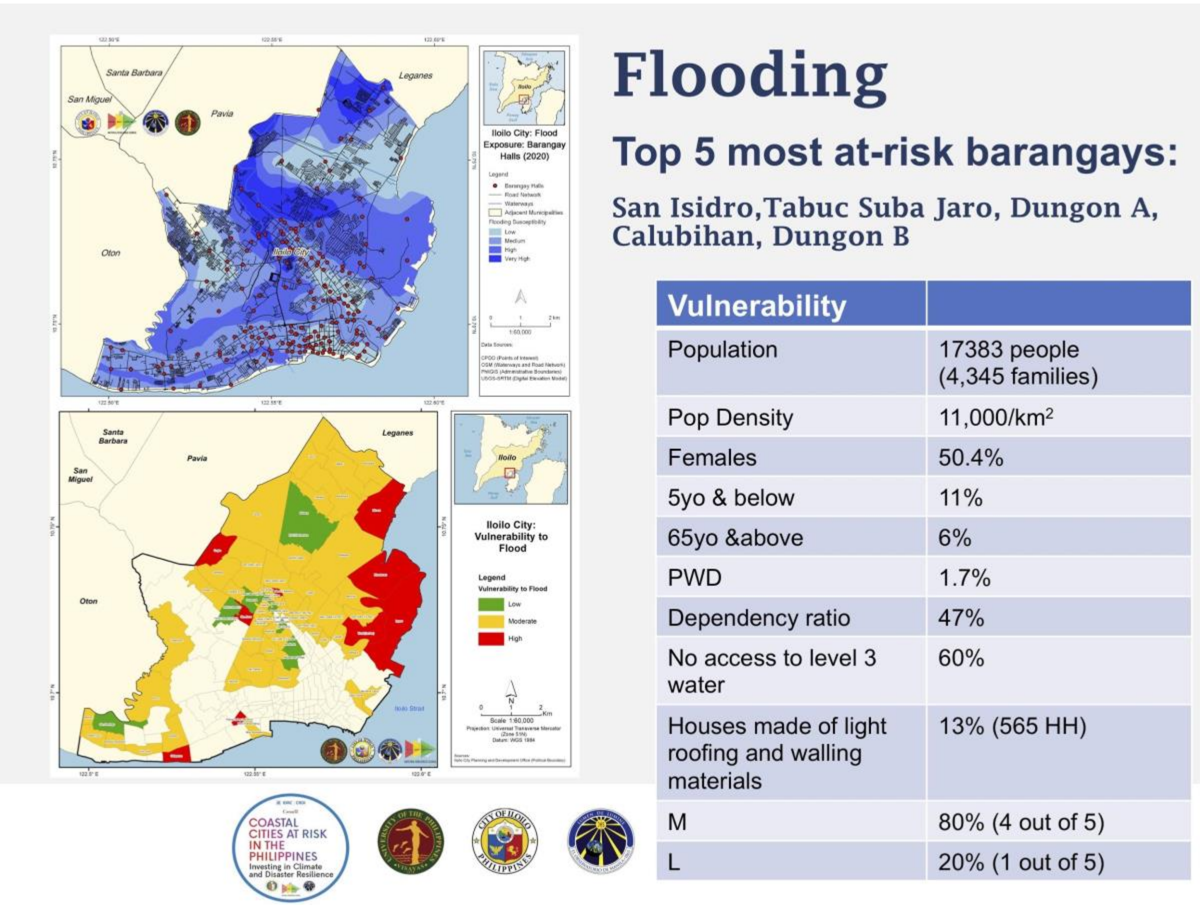
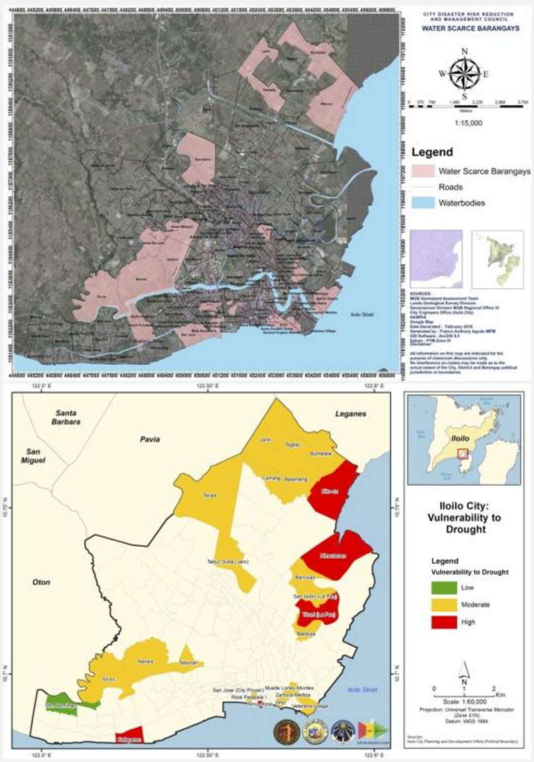


Figure 8. Top 5 barangays most at-risk of flooding in Iloilo City.

Drought

The rapid urbanization of Iloilo city has brought about issues on water security. Households' access to level 3 water sources, including the supply provided by the Iloilo city water district, is limited. On the average about 65% of families in the barangays have no level 3 water system. Drought can even exacerbate this problem especially for the 6,190 families of the most drought prone barangays in the city (Figure 9). Water access to these communities is even scarcer with 77% of the households not having level 3 water system. This implies higher expenditure to procure safe water for drinking and daily household needs.

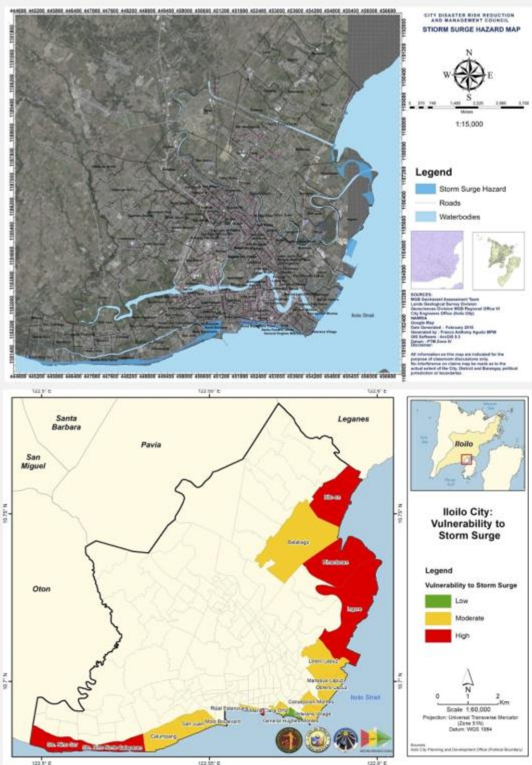


Vulnerability	
Population	24,762 people (6,190 families)
Pop Density	2,300/km²
More males	50.4%
5yo & below	12.6%
65yo &above	4.8%
PWD	3%
Dependency ratio	52%
No access to level 3 water	77%
Houses made of light roofing and walling materials	27.4% (6,784 HH)
M	80% (4 out of 5)
L	20% (1 out of 5)

Figure 9. Top 5 barangays most at-risk of drought in Iloilo City.

Storm Surge

Iloilo city's location in the coastal area makes it susceptible to storm surge. Twenty one barangays with about 96,750 people are located along the shorelines. The top five barangays that are facing the highest risk to storm surge includes 48,471 people or a total of 12,117 families (Figure 10). These are the most populated areas in the city with a population density of 22,000/km^2, fourfold of the city average. The percentage of houses made of light materials at 28% or about 6,740 houses, is also much higher compared to other barangays. The high population density also implies the presence of informal settlements in the area. The social vulnerability index show that 3 out of 5 of the barangays are categorized to under high vulnerability which simply indicates high inherent vulnerability of the population residing these areas. The socio-demographic characteristics attest to this social vulnerability. Given the magnitude of exposed population, a particularly strong storm surge will likely cause major devastation to property, livelihoods and people.



Storm Surge

Top 5 most at-risk barangays:

San Juan, Calumpang, Calaparan, Sto. Nino Norte, Sto. Nino Sur

Vulnerability	
Population	48,471 people (12,117 families)
Pop Density	22,000/km^2
Females	49.7%
5yo & below	13%
65yo &above	4%
PWD	1%
Dependency ratio	47%
No access to level 3 water	99.7%
Houses made of light roofing and walling materials	28% (6,784 HH)
M	40% (2 out of 5)
H	60% (3 out of 5)

Figure 10. Top 5 barangays most at-risk of storm surge in Iloilo City.

COVID-19

COVID-19 is the most recent hazard to have affected the entire world. Iloilo city was not spared by the pandemic. Based on the most recent data on the incidence of infection, the top five barangays disposed to the virus have around 26,017 people or 6,500 families (Figure 11). These areas are also densely populated which makes physical distancing more difficult. The lack of access of 84.5% of the households to level 3 water sources will also make it difficult for majority of the people in these communities to practice preventive health and sanitation practices such as frequent handwashing. Containment of the disease will likely be more difficult for these barangays.

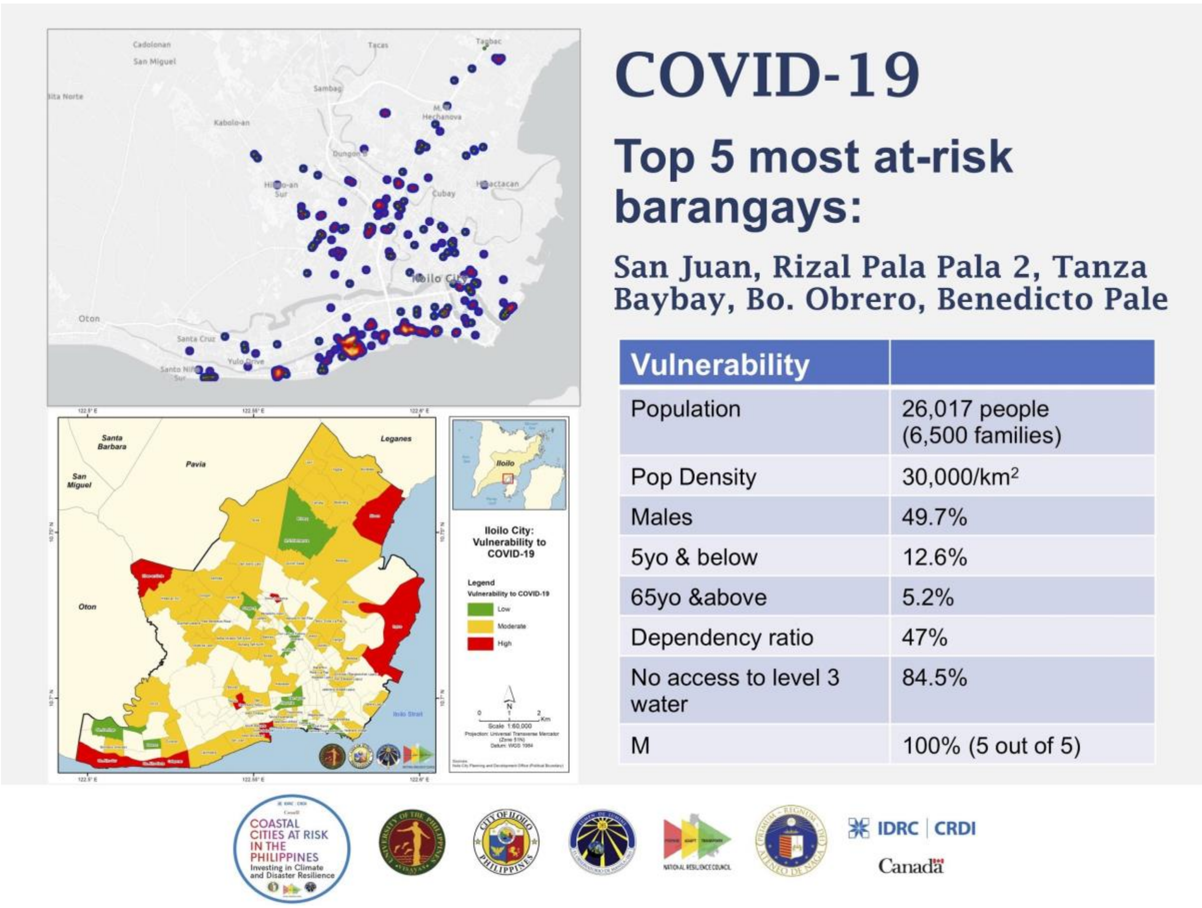


Figure 11. Top 5 barangays most at-risk of COVID-19 in Iloilo City. Data (as of Aug 9, 2020), obtained from Iloilo City Health Office.

Core messages

The social vulnerability analysis and the integrated assessment provide important insights on the climate and disaster risks confronting Iloilo city. The core messages of a complete analysis are as follows:

- An integrated analysis is crucial for specific interventions at the household level.
- Lack/limited access to water exacerbates impacts of different hazards, including COVID-19, on the communities
- Flooding and COVID-19 threatens more than 50% of the population, but storm surge has the potential of creating the biggest impact to the most vulnerable sector of the population
- Dependency cuts across all risks because it affects mobility, coping and recovery.

5 Adaptation

The local government envisions Iloilo City as a premier city of excellence, geared towards socio-economic development. With proposed projects mainly focused on transforming Iloilo City into an arts and culture hub, a center for providing services related to both manufacturing and agri-business, and a lead catalyst on research and development, the goal of the Iloilo City local government is to promote inclusive development centered on good governance (Iloilo CPDO, 2019).

To realize its vision and achieve its goals, the Iloilo City LGU adopted the WHEELS for Development strategy that divides areas of development into subsectors: Welfare, Health and sanitation, Education, Environment management, Livelihood, and Sustainability. Concrete plans will then be created and organized by the city based on the current and projected situation of each of these subsectors (Iloilo CPDO, 2019). Resilience should also be mainstreamed into these local plans by actively seeking to address the various risks faced by Iloilo City. Resilience building can be done through making informed investments in disaster risk reduction and climate change adaptation (DRR-CCA) options that maximize synergies and minimizes trade-offs with sustainable development.

Potential adaptation options

In the future, a multi-stakeholder workshop can be held to identify the adaptation options that are most appropriate for Iloilo City, and most effective against the various climate and disaster risks outlined above. Nonetheless, preliminary discussions between the City Planning and Development Office and experts from MO and UPV resulted in the following initial list of potential adaptation options.

Flooding:

- Promote alternative and supplemental flood-resilient livelihoods
- Enhancement of Iloilo City's Shelter Plan and Zoning informed by risk assessments (build vertical; land bank; resettle)
- Enhance alternative clean water access in times of flooding

Storm surge:

- Resettlement of shelters and livelihoods
- Alternative and supplemental livelihoods inland and in elevated areas
- Elevated evacuation centers
- Enhance household-based preparedness measures (e.g. Listo Pampamilya)

Drought:

- Increase the scope of clean water access via MIWD
- Drought early warning that informs drought-resilient livelihoods planning
- Community-based water management
- Rain-water harvesting and stormwater catchment plan
- Water recycling and ecosystem-based alternatives to desalination

COVID-19:

- Protect and promote safe income sources especially for daily wage earners
- Promote COMPLIANCE vs LAW ENFORCEMENT
- Localization: Activate local/community-based health protocols involving community-based organizations and volunteers
- Innovations in disinfection that are less water-intensive

To reduce urban heat and the impacts of heatwaves, urban green spaces like "greenbelts" can also be integrated into zoning ordinances (Anguluri & Narayanan, 2017).

References

Anguluri, R., & Narayanan, P. (2017). Role of green space in urban planning: Outlook towards smart cities. *Urban Forestry & Urban Greening*, *25*, 58-65.

British Ecological Society. (2013). The Impact of Extreme Events on Freshwater Ecosystems. *Ecological Issues.* pp2-68. Retrieved from: https://www.britishecologicalsociety.org/wp-content/uploads/small_single-pages.pdf

Cutter, S. (2010). Social Science Perspectives on Hazards and Vulnerability Science in Beer, T. (ed.) *Geophysical Hazards: Minimizing Risk, Maximizing Awareness*. Springer Netherlands. pp 17-30.

DOST-PAGASA, 2018: Observed and Projected Climate Change in the Philippines. Philippine Atmospheric, Geophysical and Astronomical Services, Quezon City, Philippines, 36 pp.

Food and Agriculture Organization of the United Nations (FAO). (2017). The impact of disasters and crises on agriculture and food security. Retrieved from: http://www.fao.org/3/I8656EN/i8656en.pdf

Iloilo City Local Development Council and City Planning Development Office. (2019). 2020-2025 Iloilo City Comprehensive Development Plan (CDP).

Iloilo City Local Development Council and City Planning Development Office. (2017). 2017 Iloilo City Ecological Profile.

Lloyd-Hughes, B., and M. A.Saunders, 2002: A drought climatology for Europe. Int. J. Climatol., 22, 1571–1592, doi:https://doi.org/10.1002/joc.846.

Margolis, H. (2014). Heat Waves and Rising Temperatures: Human Health Impacts and the Determinants of Vulnerability. In: K. Pinkerton & W. Rom (Eds.), *Global Climate Change and Public Health. Respiratory Medicine* (Vol.7). Humana Press, New York, NY. https://doi.org/10.1007/978-1-4614-8417-2_6

National Water Resources Board (NWRB). (2013). Groundwater Management Plan for Highly Urbanized Water Constraint Cities, Pilot Area: Iloilo City and Surrounding Areas of Oton, Pavia, and Leganes. Retrieved from: http://www.nwrb.gov.ph/images/Publications/NWRB-ILOILO-GMP.pdf

Philippine Statistical Authority. 2015 Census of Population and Housing.

ReliefWeb. (2008). Phillippines: Typhoon Frank leavesP1.6-B damages in Western Visayas infra, agri. Retrieved from: https://reliefweb.int/report/philippines/philippines-typhoon-frank-leaves-p16-b-damages-western-visayas-infra-agri

See, J and Porio, E. (2015). Assessing social vulnerability to flooding in Metro Manila using principal component analysis. *Philippine Sociological Review. Vol. 63.* Philippine Sociological Society. pp. 53-80.

Tan, J., Zheng, Y., Tang, X., Guo, C., Li, L., Song, G., Zhen, X., Yuan, D., Kalkstein, A.J., Li, F. and Chen, H. (2010). The urban heat island and its impact on heat waves and human health in Shanghai. *International journal of biometeorology*, *54*(1), pp.75-84.

Thomas, K., Hardy, R.D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, I., Roberts, J.T., Rockman, M., Warner, B., and Winthrop, R. (2019). Explaining differential vulnerability to climate change: A social science review. *WIREs Climate Change. 2019;10:e565.* https://doi.org/10.1002/wcc.565.

World Health Organization (WHO). (n.d.). Flooding and communicable diseases fact sheet. Retrieved from: https://www.who.int/hac/techguidance/ems/flood_cds/en/