Building Climate Resiliency through Urban Plans and Designs

PATH TO CLIMATE RESILIENCY

CASE STUDIES OF CITIES IN THE PHILIPPINES

UN-HABITAT FOR A BETTER URBAN FUTURE

Supported by:

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

IKI INTERNATIONAL CLIMATE INITIATIVE

based on a decision of the German Bundestag

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FOREWORD

Five stories of how cities innovatively crafted resilient urban plans and designs to strengthen their resilience -- inspiring journeys from identifying challenges to creating solutions.

The cities of Angeles, Cagayan de Oro, Legazpi, Ormoc and Tagum faced similar issues that cities across the globe grapple with: frequent flooding, stronger typhoons, accelerated sea-level rise, and increasing temperature compounded by challenges brought by urbanization. We congratulate these five cities for strategically designing projects using an integrated adaptation approach towards city-wide resilience and sustainable urban development.

With the guidance and expertise of the Department of Human Settlements and Urban Development and the Climate Change Commission, cities were able to level up from the usual practice of urban planning that focuses mainly on land use, physical design and infrastructure to a risk-based urban systems process that optimizes nature-based solutions.

The Building Climate Resiliency through Urban Plans Designs supported these processes, with funding support from the International Climate Initiative of the German government. Since 2008, IKI-BMU has funded over 800 climate and biodiversity projects in more than 60 developing and emerging countries around the globe, including UN-Habitat Philippines. This project has built on the continuing journey of our partner cities in finding solutions to the ever evolving challenges and opportunities brought by climate change and its complex interface with urbanization, pandemics and rapidly shifting political economy at all levels.

We hope that these case studies will inspire other cities and towns to take action towards implementing more transformative climate adaptation actions. By learning from each other and with our collective effort, we can transform our cities and communities as we plan and design for resilience and gradually build better urban environments that improve the lives of every Filipino.

Together with these five cities, and the rest of the cities and communities around the world, we remain committed to make cities and human settlements safe, inclusive, resilient, and sustainable.

CHRISTOPER ROLLO
Country Programme Manager
UN-Habitat Philippines

ABOUT BCRUPD

Building Climate Resiliency Through Urban Plans and Designs (BCRUPD) is a German government-funded project being implemented by the United Nations Human Settlements Program (UN-Habitat) in partnership with the Department of Human Settlements and Urban Development (DHSUD), and other Philippine governmental agencies in five cities.

It aims to support the Philippine government in improving policies, regulations, and capacities to adapt to climate change through the promotion of climate-responsive sustainable urban development plans and designs. In support of existing national climate change frameworks and strategies, it aims to enhance national and subnational government representatives' institutional capacities to guide and manage urban growth towards suitable areas and design the same incorporating resilience principles and practices. The project supplements existing planning guidelines and develops knowledge through policy inputs, capacity development, and demonstration activities.

ABOUT THE PUBLICATION

Under the BCRUPD project, innovative approaches on climate-resilient urban plans and designs were demonstrated in the cities of Angeles, Cagayan de Oro, Legazpi, Ormoc, and Tagum.

Their experiences showcased how cities can prepare for, recover from, and adapt to the impacts of climate change, considering balanced economic and ecological sustainability in the face of rapid urbanization. Given the five cities' different ecosystems, they contributed to a wide knowledge base on how processes and schemes can be contextualized and applied.

This publication captures the experiences of the five cities on their path towards climate resiliency; discussing their climate and urban profile, climate change vulnerabilities and challenges, how they used urban plans and designs to address these challenges, and their prospective climate resiliency projects. Their experiences illustrate how cities, with science-based information and urban design solutions, can thrive – and not merely survive – in the face of climate change.

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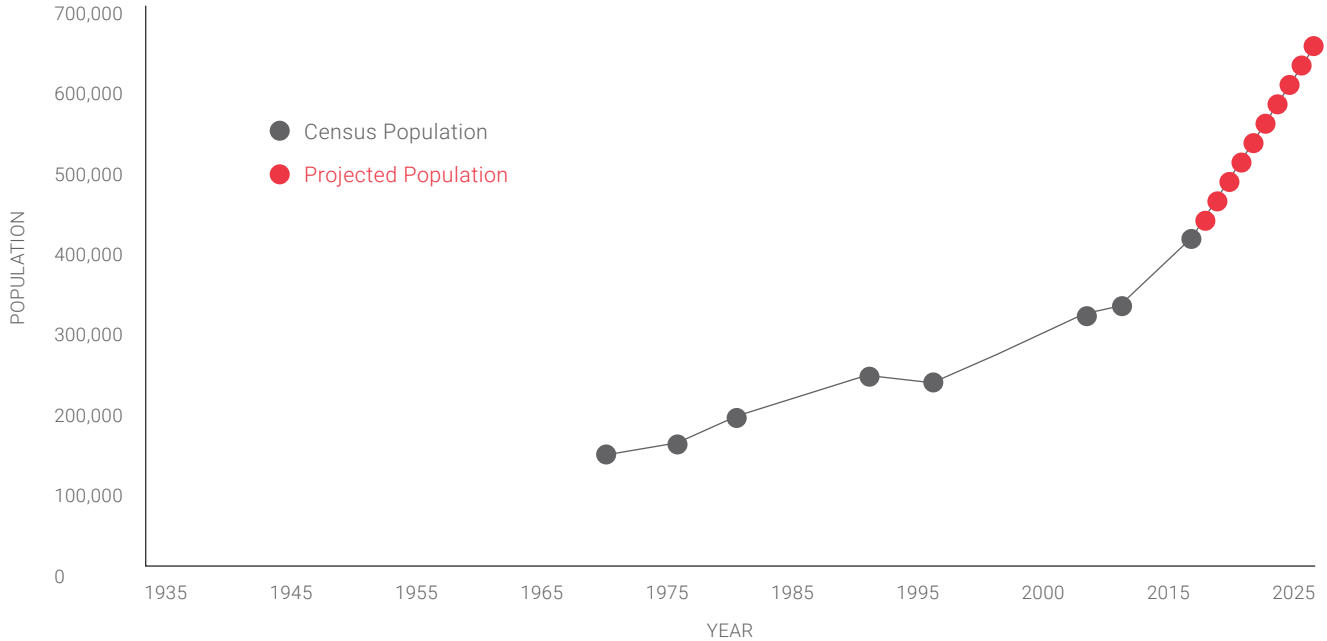
ANGELES CITY

CASE STUDY ON THE PATH TO CLIMATE RESILIENCY

ABOUT ANGELES CITY

Angeles is a highly urbanized city in the province of Pampanga in Central Luzon with a 2020 projected population [1] of more than half a million (Figure 1). This figure doubles during daytime or even more, as people from nearby towns and cities go to the city for work, school, leisure, and business purposes. Aside from being considered as one of the most economically advanced centers outside the National Capital Region, Angeles is known for its rich culture and heritage. A landmass of 6,240.22 hectares, the city is bordered by Mount Arayat, an inactive volcano,

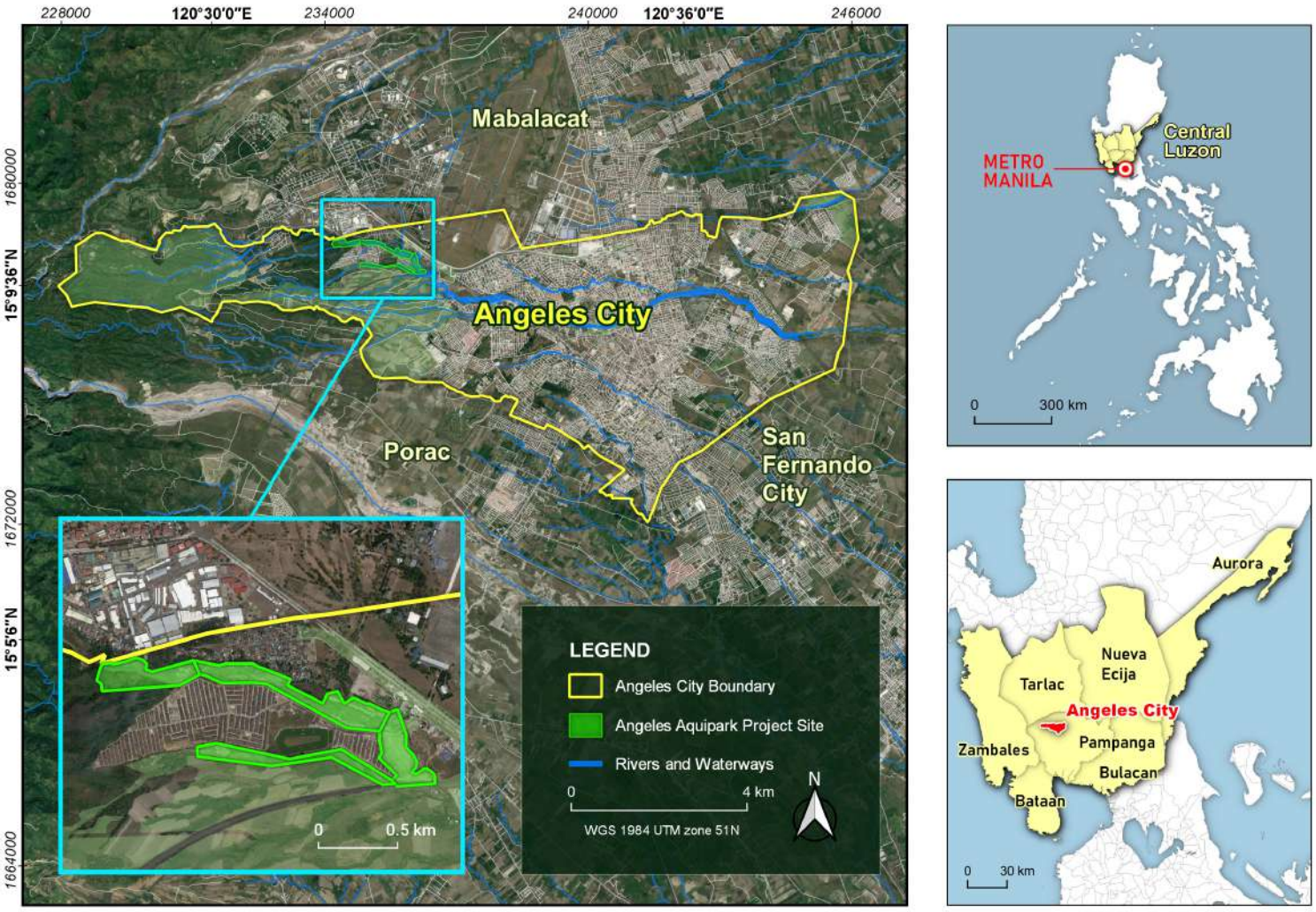
Figure 1: Projected Population in Angeles City (2016-2025)



Source: Angeles City Draft Hydrological Report 2020.

[1] 2020 Projected Population for Angeles City is 513,953.

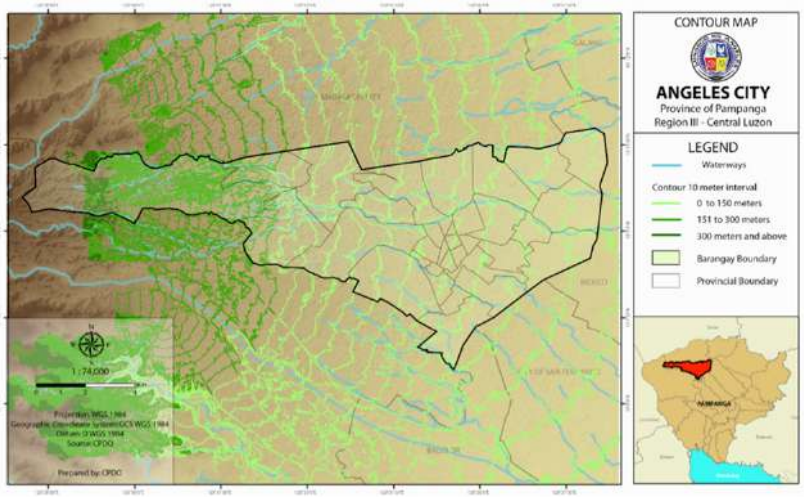
Figure 2: Location of Angeles City



Source: Angeles City Draft Hydrological Report 2020.

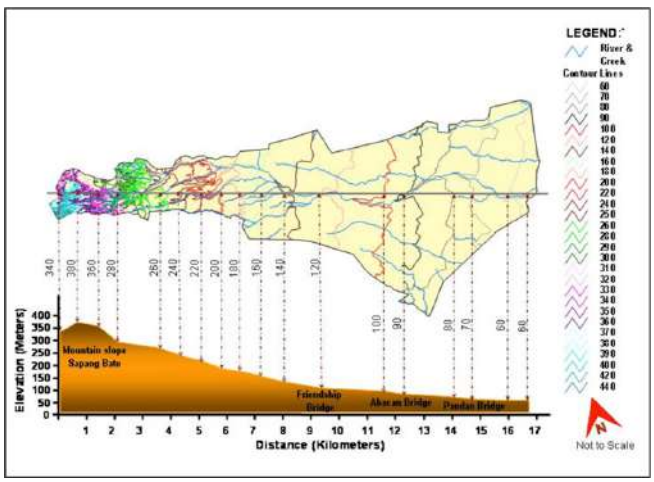
in the east and by Zambales Mountain Range in the west. Part of this mountain range is Mount Pinatubo, which erupted in 1991 and devastated the region and affected other parts of the country. The northern western edge of the city (Figure 2), where the highest elevation is located, is essentially part of the foot slope of the Zambales Mountain Range; hence characterized by steep slope and lowland secondary forest. From this elevated part of the city towards the east (Figures 3 and 4) are gently sloping plains.

Figure 3: Angeles City Contour Map



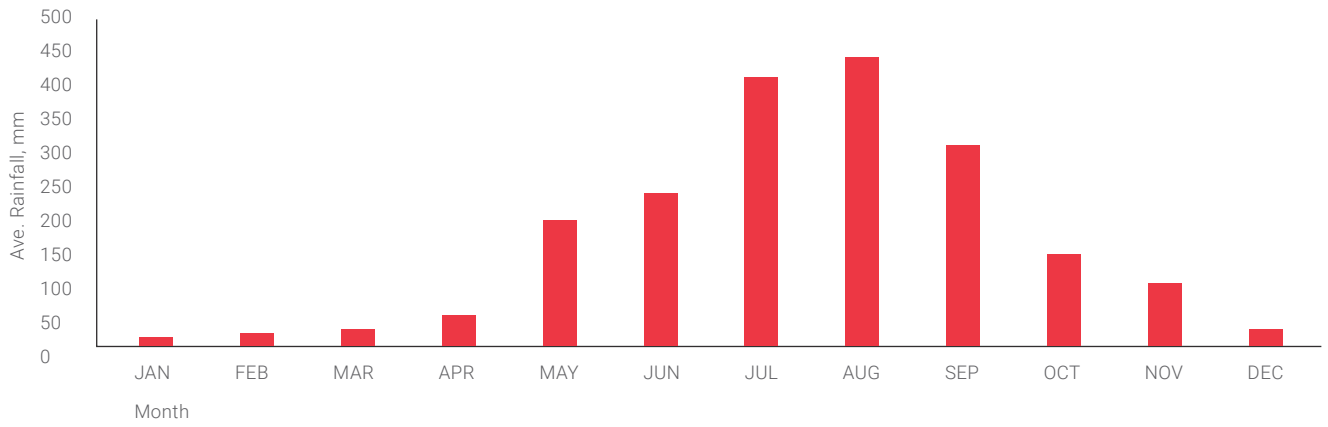
Source: Angeles City Draft Local Climate Change Action Plan 2019-2028.

Figure 4. Angeles City Elevation Map



Source: Angeles City Draft Local Climate Change Action Plan 2019-2028.

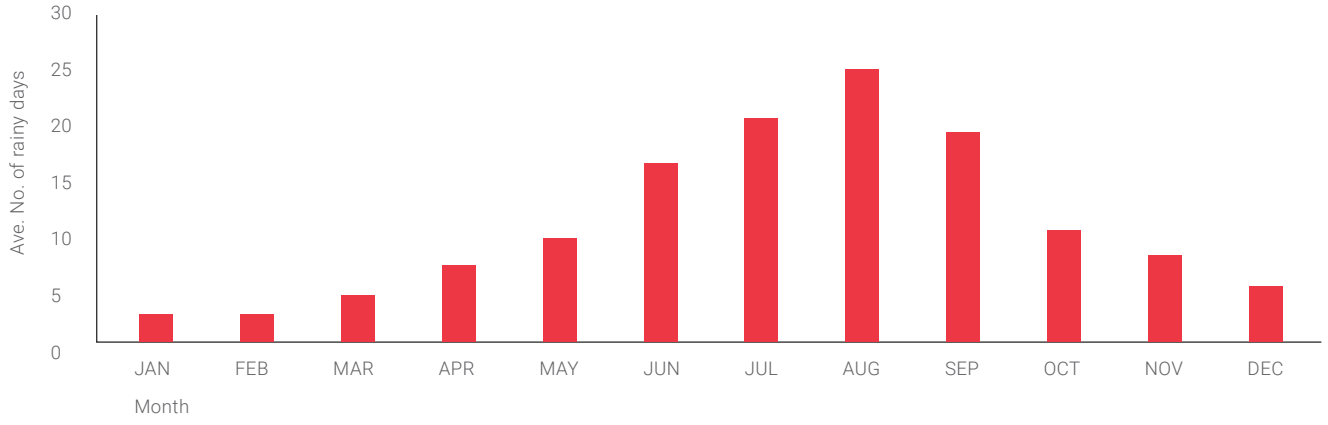
Figure 5. Mean Monthly Rainfall Observed in Clark International Airport (1998-2010)



Source: Angeles City Draft Hydrological Report 2020.

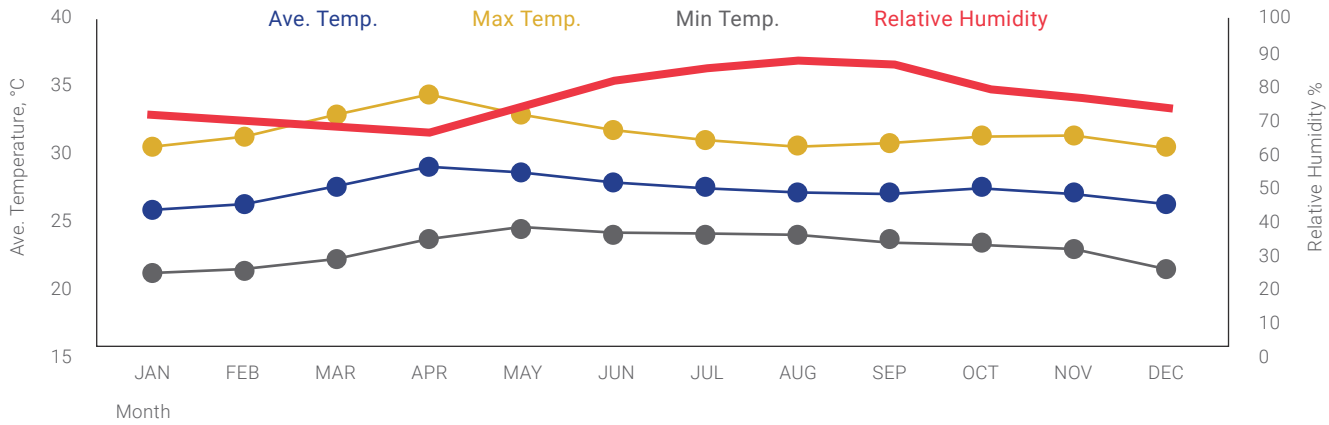
Angeles City has a pronounced wet and dry seasons due to the natural mounds at the west and east peripheries of the city. During the dry season (Figure 5), the mountains can trap heat and slow down wind flow in the city, making the dry season feel hot and arid. During the wet season (Figure 6), the Zambales Mountain Range routes water from its summit mostly to the western section of the city. The mountain range also protects the city from strong winds and heavy rains that can be brought by the Southwest Monsoon and contains the wind needed for cooling during the dry season. Mount Arayat, meanwhile, occasionally shields the northeast section of the city from possible devastating winds and rains that the Northeast Monsoon can carry.

Figure 6: Mean Number of Rainy Days Recorded in Clark International Airport (1998-2010)



Source: Angeles City Draft Hydrological Report 2020.

Figure 7: Mean Monthly Temperature and Relative Humidity Observed in Clark International Airport (1998-2010)



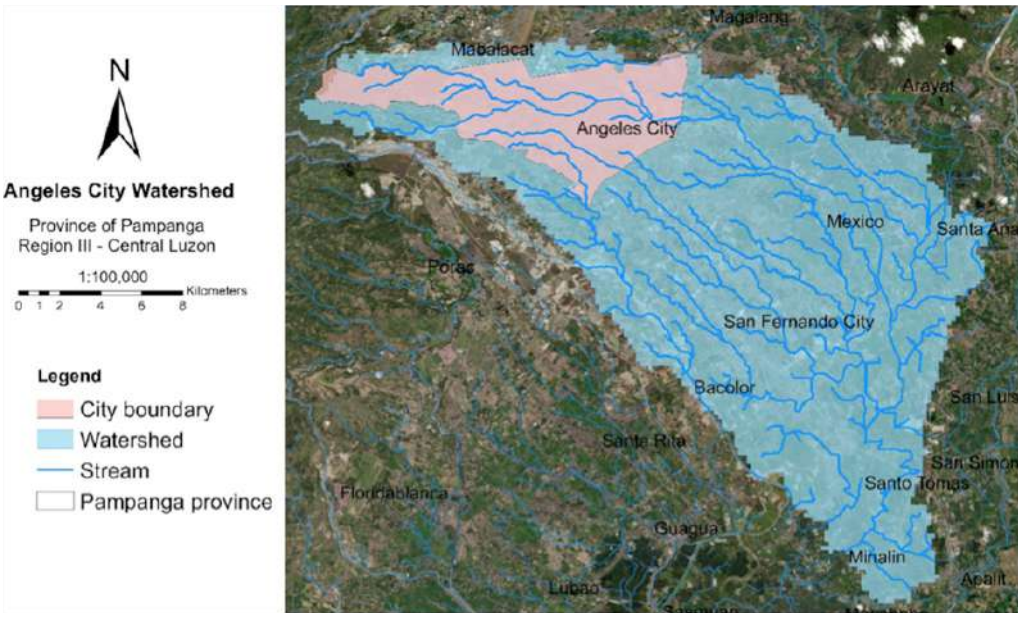
Source: Angeles City Draft Hydrological Report 2020.

Angeles is also land-locked city located within the 39,512-hectare Angeles Watershed (Figure 8). Because of its high level in the watershed, the city naturally channels surface water through seven natural waterways (Figure 9): the Abacan River, Sapangbalen Creek, Arroyo-Duquit Creek, Sapalibutad Creek, Tabun Creek, Cutcut Creek, and the Balibago/Santol Creek, to the lower areas of the watershed. In addition, surface water easily drains into the ground of the city, as its land area largely consists of sandy soil types (Figure 10). As a result, the waterways in the city normally hold a low volume of water year-round and that groundwater has been the main source of water supply in the area.

With its location and topography, Angeles City has been a convenient crossroad in the Central Luzon Region for the lowlands at its south that includes the National Capital Region and the uplands at its north and west, to wit, parts of Cordillera and Zambales, respectively. Thus, aside from being an important setting for several events in Philippine history, Angeles rapidly developed as the first highly urbanized city in the Central Luzon Region[2]. The city has been supporting the airbase in its residential and commercial demands, even at present when the airbase has been converted into the Clark Freeport and Special Economic Zone (CFSPEZ).

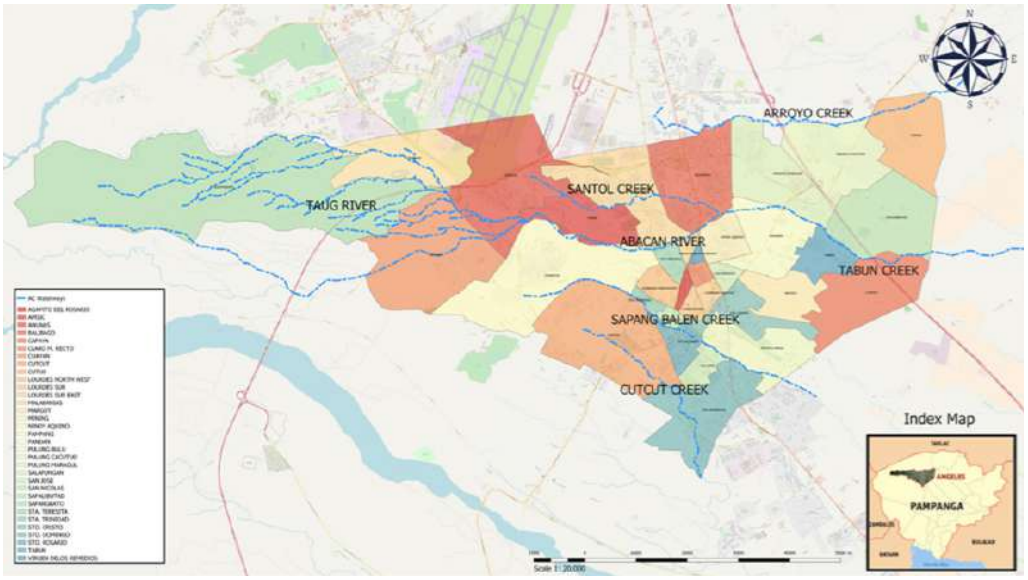
[2] Angeles was the first seat of the Philippine Government in 1899. It was the venue of the first anniversary of Philippine Independence from Spanish colonization. The first civil government of the United States (U.S.) in the Philippines was also founded in Angeles City in 1900. For 44 years, Angeles was part of the US Military Camp, which was later known as the Clark Airbase.

Figure 8. Angeles City Watershed



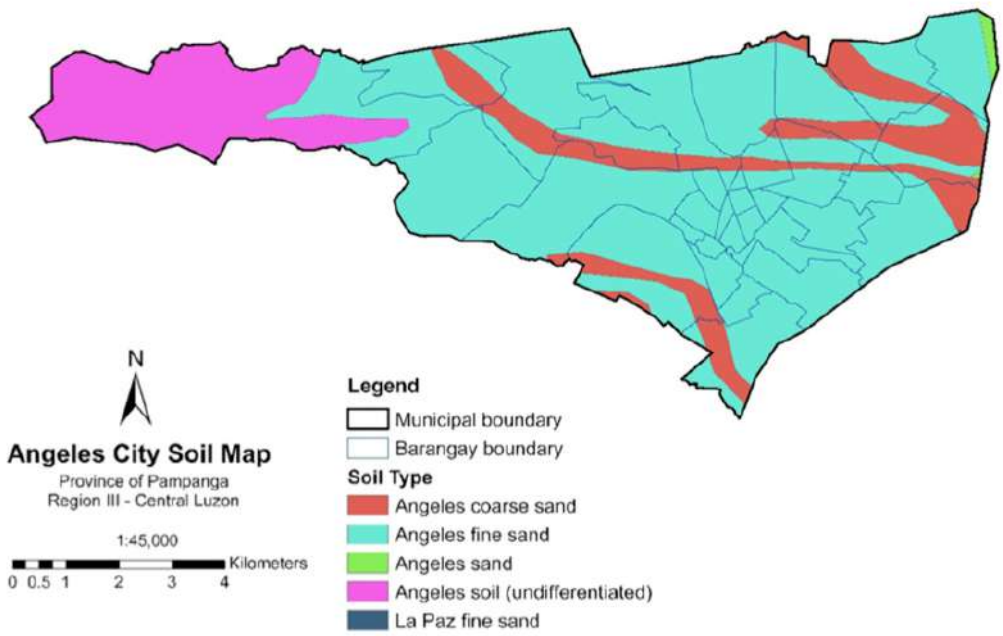
Source: Angeles City Draft Hydrological Report 2020.

Figure 9: Angeles City Waterways Map



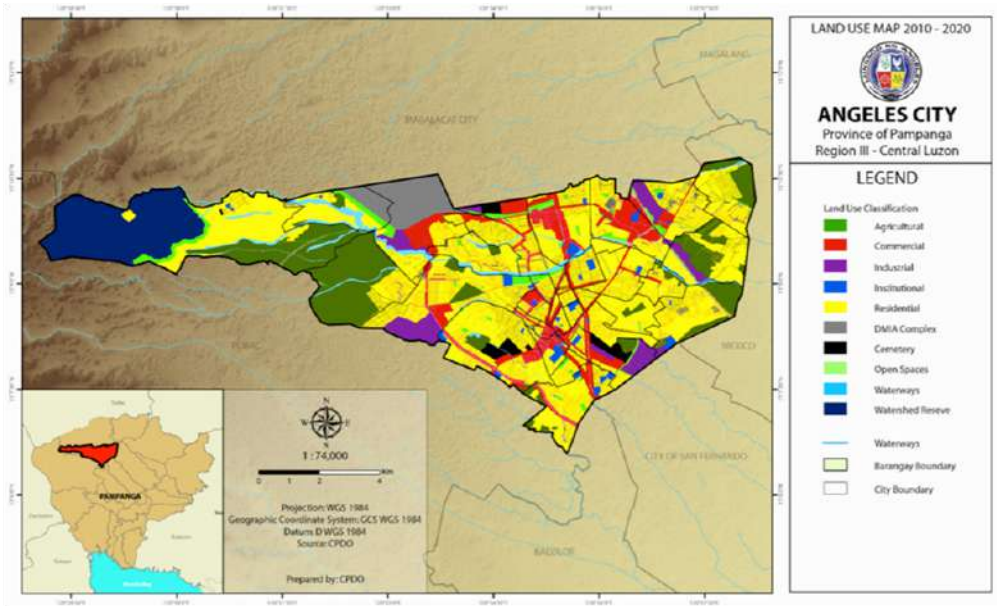
Source: Angeles City Draft Local Climate Change Action Plan 2019-2028.

Figure 10: Angeles City Soil Map



Source: Angeles City Draft Hydrological Report 2020.

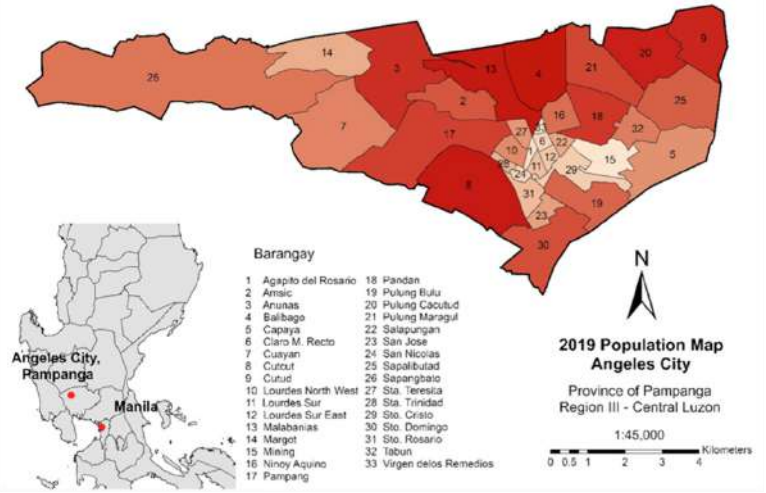
Figure 11: Angeles City Land Use Map (2010-2020)



Source: Angeles City Draft Hydrological Report 2020.

Economic zone establishments and infrastructure investments in the Central Luzon Region have also contributed to the continued urbanization of Angeles City, even after being devastated by the Mount Pinatubo eruption in 1991. The construction of the North Luzon Expressway (NLEX), Subic Special Economic and Freeport Zone, and the Bataan Freeport Zone have also spurred access and trade in the city. At the start of the new millenium, more infrastructure projects entered the region to support the established economic zones in the area. Angeles City has then greatly benefited from the improvement of the MacArthur Highway, construction of the Subic-Clark-Tarlac Expressway (SCTEX), and the upgrading of the Diosdado Macapagal International Airport (DMIA), as these provided easier access to the CFSPEZ, helping increase its locators. Angeles City is strategically located in the fulcrum of the urban corridor between the cities of Mabalacat and San Fernando, which also contributed to its growth in the past decades. Residential subdivisions and commercial districts, including malls, hotels, fast food chains, and restaurants have now populated the northern section of the city. Correspondingly, commercial land use concerted in the area (see Figure 11) and most of the barangays (villages) in the area are presently those with the highest population in the city (see Figure 12).

Figure 12: Distribution of 2019 Population Per Barangay of Angeles City



Source: Angeles City Draft Hydrological Report 2020.

The northern part of the city has been experiencing economic growth in recent years, while the southern part where the old town proper is situated also tries to catch up with the growth as the business process outsourcing industry starts to boom. This has helped in establishing more economic opportunities and has contributed to the city's high employment rate, which is at 94% in 2018 (City Technical Working Group, 2020).

As a city with a rich heritage to manage amidst the economic growth, the local government has heavily invested on heritage preservation projects. Some of the initiatives of the city government include the establishment of the old town proper as the Angeles Heritage District, declaration and restoration of the heritage structures in the district, redevelopment of the Angeles Museum, establishment of the Plaza Angel (Figure 13), improvement of the walkability of the heritage district, development of pocket parks (Agyu Tamu Parks), and the construction of the Independence Plaza. Complementing these are the cultural programmes spearheaded by the Local Tourism Office and Kuliat Foundation, Inc. such as promotion of the local cuisine and the establishment of the Center for Kapampangan Studies by the Holy Angel University.

Colorful history and heritage. Angeles City's Plaza Angel turns into a colorful spot of culture and heritage every Christmas season. Photo by the City Government of Angeles

As development in the city is incessant, the city government has also initiated efforts to restore and preserve its natural environment and reduce disaster risks. In 2012, it set up the "1 Million Tree Program", which requires businesses to provide tree, palm seedling or bamboo for the annual business permit renewal. The seedlings are planted at the Sapangbato Watershed to maintain the existing secondary forest and along the Abacan River to protect the banks from erosion especially during extreme flooding events. For waterways navigating through built up areas, the city government constructed riverwalls to safeguard citizens and their properties from flooding Angeles City will continue to be within the hub of infrastructure and investment projects[3] in the Central Luzon Region, especially with the approximately 9,000-hectare New Clark City township project being built at the CFSPEZ to decongest the National Capital Region. The city is seen to organize with neighboring cities such as Mabalacat and San Fernando as a metropolitan in the future to complement the development needs of the upcoming township. With the ongoing, mostly nationally-led projects in the region, it is imperative for the city to plan and ensure that balanced development will be pursued to preserve the city's cultural heritage and natural ecosystem, which are vital for its sustainability.

[3] Dubbed as the New Clark City, a new metropolitan area is being built in CFSPEZ. The DMIA, which is located between Angeles and Mabalacat in Pampanga, has been renamed the Clark International Airport and expanded to cater to bigger aircraft and 8 million passengers annually. The redevelopment of the Philippine National Railroad Project that traverses the city, and the construction of the NLEX-SCTEX Road Connector along the Abacan River of the city and the completion of the Tarlac-Pangasinan-La Union Expressway are some ongoing transportation projects and can improve accessibility of the New Clark City.

ANGELES CITY IN THE FACE OF CLIMATE CHANGE

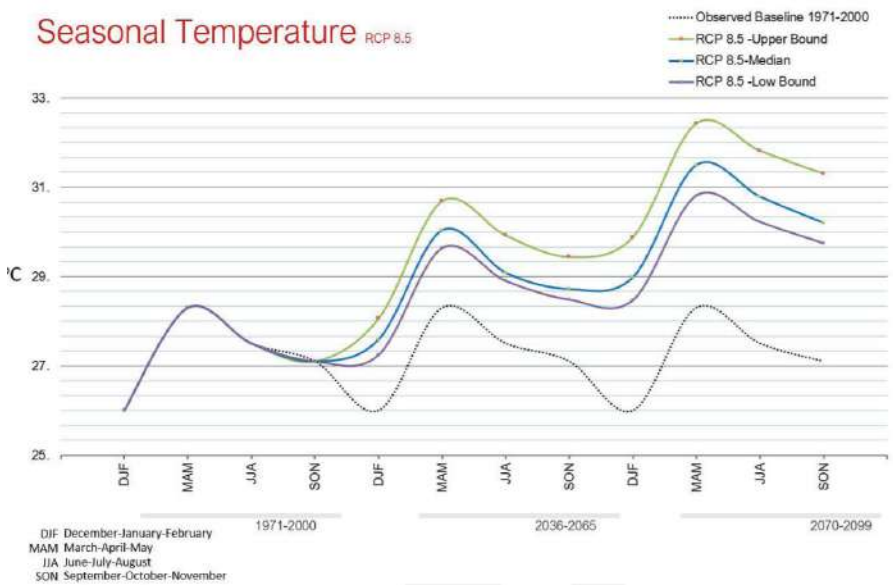
A diary of events from 1796 to 1948 titled, A Brief History of the Town of Angeles, has described the climate of Angeles during the Philippine colonial period as "suffocating heat".[4] The journal highlighted the years where there was rainfall every month, inferring that the town did not receive regular rainfall in the past. The record also noted that Angeles was frequented by typhoons, making several creeks and the Taug River swell, inundating farmlands and houses along waterways.

The narratives about Angeles City's climate from the aforementioned journal are still true at present with an observed change in intensity. Angeleños have observed in the past 10 years that the city is getting hotter yearly linking it to the loss of the natural environment to infrastructure development. Since 2010, approximately 415 hectares of land have been converted into subdivision and mixed-use residential-commercial developments. This land area equates to nearly 7% of the city's total land area and can be translated to a 0.7% rate of land conversion in the said time period. Comparing the observed baseline data (1971-2000)[5] hottest months record[6] with that of the timeanddate. com observation (2005 to 2015)[7] , there has been an increase of approximately 0.2°C. In the recent decade, impacts of climate change in the Philippines are often characterized and evidenced by super typhoons and extreme flood events. In Angeles City, however, the observed change in climate relates more with hotter days and drier seasons. Key observations by Angeleños are that the cool months, which are usually from December to February in the country, are shorter as it now ends by January.There is not much rain in the city during the wet season, usually from May to October. During the wet season, the city government accounts that flooding has not been a challenge compared to what most local governments in the country are facing in the last decade. During super typhoon visits, flooding is only experienced in built-up areas traversed by waterways coupled with riverbank erosion as well as in areas where drainage infrastructure is insufficient.

Other local observations on impacts of climate change is from the water sector, as the city is dependent on groundwater supply. Several groundwater wells were recently reported as idle or abandoned. There have been reports that iron and manganese have been detected from monitoring wells. These records by the Angeles City Water District have been linked to possible decreasing quantity and quality of the city's groundwater.

[4] Henson, M.A. 1948. A Brief History of the Town of Angeles in the Province of Pampanga, Philippines: From Its Foundation in 1796 A.D. to the Present 1947-1948. Indiana University.
[5] Local Climate Change Action Plan First Draft
[6] 28.3°C
[7] 28.5°C

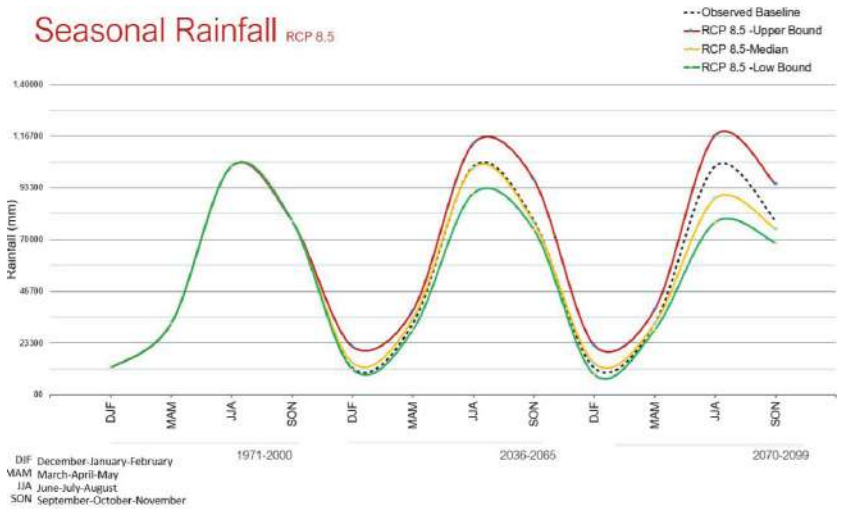
Figure 13: Seasonal Temperature Representative Concentration Pathway (RCP) 8.5 Scenario of the Province of Pampanga



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

The city-level observations is now corroborated by science. Climate change projections from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) using Representative Concentration Pathway (RCP) 8.5 show that the Province of Pampanga, which includes Angeles City, will be hotter across all seasons of the year for both mid-century and end-century forecasts. RCP, a greenhouse gas concentration, refers to the trajectory adopted by the International Panel on Climate Change for its Fifth Assessment Report in 2014. The range of plausible scenario is from 1.6°C increase to as high as 3.9°C increase (Figure 13). Precipitation in RCP 8.5[8] projection for mid-century shows that the dry season could receive the same or increased rainfall average of +100 mm during December to February and about +60mm from March to April (Figure 14). The wet season in the province, however, is estimated to be drier in the future. Generally, precipitation will be less than the currently observed rainfall during the wet season to a max of -24% from September to November in mid-century and -28% or 253 mm less than the mean for June to August by end-century.[9] The climate change projections for Angeles City will place nearly 45% of the current population in extreme conditions. The projected warmer climate in the future is expected to be extreme in the currently highly built-up barangays (villages), especially, Malabanias, Balibago, and Santa Teresita (Figures 15 and 16). The population of these three barangays sums up to nearly 20 % of the current total population of the city.

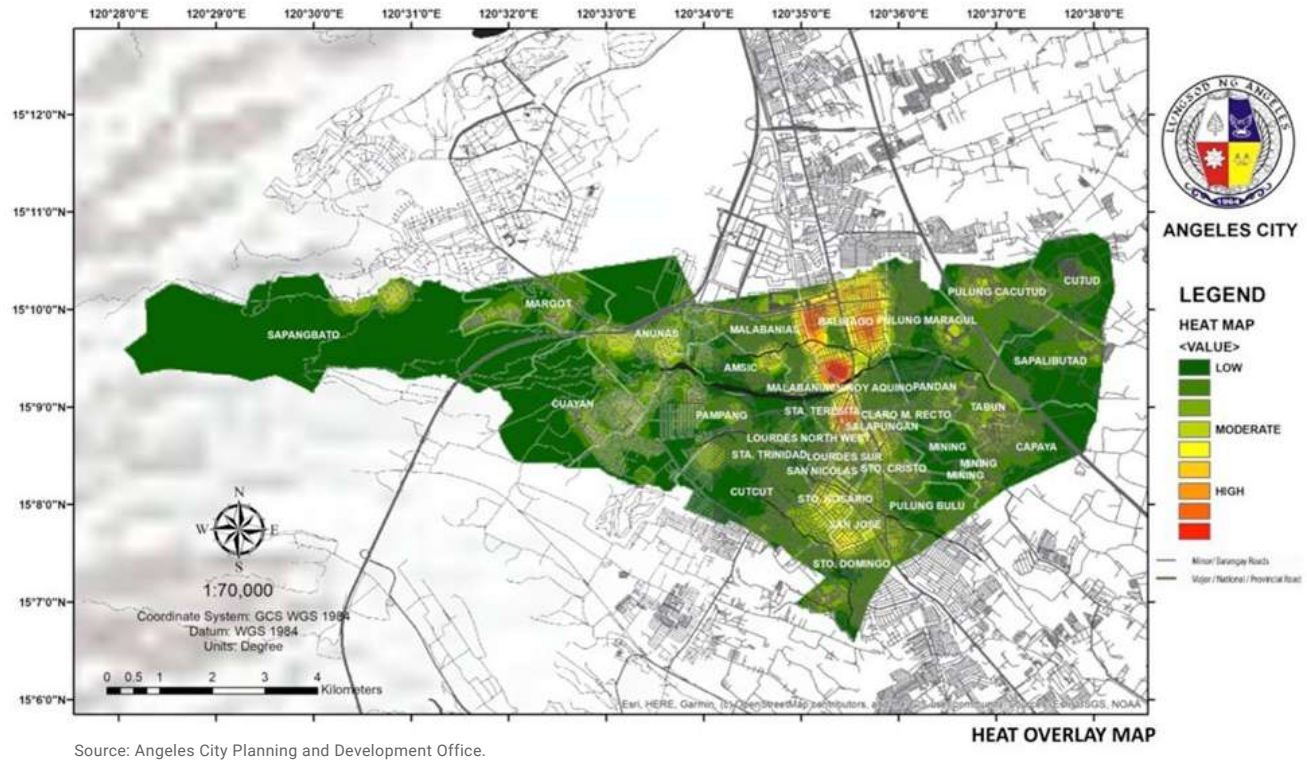
Figure 14: Seasonal Rainfall Representative Concentration Pathway (RCP) 8.5 Scenario of the Province of Pampanga



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

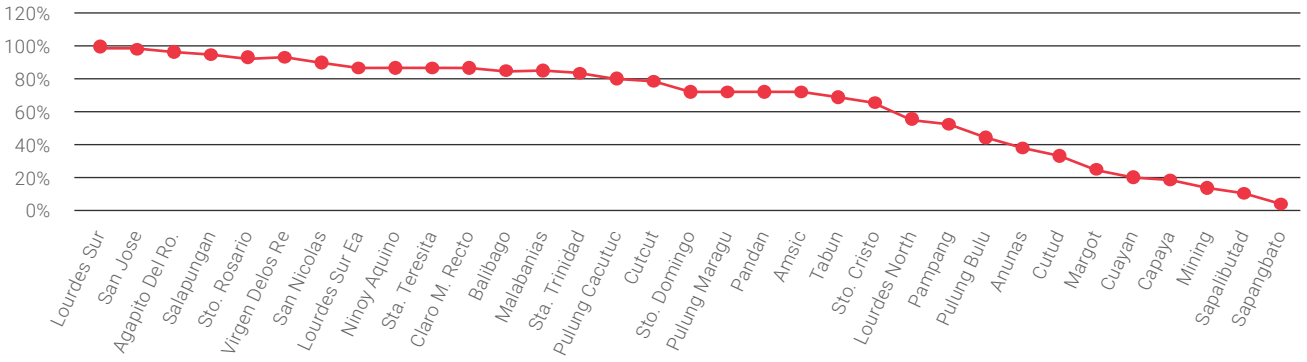
[8] HRCP 8.5 denotes the high emissions scenario.
[9] Cinco, Thelma A. "Observed Climate Trends and projected Climate Change in the Philippines". Presentation file. https://designingresilience.ph/wp-content/uploads/day-1-observed-climate-trends-and-projected-climate-change-in-the-philippines-pagasa-15lzz9-file.pdf

Figure 15: Heat Overlay Map



Source: Angeles City Planning and Development Office.

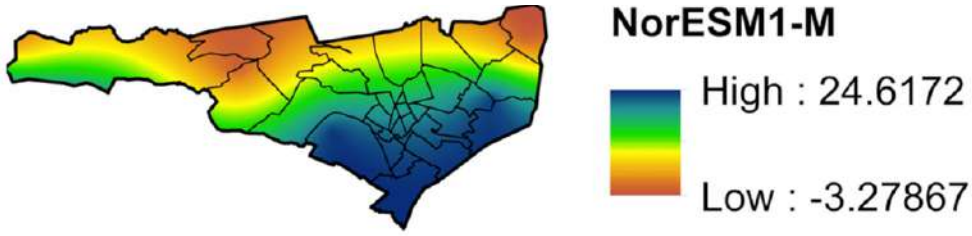
Figure 16: Percentage of Barangay Land Area Affected by the Projected Increasing Heat over Total Land Area of Angeles City



Source: Angeles City Planning and Development Office.

Based on the Climate and Disaster Risk Assessment developed by the city, the forecasted drier years will extremely affect barangays in the northern section of the city: Barangays Sapangbato, Margot, Anunas, Malabanias, Balibago, Pulung Maragul, Pulung Cacutud, and Cutud. (Figure 17). The population of these nine barangays (villages) aggregates to more than 41% of the current total population of the city. Three of these barangays (villages) are also those extremely affected by the predicted increase in temperature.

Figure 17 Rainfall Map 100-Year Return Period (Representative Concentration Pathway (RCP) 8.5 Scenario)



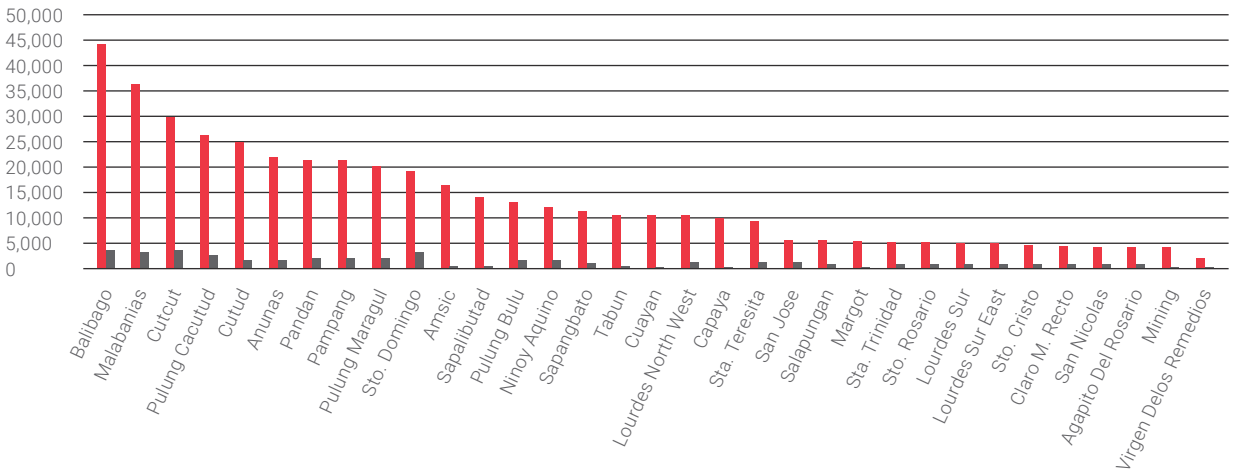
Source: Angeles City Hydrological Assessment Report 2020.

Though the heat and rainfall maps translate an estimated 45% of the current city population that will be extremely affected by the projected increase in temperature and decrease in rainfall, the rest of the population are still exposed to the risks of the projections in various levels. The maps presented low, moderate to high exposures.The 45% estimation falls under the high exposure areas.

The projected increasing mean temperature for Angeles City may negatively affect the health of its population, which could already be more than one million by 2050.[10] Prolonged exposure of humans to a higher temperature can cause heat stroke, heat cramps, or heat exhaustion. Similarly, less air moisture can cause certain skin and respiratory diseases. In extreme cases, very low humidity can be fatal. Senior citizens (Figure 18), persons with an existing medical condition, and pregnant women will be the most affected by the projected hotter climate in the future.

On the economic side, the projected climate change may result in higher cost of living since it will be indispensable to have cooling system, comfortable transportation system, a possible need for water filtration in each household, higher potable water consumption, and a more comprehensive health insurance coverage.

Figure 18: Percentage of Current Population per Barangay Affected by the Projected Increasing Heat in Angeles City vs. Population of Aged 60 Years and Above per Barangay



Source: Angeles City Planning and Development Office.

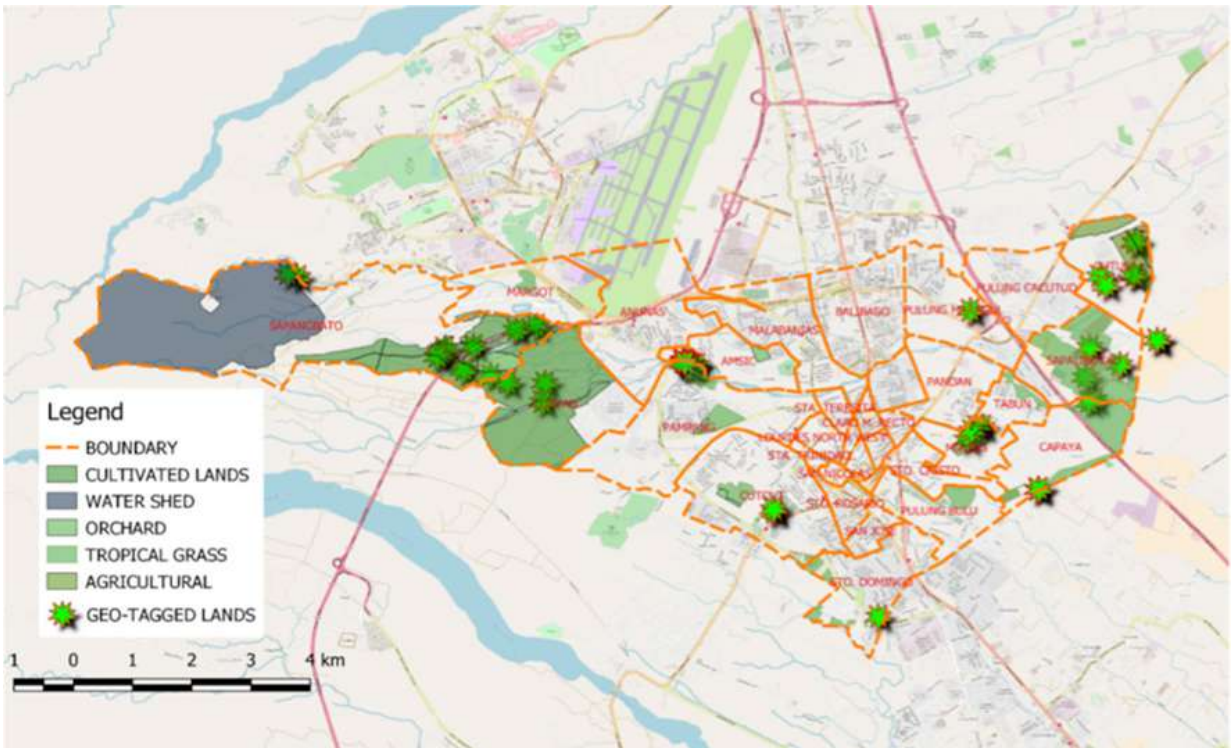
[10] Population projection for the city by 2050.

A challenge for the vulnerable groups to adapt to climate change is the limited infrastructure to support their health and mobility. Barangay (village) health centers are yet to spread awareness of the health risks that the changing climate will bring. The city health department is also yet to plan measures on how to provide basic health support among citizens concerning the projections. Basic health will also include access to public recreation spaces such as parks, plazas, and other urban open spaces that will encourage physical fitness, mental well being, and sense of community. The city government also needs to improve the inclusive accessibility of roads and efficiency of public transportation to help the vulnerable groups move around in the city.

Another pressing challenge comes from the information that Angeles City is one of the nine water-stressed cities in the country based on the National Water Resources Board (NWRB) and the Japan International Cooperation Agency (JICA) study in 2008. The supply and demand analysis of the study revealed that the groundwater recharge of the Angeles City watershed will be exceeded by the year 2025. Access to clean and adequate water is a basic need. The city and other stakeholders must plan and invest in water security initiatives in the face of a changing climate to ensure a healthy population and sustainable development. Several wells were constructed in the past years to augment the increasing demand from the continuous growth of the city. However, they will require more measures for the sustainability of the groundwater supply given the climate change projections.

The projected hotter and drier years will also distress the health of other life forms such as plants and animals that are particularly important to the food security and bio-diversity of the city. Farming will also be directly impacted by the observed change in climate since many farmlands depend on rain for irrigation. Some farm lands in the eastern edge of the city (Figure 20), which is the lowest part of the city, have already been abandoned as current rainfall is not an enough source as well as the natural waterways in the area that are conveying a very low volume of water that cannot be tapped for irrigation.

Figure 19: Angeles City Spatial Distribution of Agricultural Lands



Source: Angeles City Planning and Development Office.

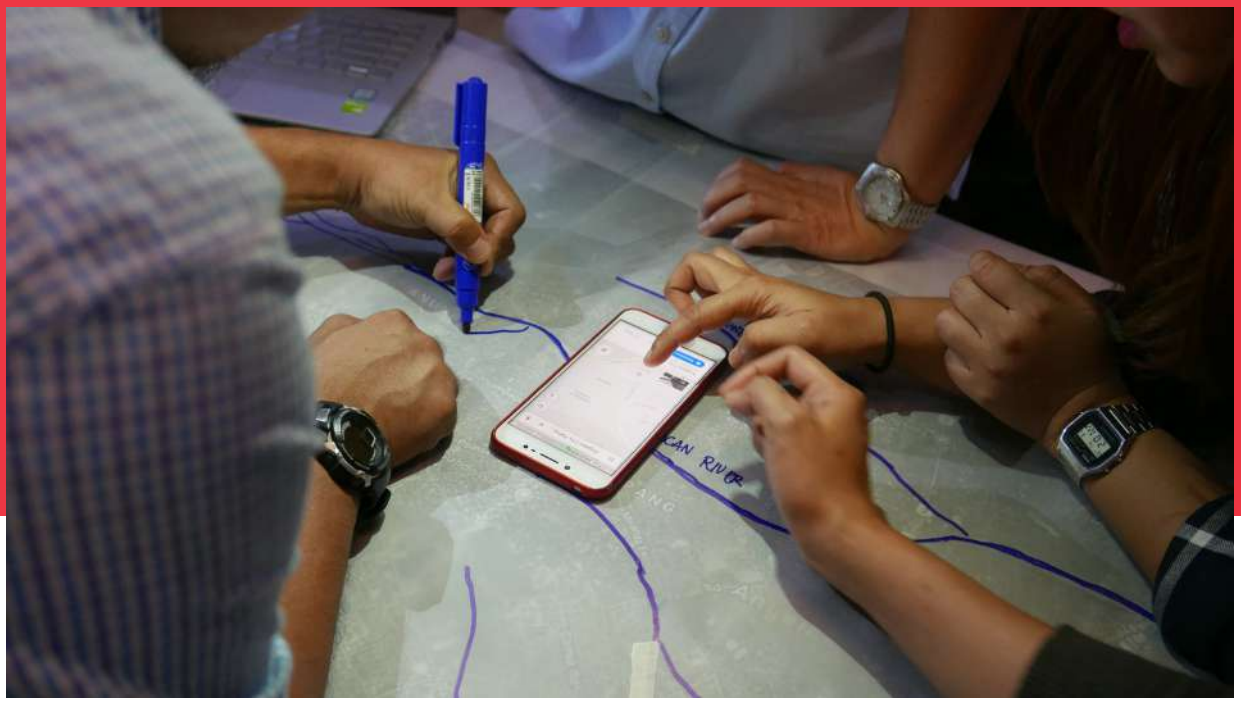
The built-up areas or paved spaces can intensify the effect of the climate projections resulting in urban heat stress. The city has been investing in developing open spaces, which include plazas, parks in residential villages, the unused PNR rail tracks,and the forest reserve at the western edge of the city, the open spaces are not yet strategically positioned and interconnected. As the LGU is currently updating its Comprehensive Land Use Plan, it will yet need to strategize a network of green spaces that will help combat urban heat stress, including recovering other ecosystem functions such as natural cooling to adapt to the PAGASA projections for the city.

The projected temperature rise and rainfall decline will also heighten the suseptibility of non-fire resistant buildings to fire incidents, particularly the 3,000 existing structures mainly made of wood and more than 500 structuresmainly made of cogon/nipa/ anahaw. Some of these non-fire resistant structures are part of the 1,666 informal settlers along waterways. Measures are yet to be proposed to address this risk.

With the expected economic growth of the city in the future brought about by the continuous development of the CFSPEZ, more than half of the total population in the future can be tremendously distressed by the climate change forecasts.

In 2017, the city government crafted its first Local Climate Change Action Plan (LCCAP) based on the PAGASA projections. The action plan, however, only focused on rain-induced hazards such as flooding and landslides. It also covered greenhouse gas emissions. This has possibly been brought about by various perceptions on climate change.[11] Because of the Building Climate Resiliency through Urban Plans and Design (BCRUPD) project of the United Nations Human Settlements Programme (UN-Habitat) Philippines, relevant city government now has a better understanding of climate change and climate-related hazards, their localized impacts, and how the city can address the impacts including adaptation actions through urban design projects. Angeles City was selected as a pilot city of the project for its ability to represent one of the five specific urban ecosystems (i.e., landlocked) in the country. Among the five pilot cities of the project, Angeles also presented a unique opportunity to underscore urban heat as a slow-onset impact of climate change, including water stress and be a case study on how city planning and designing could be enhanced to address this impact.

[11] One of the perceptions of the city government that emerged during the LCCAP validation and crafting activities of the BCRUPD Project was the notion that climate change would bring more rain and cause devastating floods as perhaps, most the areas in the country will receive more rainfall in the future. This can explain why most of the proposed strategies of the first LCCAP focused on flood mitigation.
In addition, the city government has understood climate change as a disaster risk and not as a natural process of which effects can be heightened by human activities throughout time. This outlook has ensued into developing strategies in the first LCCAP that only minimize the risks of the projections and do not address those factors that exacerbate the ill effects of climate change, such as human activities.



Building capacities and resilience. The Technical Working Group during the design charette activity of the City Adaptation Strategy and Urban Planning and Design Policy Framework Workshop held on 29-30 April 2019 in Angeles City (photo by UN-Habitat Philippines).

BUILDING RESILIENCE THROUGH URBAN PLANS AND DESIGNS

To build climate resilience, the first step for Angeles City was to validate and update its first LCCAP. Through a series of trainings and workshops of the BCRUPD Project since its commencement in 2017, the city's technical working group (TWG) has been equipped with the technical know-how that would allow them to improve the first LCCAP.[12] Aside from a better understanding of climate change and its adverse effects on the city, the process of validating and updating the LCCAP has helped the TWG address the technical knowledge gaps that they had before identifying project interventions, which were focused on flood mitigation and carbon emission reduction.

Through the trainings, the TWG learned how to interpret climate data and use assessment tools such as the Climate and Disaster Risk Assessment (CDRA) of the Housing and Land Use Regulatory Board (HLURB). The conduct of CDRA workshops in the city was facilitated in close collaboration with the technical staff of the HLURB Policy Development Group. Using the RCP 8.5 data, the CDRA process was applied not only to strengthen the city's local climate change assessment but also served as a venue to test the CDRA template and capacitate the HLURB.

The CDRA workshops brought key learnings along the process. First is that increase in precipitation is not always tantamount to flooding. Second, climate change does not only trigger negative impacts (e.g., disasters) but also provides opportunities for development (more rain in the area is an opportunity to collect water and use this resource during dry periods). Third is the inclusion of urban heat issue (slow creeping impact), which was lacking in the CDRA tool. These lessons were discussed with the HLURB and were considered critical components of the climate assessment of the LCCAP. The CDRA is now being enhanced by DHSUD to cover these issues.

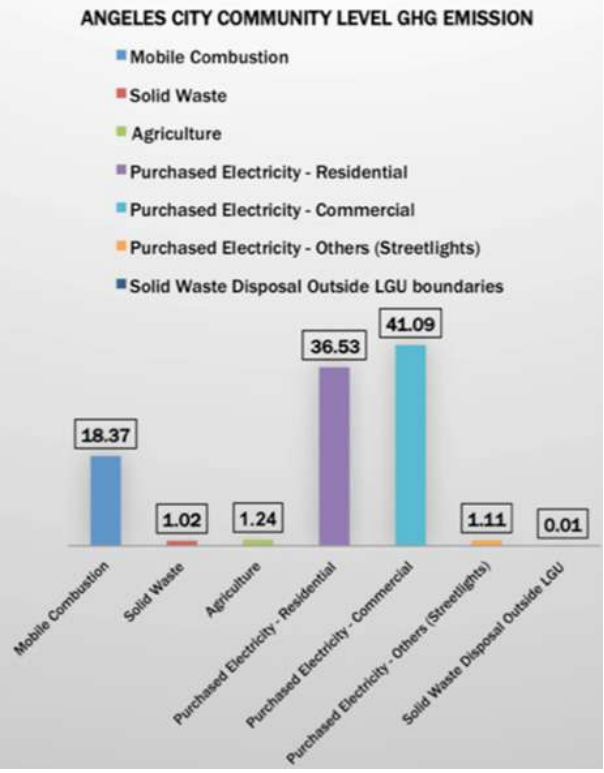
Firming up the climate change assessment of the LCCAP has also ensued to a revisit the study done by the NWRB-JICA in 1998 where Angeles

[12] When the project started in 2017, the Angeles City Government formed a technical working group (TWG) who will be directly working with UN-Habitat Philippines and partner national government agencies in implementing the project. The group was composed by heads and representatives of the different departments of the city government.

has been identified as one of the nine cities that are groundwater-stressed and that will be possibly aggravated by the climate change projections as released by PAGASA. Hence, the BCRUPD Project partnered with the NWRB in steering a Water Summit for the TWG last June 2019. Thereafter, the project sponsored a hydrological study to assess and address groundwater and surface water supply of the city vis-à-vis the predicted decreased rainfall in the future. The project also provided assistance to the city government for the digitization of hazard, lifeline, and climate-related maps pertinent to the LCCAP and Geographic Information System Mapping coaching to selected TWG members. These efforts pushed the city to refine its resilience goals. The local government now aims for a cooler microclimate and water security for the city.

UN-Habitat Philippines, in partnership with the Climate Change Commission, also assisted the city government to learn about greenhouse gas (GHG) emissions inventory and planning for mitigation actions.The results revealed that the GHG emissions of the city (Figure 20) from electricity usage and transportation is the highest and that it will continue to rise in the future given the forecast of hotter and drier climate. The upsurge is premised on the information that the people in the city is dependent on the use of motorized transportation and airconditioning systems for cooling. The city government is currently planning more strategies to lower its carbon emissions, aside from the current one million trees programme.

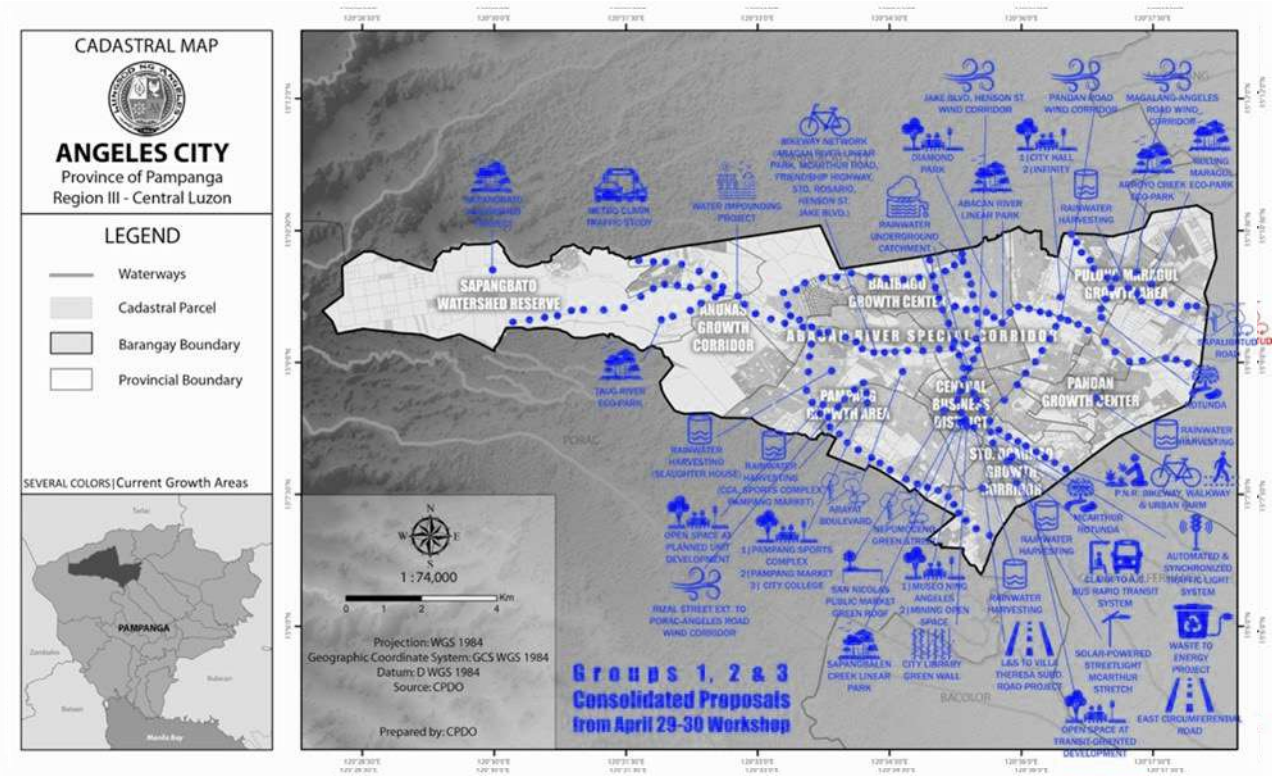
Figure 20: 2017 Angeles City Community Level Greenhouse Gas Emission



Source: A Draft Local Climate Change Action Plan, 2019-2028.

Following the CDRA and GHG inventory, updating the LCCAP required the enhancement of the adaptation strategy and its corresponding urban design interventions. Defining the adaptation strategy has been an iterative exercise for Angeles City as understanding the PAGASA projections, especially veering away from addressing flooding and rather tackling water stress risk, took time. In addition, the preliminary identification of the heritage district[13] as the decision area of the city adaptation strategy based on the existing and ongoing effort on developing open spaces had to be aligned with the refined city climate assessment. With these, the BCRUPD Project hosted the City Adaptation Strategy and Urban Planning and Design Policy Framework Workshop on 29-30 April 2019. Through the design charette of the workshop, the adaptation strategy transformed from a district into a city-wide spatial strategy or an urban structure framework of interventions. Through the lectures, the TWG also gained knowledge of nature-based design solutions and projects addressing urban heat stress and water stress that were considered as best practices. This learning helped the TWG in identifying what is the apt intervention in addressing the PAGASA forecasts in different areas of the city that resulted into a corridor type of urban structure of city-wide urban design interventions (Figure 21).

Figure 21: Map of Consolidated Proposals to Address Increase in Temperature and Decrease in Rainfall



Source: Angeles City Planning and Development Office.

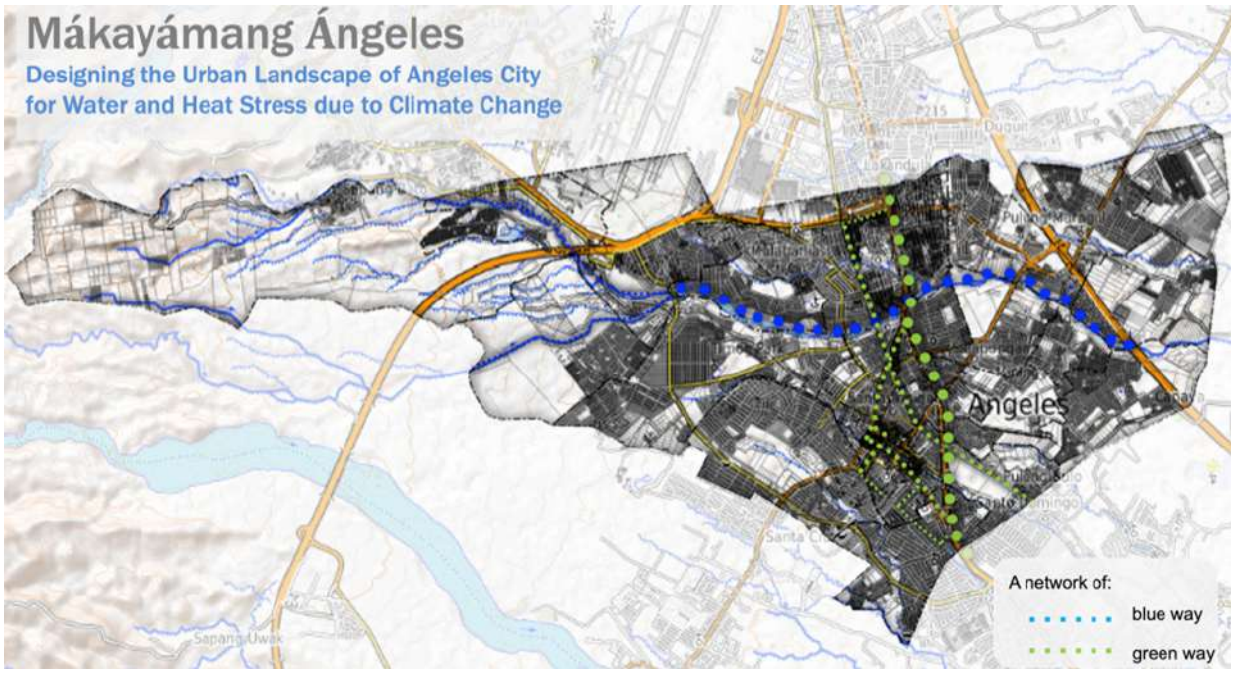
[13] The specific projects identified for the heritage district included converting the roof deck of the San Nicolas Public Market into a green roof, making Nepumoceno St. pedestrian-friendly, greening of the city's sidewalks, vertical greening of the City Library façade, installation of rainwater harvesting in public buildings, and the installation of solar streetlights. During the conduct of preliminary conceptual design studies of the area, the redevelopment of the Sapang Balen, a creek that traverses through the district, into an esplanade, has been included as part of the proposed projects. This is to address the projected climate effect of having drier years. The TWG called the set of projects as Balen Kuliat Heritage District Urban Design Improvements.

THE CITY ADAPTATION STRATEGY: MÁKAYÁMANG ÁNGELES

Anticipating a hotter and drier climate in the future, the LGU aims to ensure a cooler microclimate and water security for its people. The city government came up with a adaptation strategy dubbed as "Mákayámang Ángeles" ("pleasant weather"), which reflects the city's resilience goals.

To achieve a cooler climate, the city government will aim to: maintain and recover natural cooling systems; reduce greenhouse gas emissions; and invest in sustainable cooling technology or infrastructure. The local government intends to invest in water supply securing technology or infrastructure to help

Figure 22: "Mákayámang Ángeles": Angeles City Adaptation Strategy



Source: Angeles City Planning and Development Office.

ensure the city's water security. "Makayamang Angeles" encapsulates the ambition of the city to become competitive, livable, and sustainable by adapting to climate change.

The city's adaptation strategy is characterized by a network of blue- and green-ways (Figure 23), which also improves the: (1) urban grain of the city, particularly balancing the existing large expanse of built-up area with corridors of open spaces; (2) the density, especially increasing access to public service such as inclusive mobility, public recreation and livelihood opportunities; and (3) massing, which will require buildings along identified wind corridors to have a height that will be dictated by the 45-degree angle from edges of the street. The blue and green- ways are comprised of several urban design interventions to effect cooling and securing water in the city, especially at the areas identified by the climate change assessment as extremely affected by increase in temperature and decrease in rainfall. The blueway is an east-west corridor mainly tackling water security while the greenway is a north-south corridor largely undertaking cooling from heat stress. These urban design interventions of each corridor are detailed as follows:

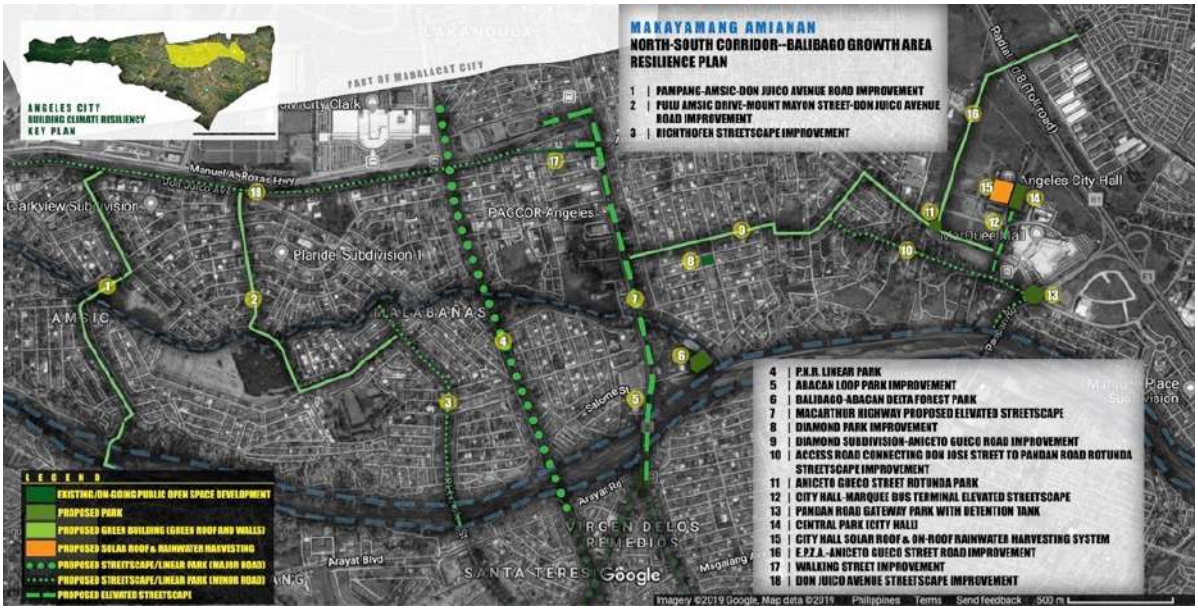
NORTH-SOUTH CORRIDOR

Comprised of greenways, the North-South Corridor generally addresses the projected urban heat stress. Since maintaining and recovering natural cooling systems is among the objectives, most urban design interventions involved recovering green spaces from paved spaces thereby reducing heat from built-up areas and allowing plants perform ecosystem functions such as natural shading by canopies and air cooling and movement by evapotranspiration. To reduce GHG emissions, the the city aims to decrease dependence on motorized transport by improving the walkability of public spaces and reusing renewable resources such as solar energy and rainwater. Capital spending interventions such as insulating large public structures from heat through green roofs and vertical greenery will be considered as well.

Amianan (Balibago Growth Center)

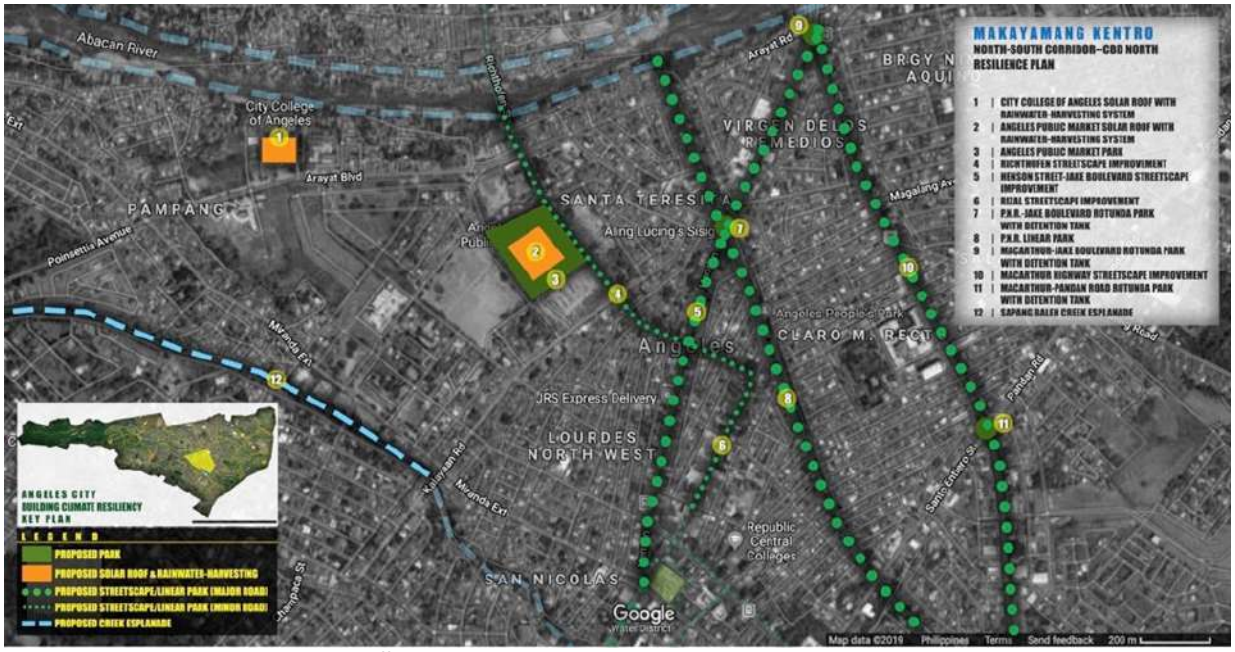
The Balibago Growth Center is essentially the northern growth center of the city linked to the CFSPEZ. As the northern end of the North-South Corridor, "Amianan" (Kapampangan word for "north") is the perfect designation to the section (see Figure 23). Projects to attain "Makayamang Amianan" (a pleasant weather for the north) include improving existing parks in subdivisions; making streets of a commercial and tourism pedestrian-friendly; creating a one-hectare forest park that will be a significant addition to the existing green spaces in a heavily builtup area; designing the streets and a linear park that is part of the existing Philippine National Rail (PNR) corridor as wind corridors; proposing the new city hall building to demonstrate use of renewable resources such as solar roof, on-roof rainwater harvesting system, and green-roof; and improving the walkablity of the busiest street in the city, the MacArthur Highway, through an elevated walkway system. These projects aim to induce a cooler microclimate in the

Figure 23: Locations of the Proposed Resiliency Projects for Amianan or the Balibago Growth Area, North-South Priority Corridor



Source: Angeles City Planning and Development Office.

Figure 24: Location of the Proposed Resiliency Projects for Kentro or the northern part of the Central Business District, North-South Priority Corridor



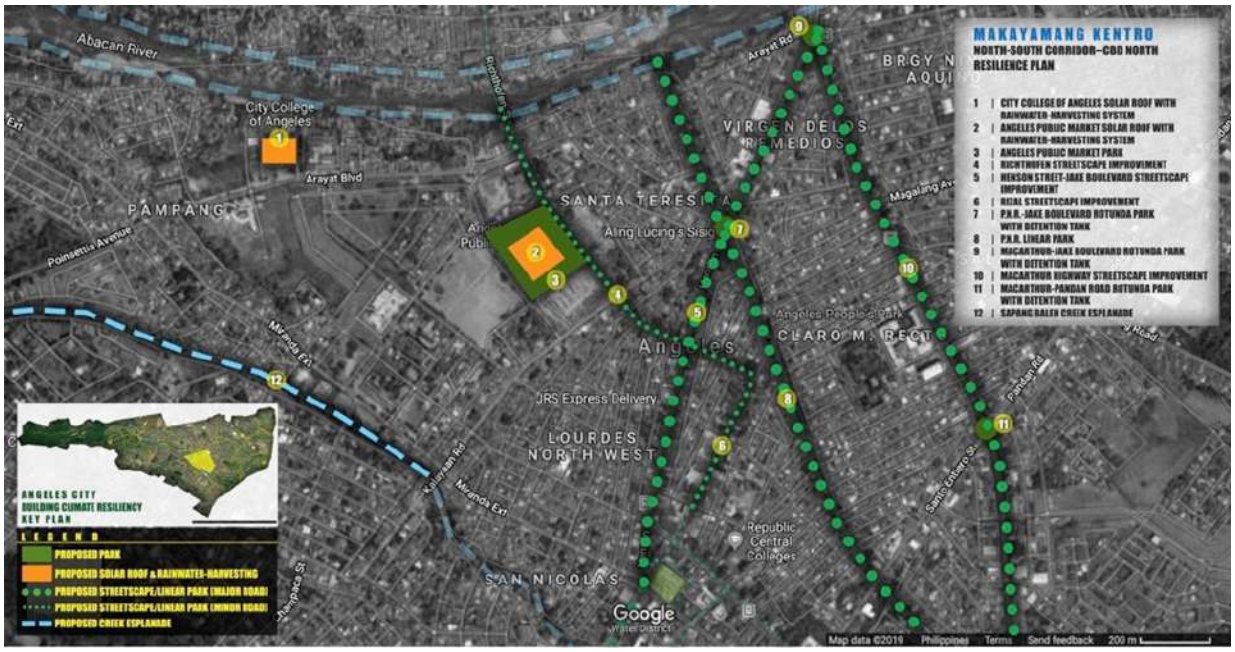
Source: Angeles City Planning and Development Office.

area identified by the city heat map as that will extremely be affected by the projected increase in temperature.

Kentro (North Central Business District and East Section of the Pampang Growth Center)

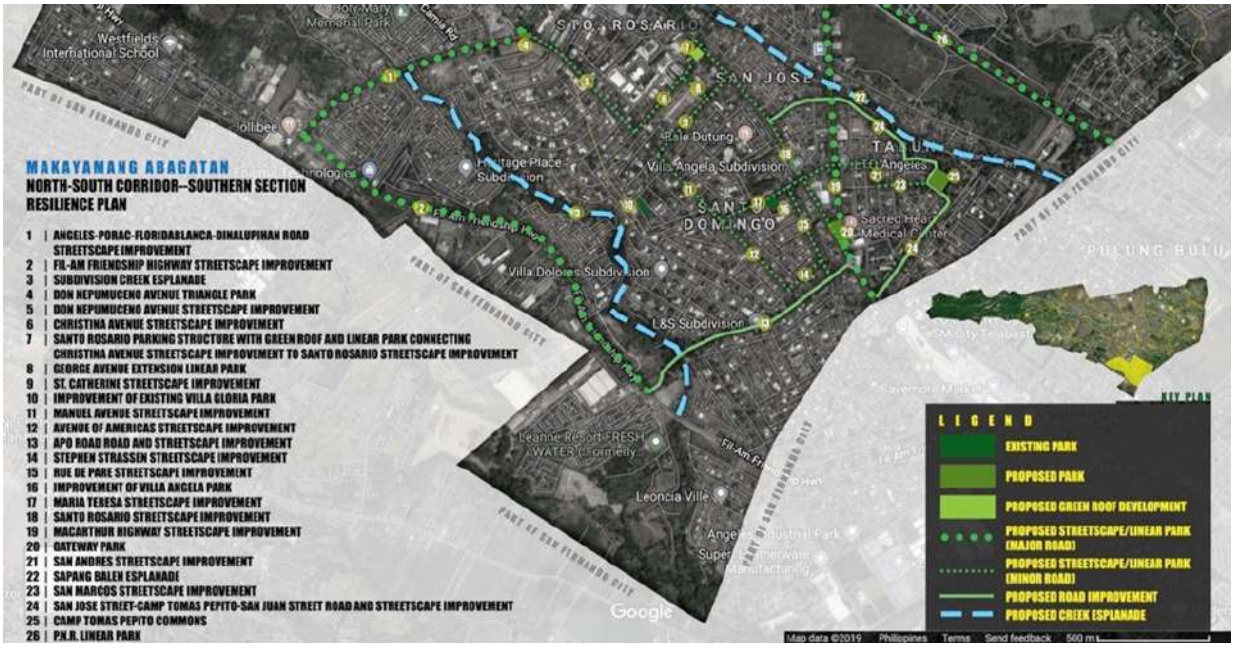
As the northern part of the Central Business District, this section of the North-South Corridor is apt to be termed as “Kentro” (Kapampangan word for “central”). Projects to achieve “Makayamang Kentro” (a pleasant weather for the central area/section) include proposing an approximately 1-hectare park within the public market grounds, solar roof, and on-roof rainwater harvesting system for the public college and market large structures, streetscapes, and a linear park as part of the PNR corridor that will function as wind corridors, and a creek esplanade (Figure 24). The proposed projects intend to transform the public spaces of the area such as the public market and college, creek easements, and transport ways into cooling patches and wind corridors of the district. The projects aim to make the large public properties such as the market and college

Figure 25: Location of the Proposed Resiliency Projects for Balen Kuliat or the Heritage District, North-South Priority Corridor



Source: Angeles City Planning and Development Office.

Figure 27: Location of the Proposed Resiliency Projects for Abagatan or the Sto. Domingo Growth Area, North-South Priority Corridor



Source: Angeles City Planning and Development Office.

as demonstration for large-scale developments to incorporate use of renewable energy and reuse of rainwater. In addition, the streetscape and linear park projects will greatly benefit mobility of students of several public schools and a university in the area.

Balen Kuliat (Heritage District)

This section of the North-South Corridor is the heritage district of the city that is also part of the Central Business District (see Figure 25). "Balen" literally means "house" while "Kuliat" refers to a vine that is abundant in the old town proper during the Spanish colonial period.

Projects to achieve "Makayamang Balen Kuliat" (a pleasant weather for the heritage district or old town proper) include developing a creek esplanade; interconnected streetscapes that include resizing existing carriageway widths to allocate sufficient walkways; solar roof and on-roof rainwater harvesting system for the City Library and Information Office; a linear park as part of the PNR corridor; parking buildings with green roofs and walls strategically placed within the district to reduce traffic congestion; and redeveloping the grounds of the San Nicolas Public Market into a proper street market and its roof deck as a dining destination for locals and tourists. The project will impact an area defined by the urban heat map that will experience moderate to high heat in the future.

Abagatan (Santo Domingo Growth Area Southern Portion of the Pampang Growth Center)

As the southern end of the North-South Corridor, "Abagatan" (Kapampangan word for "south") will be the term to best describe the Sto. Domingo Growth Area (Figure 26). Projects to achieve "Makayamang Abagatan" include proposing a public park at Camp Pepito, a creek esplanade, interconnected streetscapes, a linear park as part of the PNR corridor, improved parks in existing villages, and traffic islands converted into pocket parks. These projects aim to not only maintain and recover green spaces in the area but also increase accessibility in an area largely comprised of gated subdivisions.

EAST-WEST CORRIDOR

The east-west corridor consists of a major blueway, the Abacan River, and minor waterways. The corridor generally addresses the projected water stress.As the city aims to ensure water security, most urban design interventions involved recovering water flow in waterways, protecting the watershed, and easement of the natural waterways. Capital spending on strategies such as water treatment facilities to augment the existing water supply of the city for consumption and/or agricultural irrigation is also being cosnidered. Lastly, interventions of the greenways support the objectives of the blueway. The proposals to recover or increase green spaces for the natural ecosystem to flourish will facilitate groundwater recharge and precipitation from evapotranspiration by plants and evaporation from river water, and wind circulation through vegetated corridors.

Abacan Pangulu (Sapangbato Watershed Reserve)

As natural water sources are located in this section of the East-West Corridor, the local

Figure 27: Location of the Proposed Resiliency Projects for Abacan Pangulu or the Sapangbato Watershed Reserve, East-West Priority Corridor

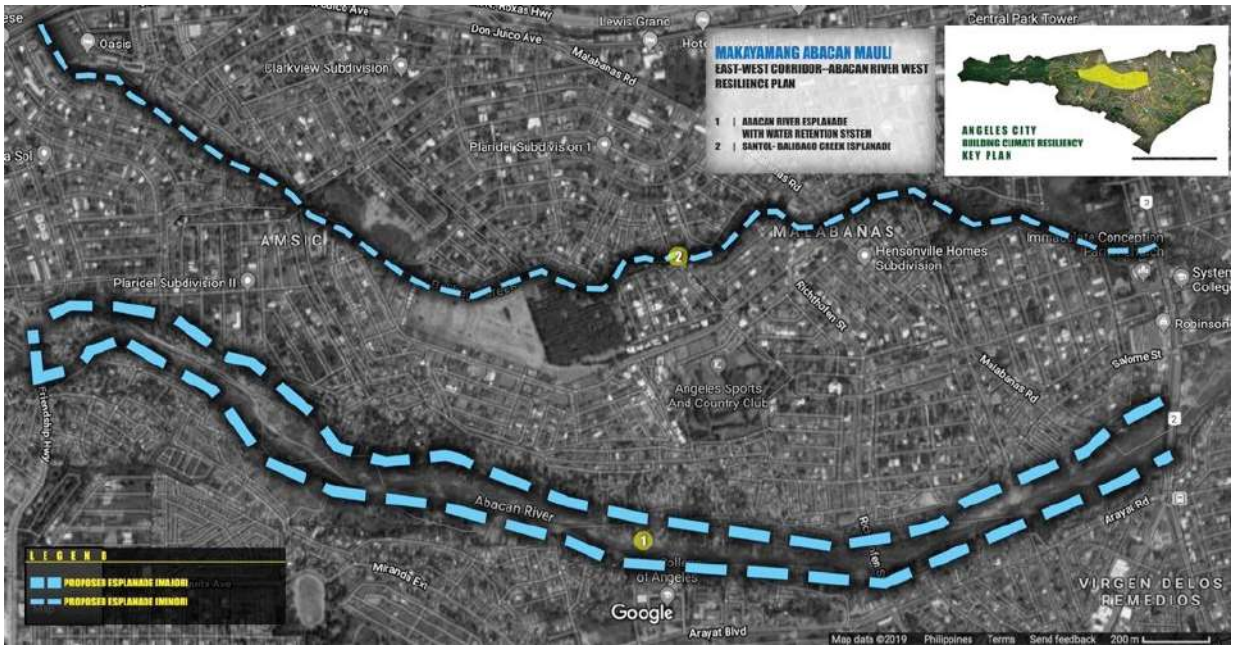
Source: Angeles City Planning and Development Office.

word, "Pangulu" will be the ideal term for the section (Figure 27). "Pangulu" means "water source" in the Kapampangan language. Projects to attain "Makayamang Abacan Pangulu" include designating this section as a forest park where nature conservation will be a priority and development restrictions will be strictly implemented, through institutional measures such as a city ordinance; and developing a river esplanade. These projects will greatly secure water supply in the city, as the natural springs in Sapangbato has been identified by the Angeles City Water District during the Water Summit of the BCRUPD Project in 2019 as a key water source for the city, and ensure water flow and quality of the Abacan River, which is the largest river in the city.

Abacan Mauli (Abacan River Western Section)

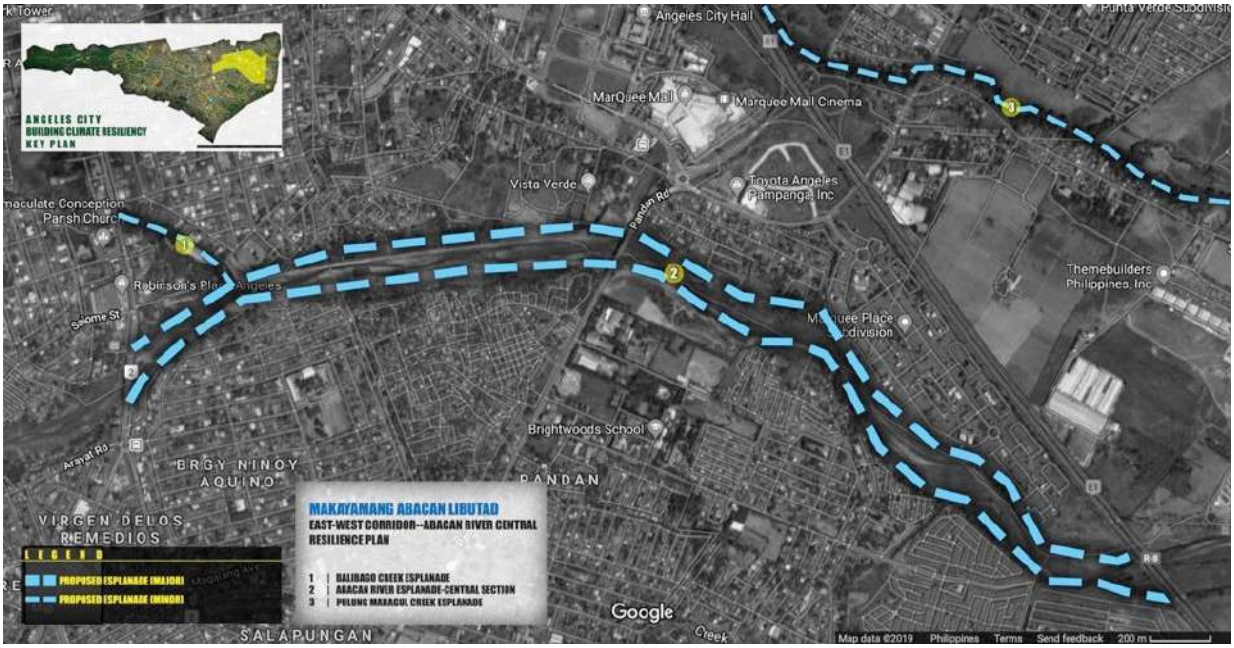
As this section is the headwaters of the Abacan River, the area is fitting to be named as "Abacan Mauli" (see Figure 28). "Mauli" means headwaters in the Kapampangan language. Projects in this section involve developing the upstream of the Abacan River and the Santol-Balibago Creek as esplanades. As these waterways traverse the most populated barangays of the city, the

Figure 28: Map showing the proposed resiliency projects for Abacan Mauli or the Abacan River Western Section, East-West Priority Corridor



Source: Angeles City Planning and Development Office.

Figure 29: Location of the Proposed Resiliency Projects for Abacan Libutad or the Abacan River Central Section, East-West Priority Corridor



Source: Angeles City Planning and Development Office.

projects will recover and ensure the health of the river and creek ecosystems in one of the heavily builtup areas of the city. The proposed Abacan River esplanade in this section is also a continuation of the esplanade in the "Abacan Pangulu" section.

Abacan Libutad (Abacan River Central Section)

As this section is the central segment of the Abacan River, it shall be termed as "Abacan Libutad", the Kapampangan word for "center" (Figure 29). The proposed projects under this segment are continuations of the esplandes in the Abacan Mauli section. The projects involve easing and greening the existing waterways: Abacan River, the delta of Abacan River, Santol-Balibago Creek, and a creek at Pulung Maragul. The projects will contribute to improving the quality of the urban environment in one of the heavily built-up areas of the city.

The formulation of the city adaptation strategy strengthened multi-sectoral cooperation in the planning process of the city government. Two essential multi-sectoral development approaches transpired in developing the chosen adaptation strategy: (1)the convergence of the urban development sector with the agricultural sector in the TWG membership; and (2) constant consultation of the TWG with non-government agencies such as foundations and the private sector regarding the activities.. The Kuliat Foundation, Inc. actively participated in design charrettes of the demonstration project of the adaptation strategy and provided historical references on the climate of Angeles City. The Center for Kampangan Studies, meanwhile, assisted in creating the theme for the adaptation strategy, "Makayamang Angeles".

The city adaptation strategy developed two key urban design strategies that can be accounted as emerging in the context of the Philippine urban design setting. First is redesigning existing roadways lined with buildings as a wind corridor. Typically, designing for wind corridors are planned at the beginning of development projects or are just inherent with tall buildings constructed over time on both sides of a road. For Angeles City, the areas identified as wind corridors are generally road segments bordered by low-rise buildings and some medium-rise buildings. To create a wind tunnel based on the proportion of road width and a 45-degree angle from the edge of the road to the top of the building, existing structures need to be rebuilt or reinforced to accommodate more floors to create the tunnel effect. Rows of trees on both sides of the road will be also provided to augment air circulation within the area, provide cooling effect, and improve air quality. The second strategy is designing esplanades or linear parks along waterways to collect, treat, and use water for domestic purposes by a barangay (village). This can be considered as an emerging urban design intervention in the country as rivers are usually enhanced as an esplanade or a waterfront public open space. Aside from urban design interventions, the adaptation strategy helped the TWG identify two key policies to address the impact of climate change. First is the declaration of the footslope or the Sapangbato forest area as a nature reserve or urban forest. Second is the development of a local green building code.

The formulation of a local green building code aims to require big businesses and developers to employ sustainable building strategies that will help mitigate the effects of climate change. Recommendations include rainwater harvesting system, vertical greening, green roof, urban farming, and energy efficient lighting systems.

The top priority for the adaptation strategy are the urban design interventions of the East-West Corridor, particularly the major blueway or the Abacan River Corridor. The corridor transects areas that will be most affected by the projected increase in temperature and decrease in rainfall. The corridor traverses through the areas covering about 40% of the total population of the city. Finally, the corridor navigates through the steep slopes of the city, farm lands, and through the most built-up part of the city, which includes the northern growth center where part of the CFSPEZ is located.

The proposed development of the Abacan River Corridor will improve the way-of-life of the vulnerable, particularly children, elderly, poor, women, persons with disability, and farmers as the proposed urban design interventions will improve mobility, encourage physical fitness, and enhance the quality of the urban environment. Overall, the interventions seek to augment the existing water supply of the city, provide natural cooling, contribute to local food supply, and decrease carbon emissions of the transport sector.

In terms of financing the adaptation strategy, the city government has availed of the Green Green Green Program Fund by the Department of Budget and Management yearly since 2018. The Green Green Green Program funds the construction of parks at the Diamond Subdivision and Abacan Loop, which are part of the are part of the urban design interventions of the Amianan (North-South Corridor). The city government also utilizes its funds to implement some of urban design interventions such as the development of several segments of the proposed streetscapes. Additional funds, however, are still needed to implement more interventions that will address the climate change projections at a larger scale.

Pitching project ideas. Members of the Technical Working Group present their urban design projects to the representative of the Ministry of Environment of Germany during the one of the BCRUPD workshops (photo by UN-Habitat Philippines).

THE PILOT DEMONSTRATION PROJECT: MAKAYAMANG ABACAN PANGULU PROJECT: ANGELES AQUIPARK FOR CLIMATE RESILIENCE

Similar to the adaptation strategy, the identification of the pilot demonstration project, including its pre-feasibility design, has also gone through a series of site selections and workshops. This was primarily due to issues on land ownership on the initial sites proposed. Several lectures, design charettes, and design proposals have been conducted on the possible sites as demonstration project. The Urban Design Class of the Mapua Institute of Technology of Academic Year 2019 led by Arch. Mark de Castro had also looked into the proposed sites and included this in an urban design exercise in climate resilience.

Throughout the whole process, from project conception to finalization, the TWG has been assisted by the BCRUPD Project. A set of site selection criteria has been determined prioritizing the site to be part of the public domain and that it must be at an area distinguished in the city climate assessment that will be extremely affected by the PAGASA projections. Hence, a segment of the proposed Abacan Pangulu of the East-West Corridor has been identified as the project demonstration site. The site is part of the areas identified by the hydrological study that will receive the least rainfall in the future. Classified as waterway in the city's land use map, it is also part of the remaining open spaces of the city that must be protected especially that it is directly linked to the headwaters of the main waterway of the city, the Abacan River. Finally, the site is adjacent to the remaining farmlands at the northwestern edge of the city and the existing watershed reserve of the city.

Several TWG meetings and design charettes with key stakeholders such as barangay representatives, home owner's association, women's group, Kuliat Foundation, Inc. were conducted to craft the pre-feasibility design of the demonstration project. The project involves designing a 2.4-kilometer section of the Abacan River and a 1.4-kilometer segment of a tributary that merge at the southeastern edge of the Deca Clark township, is approximately 40 hectares in land area.[14] The northwestern edge of the site, particularly 9.8 hectares is located at Barangay Sapangbato, while the remaining majority of the site is part of Barangay Margot.

[14] Part of the project site, which is near the intersection of Abacan River and a tributary has been part of the design exercise of the urban design class of the Mapua Institute of Technology that worked with the city last year. The park has been presented as well to the representative of the Ministry of Environment of Germany last November.

Figure 30: Satellite Image of the Demonstration Project Site

Source: Angeles City Planning and Development Office.

As part of the East-West Corridor, the site is primarily envisioned to fulfill the resilience goal, water-secured city, by endeavoring to contribute to the Water Balance Equation such as through groundwater recharge, evapotranspiration, and surface water run-off management. However, as it is a significant addition to the public green space of the city in terms of land area, it also satisfies the goal, a cooler climate, by allowing vegetation to perform natural shading and evapotranspiration that contributes to cooling and facilitating wind movement.[15] The project is essentially a waterway development that multi-functions as groundwater recharge and surface water management including treatment to be reused for irrigation of the approximately 50 hectares of farmland adjacent to the site; and a public river park that can contribute to a cooler microclimate especially for the communities along the river stretch, which is about 6,000 residents at present. Hence, it is named as Aquipark[16]—"aqui" referring to the drainage and collection of surface water purposes of the project and "park" referring to the park function of the project.

The Aquipark Project starts with the intervention of preserving the Sapangbato Watershed, which is at the northwestern edge of the demonstration project site. This can be through an ordinance that the city government is currently considering as its CLUP for 2021-2031 is being updated. The second step is both to retain the natural waterway and its easement and protect existing structures or the settlement along the waterway. After retaining the mandated extent of the natural waterway, the next interventions are to simoultenously collect and convey surface water in through the waterway. The final step is to reuse the surface water collected in the catchment areas of the natural waterway such as for landscape or agricultural irrigation.

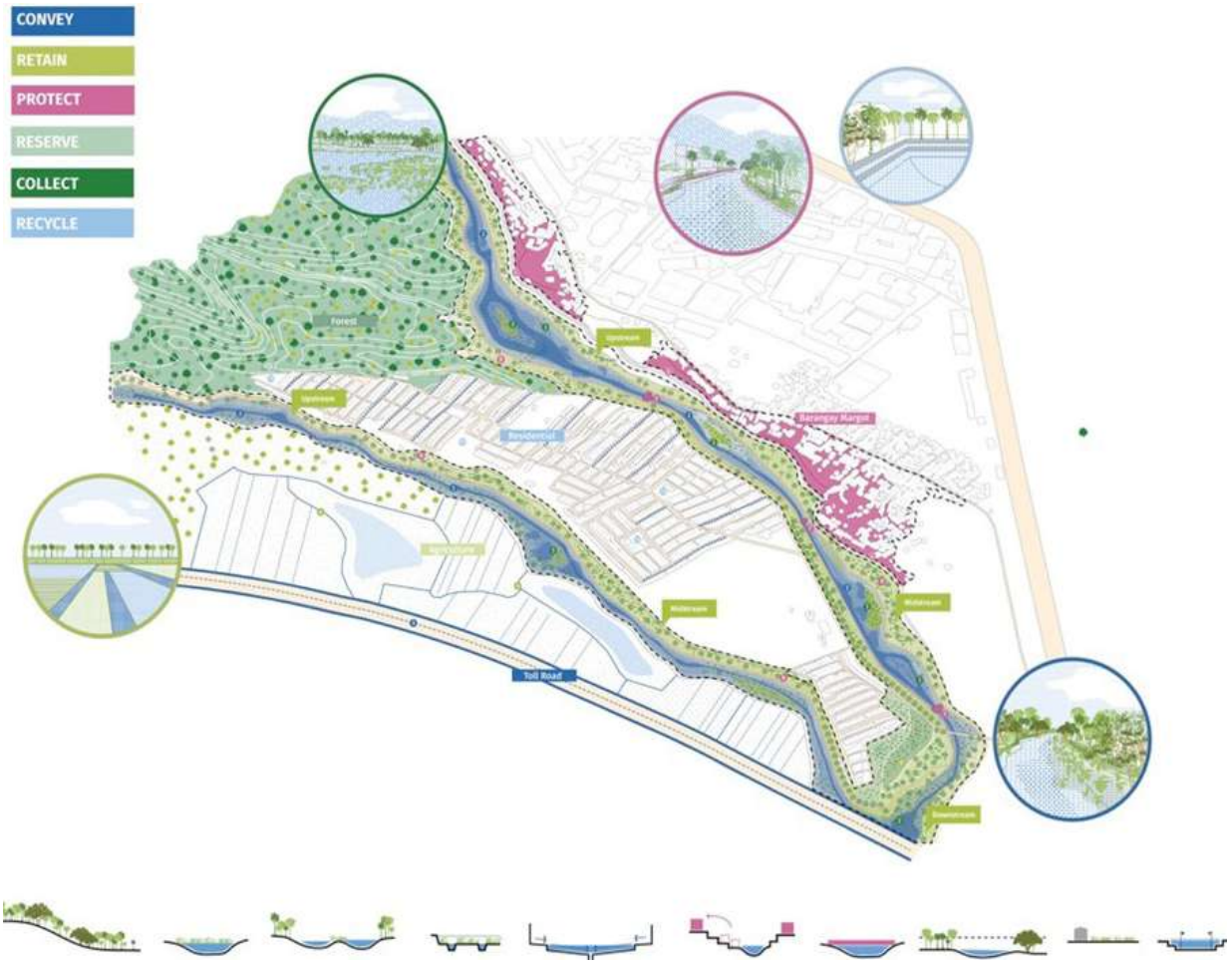
The Aquipark (Figure 33) consists of four sections: the upstream, midstream, downstream, and the tributary. The upstream collects surface water and strain solids from the water before the water flows to the midstream. The midstream is a series of ponds and low dams that act as secondary stage to filter again solids from the water from the upstream before exiting to the downstream. The downstream is the final collection and filtration area of the water from the upstream and midstream. In addition, the tributary also consists of a catchment that collects surface water from its upstream and surrounding areas that can also used for irrigation by the agricultural lands along its stretch. Collectively, the ponds of the upstream, midstream, downstream, and tributary can accommodate 80,000 cubic meters of water at 2 meters of depth. With the climate change projections, the ponds can hold an average of 38,400 liters of water annually in the future.[17]

[15] The United States Environmental Protection Agency estimates that evapotranspiration alone or combined with shading cools the temperature under the plant's canopy from 1 to 5°C.

[16] The name, Aquipark, has been termed by the urban design class students of the Mapua Institute of Technology for the area near the intersection of Abacan River and a tributary that they have designed as a surface water collection and treatment park with urban farms and community gathering spaces. For consistency, the name is retained for the demonstration project.

[17] If the temperature in the future will be at an average of 33°C(RCP 8.5), 33°Ctemp. in a day can vaporize approximately 10mm of water per hectare per day (based on the FAO standard on evapotranspiration: 20°Ctemp vaporizes approximately 1mm of water per hectare per day) and if the RCP 8.5 states that 52% of the year will be dry or 192 days (while 104 days will receive rain of 2.5mm and less), let's say, for 192 days of 33°Ctemp. and no rain, the 80,000 cubic meters of water will be reduced to 3,200 liters of water (8mm depth of water) at day 192. Getting the average of the water depth, the ponds can contain an average of 38,4000 liters within the 192 dry days.

Figure 32: An Axonometric Illustration of the proposed Urban Design Interventions at the Demonstration Project Site



Source: Angeles City Planning and Development Office.

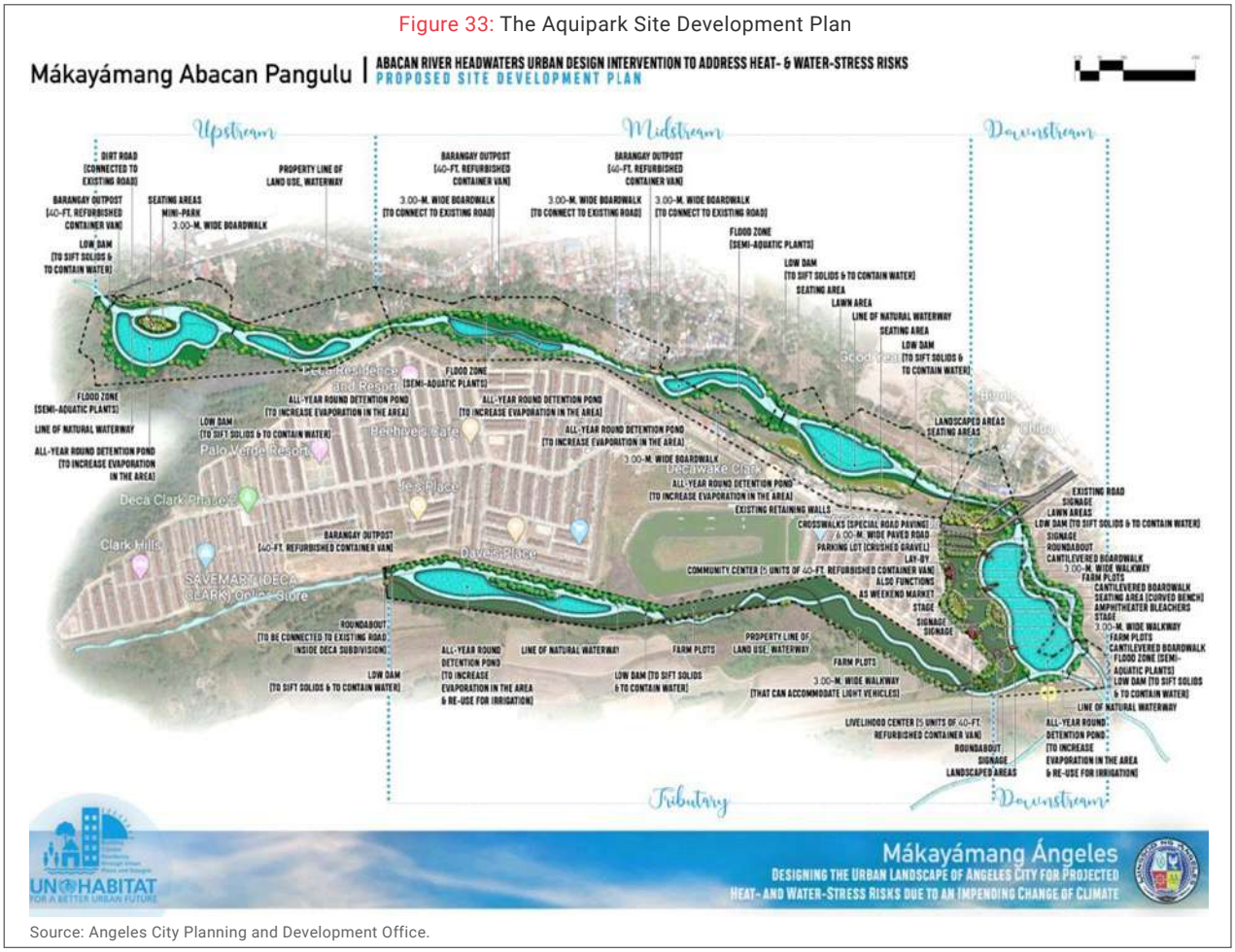
As an enhanced public park, the Aquipark is bordered by clusters of trees that can provide shade to its circulation and activity spaces and facilitate airflow to cool the area. Aside from natural shade and wind flow, the Aquipark consists of several ponds throughout its stretch. The evaporation of the pond and the transpiration of the vegetation in the Aquipark may help in cooling the area and increasing both the amount of surface and groundwater in the area.

The Aquipark serves both as a front yard and connector of the communities along the river stretch. For houses and other structures facing the waterway, the Aquipark offers a lush foreground and facade. Aside from interconnecting existing sidewalks for better pedestrian mobility, it provides the residents a community space for socialization, physical fitness, and livelihood, among others. A main walkway and bikeway spine traverses the length of the upstream, midstream, downstream, and tributary. Along the spine, particularly at the upstream and midstream, are spaces to sit and view the waterway as well as large expanse of lawns for playing, outdoor learning and other small group activities. The downstream offers spaces for more varied activities such as high-value crop farming, weekend markets, amphitheater for events and gatherings, and view decks as it is the most accessible from the existing local road compared to other sections of the project.

The detailed design of the Aquipark features sustainable design practices. As part of the waterway parcel, most areas of the Aquipark is expected to be inundated in an extreme flooding event; hence, the design of the gathering spaces, seating areas and other structures allows them to be submerged while the pavements are permeable to allow infiltration of water into the ground. For the larger structures of the Aquipark such as the community health center, livelihood center and barangay (village) outposts, they will be made from used container vans on stilts. This also contributes to the permeability of the park as well as complying to the rules of the Water Code of the Philippines where only temporary structures are allowed in waterway areas. Solar panels and a rainwater harvesting facility for the container vans are parts of the design as well..[18] Walkways of the entire Aquipark will be illuminated by solar lamp posts at night while the urban farms and ornamental plants within the park will source irrigation water from the ponds of the park.

[18] The rainwater harvesting facilities of the livelihood center and health center are designed to store 72 cu.m. [36 cu.m. each] of water per year [estimated to 1 year water needs of 5 personnel based on the 20 liters/capita standard of WHO [a standard not including laundry water needs] and the remaining liters for the water needs of the weekend market[toilet flushing, handwashing]). The rainwater harvesting facilities for the three barangay outposts to store 36 cu.m. [12 cu.m. each] for a year.

Figure 33: The Aquipark Site Development Plan



Source: Angeles City Planning and Development Office.

Though the Aquipark will largely benefit the residents of Barangay Margot including the nearby Barangay Sapangbato at west, its design intent can be replicated in other areas of the Abacan River and/or other waterways of the city, benefitting other barangays or communities of the city with a cooler climate and water source. With seven waterways traversing different parts of the city, the city government will need funding for the feasibility design and project implementation.

In summary, the BCRUPD Project brought three fundamental paradigm shifts to the TWG and to the city government:

Technical

The TWG members deepened their understanding of climate change and urbanization, allowing them to improve science-based findings, targets, strategies, programmes and projects as main contents of the LCCAP. The members learned that the climate adaptation strategy [19] will not only address the projections but will bring forth other benefits such as food security, inclusive mobility, and public spaces encouraging a healthy lifestyle, building a sense of community and providing livelihood opportunities.

Institutional

The BCRUPD Project helped bring the different departments together. During the start of the project, the City Disaster Risk Reduction and Management Office led the TWG and the LCCAP updating, andthis has possibly resulted in the DRRM orientation of the LCCAP. The leadership eventually shifted to the City Planning and Development Office (CPDO) at the latter part of the project. As the CPDO spearhead development planning of the entire city, it approaches planning comprehensively and is equipped with the necessary resources needed such as data and personnel.

Development thrust

Despite the city's continuous urbanization, it is worth noting that the city government intends to preserve its agricultural sector, which is at risk of the projected decrease in rainfall, and important for the future food security of the city. Representatives of the City Agriculture Office have been actively participating in workshops of the BCRUPD Project and TWG meetings. In addition, in its ongoing updating of the CLUP, the city is currently envisioning itself as a smart and green city that will be an example to the region of climate resilience and sustainable development.

[19] The urban adaptation strategy aims to achieve a cooler climate and a water-secured city. To achieve a cooler climate, the following are the order of the objectives: first is to maintain and recover natural cooling systems; second is to reduce greenhouse gas emissions; and last is to invest in sustainable cooling technology or infrastructure. To realize a water-secured city, the following is the order of the objectives: first is to secure natural water source and supply; and second is to invest in water supply securing technology or infrastructure.

THRIVING—AND NOT MERELY SURVING—IN THE FACE OF CLIMATE CHANGE

A better understanding of the projected climate impacts of Angeles City has resulted in the crafting of the "Makayamang Angeles". The proposed adaptation strategy brings various leverages aside from building the city's climate resilience from a future hotter and drier climate.

"Makayamang Angeles", the climate resilience urban adaptation strategy of Angeles City, primarily targets to improve the city's capacity to provide a comfortable temperature in its landlocked ecosystem while securing the water needs of the city. The strategy re-emphasizes the enforcement of the existing development guidelines in the country that safeguard the natural environment through improved urban management. Through the improved urban plans and design for climate change, implementation of policies such as those from the Water Code, the Housing and Land Use Regulation Board Guidelines, the Building Code, could be effectively applied in the city. Further, the strategy espouses new policy directions for the city government such as the formalization of the Sapangbato Watershed as a protected zone; designating a city-wide network of public open spaces or the blue- and green-ways that will champion the climate resilience goals and objectives of the city; proposing a local water security plan, and crafting of a local green building code.

The enhanced knowledge on the projected climate impacts has rectified the perception, especially of the city government's technical working group for planning resilience from climate change, which has been initially associated with flooding and typhoon events that are being experienced in most parts of the country. This corrected perception was key to developing the appropriate policies and adaptation strategy as well as has led the TWG to a revisit of project recommendations in the past years that are now related to building climate resilience.

The proposed policies to build the city's climate resilience are primarily fortifying the aspects of the city that have been relegated while the city has been expanding. Primary to this is the protection of the remaining forested area of the city.

With the proposed formalization of the Sapangbato Watershed as an urban forest, the natural springs at the area will be secured. The better appreciation of the projected climate impacts has led to a revisit of the past proposal by the NWRB to the city to implement a local water security plan, which will be a major solution to the projected drier climate. Finally, the proposed establishment of a local green building code will cover the small-scale development details of the city, such as site planning and building design. For a city that may have generally prioritized economic growth in the past, the code will mandate environmental sustainability in spatial planning and design in

the city, which is currently largely heavily built-up and highly dense.

The proposed adaptation strategy also aims to revive sectors that have been disregarded by urbanization processes throughout time. Foremost of all, this entails access to a network of green open spaces such as parks, plazas, streetscapes, and other open space types, and farmlands or spaces to grow crops for food. Access to a network of blue open spaces such as natural waterways that are teeming with riverine life is also equally important to address the climate projections.

Open spaces are venues in urban areas where nature can perform ecosystem services. For Angeles City, the services, natural cooling, and groundwater recharge are key to adapting to the projected climate impacts. Access to public open spaces reinforces inclusive mobility, physical fitness, and community ties. Access to public open spaces enables all people groups to move around the city with ease whether for livelihood, household needs, or recreation and cheaper compared to motorized transportation. Access to farmlands or areas for growing food crops furthers food security in the highly built-up city as well as promotes a healthy diet among citizens.

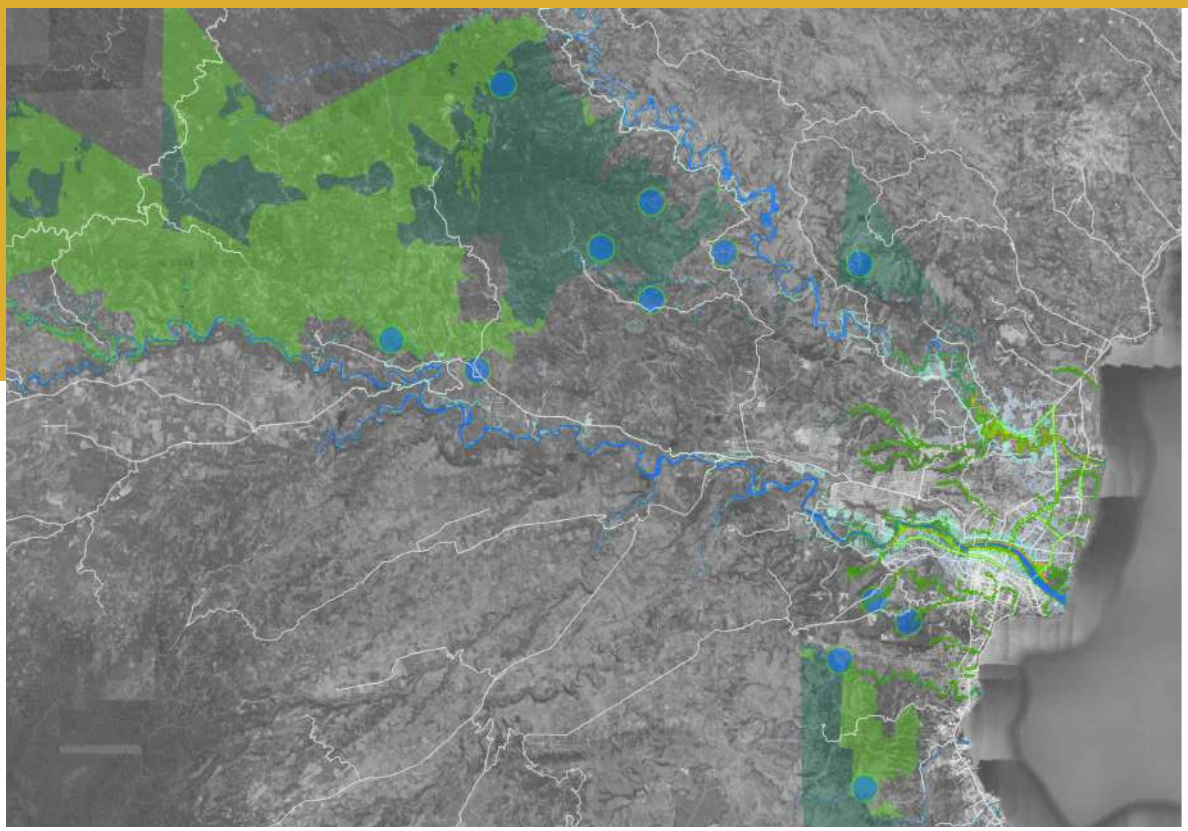
At the outset, the projected climate impacts will affect the health of the people. A hotter climate brings heat-related diseases, which can be fatal, while a drier climate will deprive people of clean water. The new policies and adaptation strategy intend to bolster the general health of the Angeleños for them to be able to adapt to the projected increase in temperature and decrease in rainfall, particularly by helping ensure a cooler microclimate and water security.

Aside from facilitating a cooler and water-secure city, the policies and urban adaptation strategy envision a more sustainable and resilient Angeles City. With natural systems revived and prioritized, more equitable growth of the city can be achieved in the future since the proposed adaptation strategy affects all districts of the city. The proposed network of green- and blue-ways strategy will generally improve the accessibility of human settlements to commercial districts and other business zones and vice versa, thereby allowing all people groups to move freely around the city. The strategy will enable farmlands to continue producing food crops for the city, thus, reducing dependence on food imports and maintaining food to be affordable in an ever-expanding city. The strategy will also improve the air quality of the city and reduce GHG emissions, especially in the transport and energy sectors.

The Angeles City Government has already started to implement the urban adaptation strategy. A segment of the streetscape project under the Balen Kuliat District, the Nepomuceno Streetscape, and an improvement of a plaza and park at the Amianan Section have been funded by the 2018 Green Green Green (GGG) Program of the Department of Budget and Management (DBM). For the 2019 GGG Program, the city government submitted to the DBM other open space projects for funding. As the GGG Program will be offered annually, the city government intends to continuously apply from the DBM funding to continuously develop parks, plazas, streetscapes, and esplanades. This will accomplish throughout the next years the north-south corridor projects of the strategy that primarily address the projected increase in temperature. As the city government is also currently updating its CLUP, the policies to support the adaptation strategy as well as the proposed urban design interventations are in the process of being integrated in the planning and legal outputs. The hydrological study and the series of capacity building activities supported by the BCRUPD project are a good start to turn the vision of the adaptation strategy into reality. However, much needs to be done. The city government needs resources to fully implement the strategy in order to build a sustainable and climate-resilient city for its people.

CAGAYAN DE ORO CITY

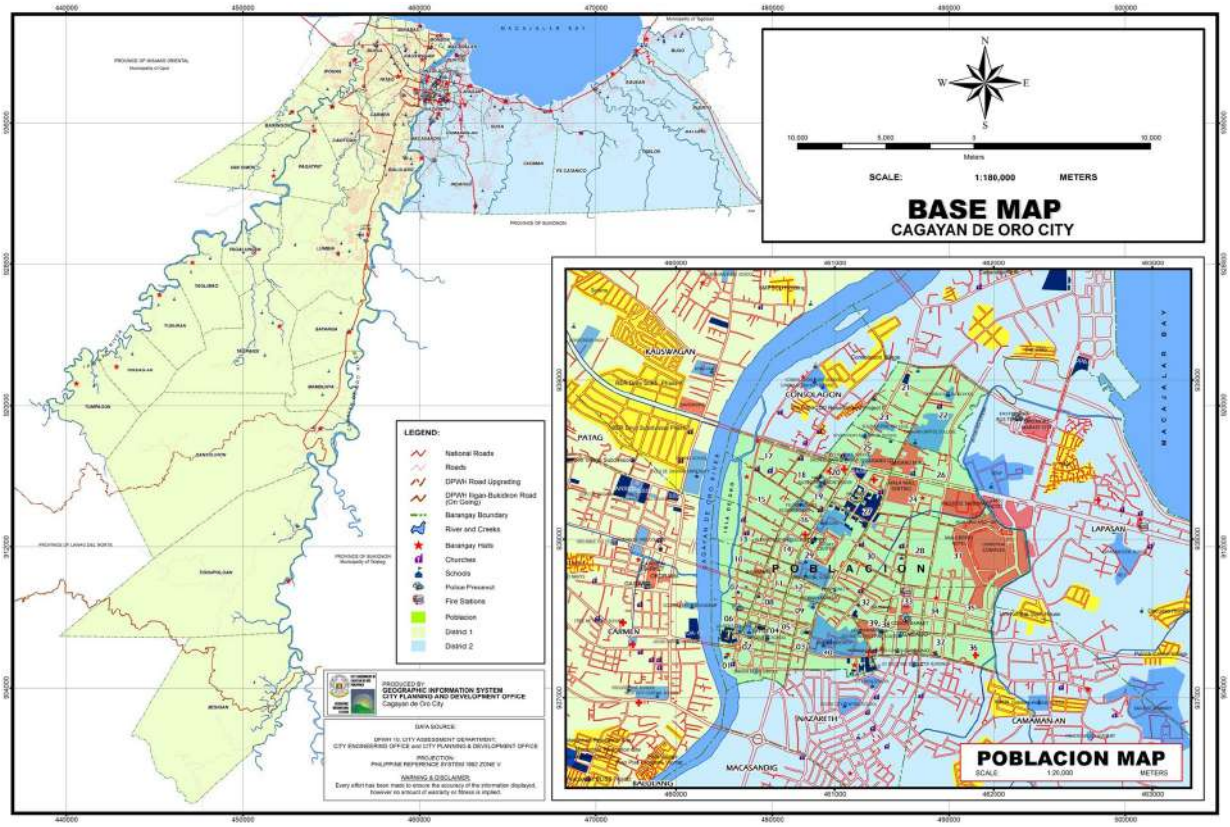
CASE STUDY ON THE PATH TO CLIMATE RESILIENCY



ABOUT CDO

Cagayan de Oro City is a first class, highly urbanized city located at the center of Northern Mindanao (Region X). Its total land area of 57,851 hectares (578.51 sq km) spreads across 80 *barangays* (villages), 14 of which are located along Macajalar Bay and facing the Mindanao Sea. Its upland *barangays* in the south share borders with Bukidnon province's watershed areas that drain into either the Cagayan de Oro River or the Iponan River, both located in the city.

Figure 1: Base Map of Cagayan de Oro City



Dubbed as the "Gateway to Northern Mindanao" and the logistics hub of the region, the city has a deep water seaport serving both passenger and cargo ships; and bus terminals with transportation services to nearly all areas in Mindanao, as far as Surigao City to the east, Zamboanga City to the west and General Santos City to the south, and connecting to the rest of the country.

The airport, which was transferred from Lumbia, Cagayan de Oro to Laguindingan, Misamis Oriental in 2013, caters to passenger and cargo planes from the Northern Mindanao area, most of which travel from and to Cagayan de Oro. The Laguindingan Airport connects the city to Metro Manila by an hour and half and to Cebu City by 50 minutes. There are also daily flights going to the cities of Iloilo, Dumaguete, and Davao.

The city has an estimated population of 746,000[1] with a population density of 1,289 persons per sq km. The city's annual average population growth rate of 2.69% is higher than the national average. The city's highly urban and relatively young[2] population is estimated to grow even further and could double in year 2047.

Such a high growth rate is attributed not only to increase in birth rate but also to migration, as the city is a magnet for employment and education in the region. In 2019, Cagayan de Oro registered over 26,000 businesses, resulting to Php 112 Billion gross sales. Agriculture, fishery, and forestry represent the biggest share in businesses at 53.93%, with manufacturing and quarrying close second and third places at 14.37% and 14.28%, respectively. Other sectors contributing to the income of the city are: construction, wholesale and retail, transport/ storage/communications, business services, and community services. The city also serves as a home to several business process outsourcing offices, one of the sectors that contribute to the region's economic development, particularly to Region X's Gross Domestic Product.

Cagayan de Oro is also the center of education in the region, with four universities and several other higher education institutions and technical-vocation institutions. Education is a priority of the city government: the collected real property taxes are heavily invested in improving and constructing school buildings. Since 2013, over 600 school buildings and 20 new campuses have been built and has produced over 28,000 graduates. The city also introduced the IskolarsaDakbayan (IsDa) Program, which offers fully subsidized tertiary education for qualified students at a university of their choice. The inclusive education-targeted programmes have earned the city awards and recognition, such as the Seal of Good Education Governance by the Synergeia Foundation for 2017, 2018 and 2019 and the Galing Pook Award for 2017 and 2018.

Recognizing that Northern Mindanao is the center for trade, logistics, ICT, and education, the national government has initiated efforts to establish the Metro Cagayan de Oro with the city as the center, as indicated in the Philippine Development Plan 2017-2022. This effort is backed by approved investments for the region totaling Php 228.8 billion in 2018[3], the biggest in the country.

An enabling and resilient natural and built environment is necessary for the city to realize and sustain the projected growth. Just as the city has played an important role in the growth and development of the region, it continues to do so as it moves closer to achieving climate change resilience. This path, however, has been fraught with challenges.

For a city that used to be hit by typhooons only 11 times during a 20-year period, Typhoon Sendong (international name: Washi) in December 2011 proved to be devastating. While it barely rained in the city proper, the heavy downpour dumped a month's worth of rain in nine hours in some areas in Bukidnon province, which was eventually drained into the Cagayan de Oro River. From two meters, water level rose to as much as 9.86 meters at the Cabula river area. This unprecedented event resulted in 674 lives lost, decimated riverside communities, and irreparable damage to critical habitats.

This disaster forced the city to acknowledge that it experienced the effects of climate change, and pushed it to take necessary steps in implementing adaptation and mitigation measures and mainstreaming these in planning and development.

This is the story of Cagayan de Oro, and its people's journey towards climate resiliency—the city that has endured tortuous challenges, but also one of hope rising from the aftermath of Typhoon Sendong.

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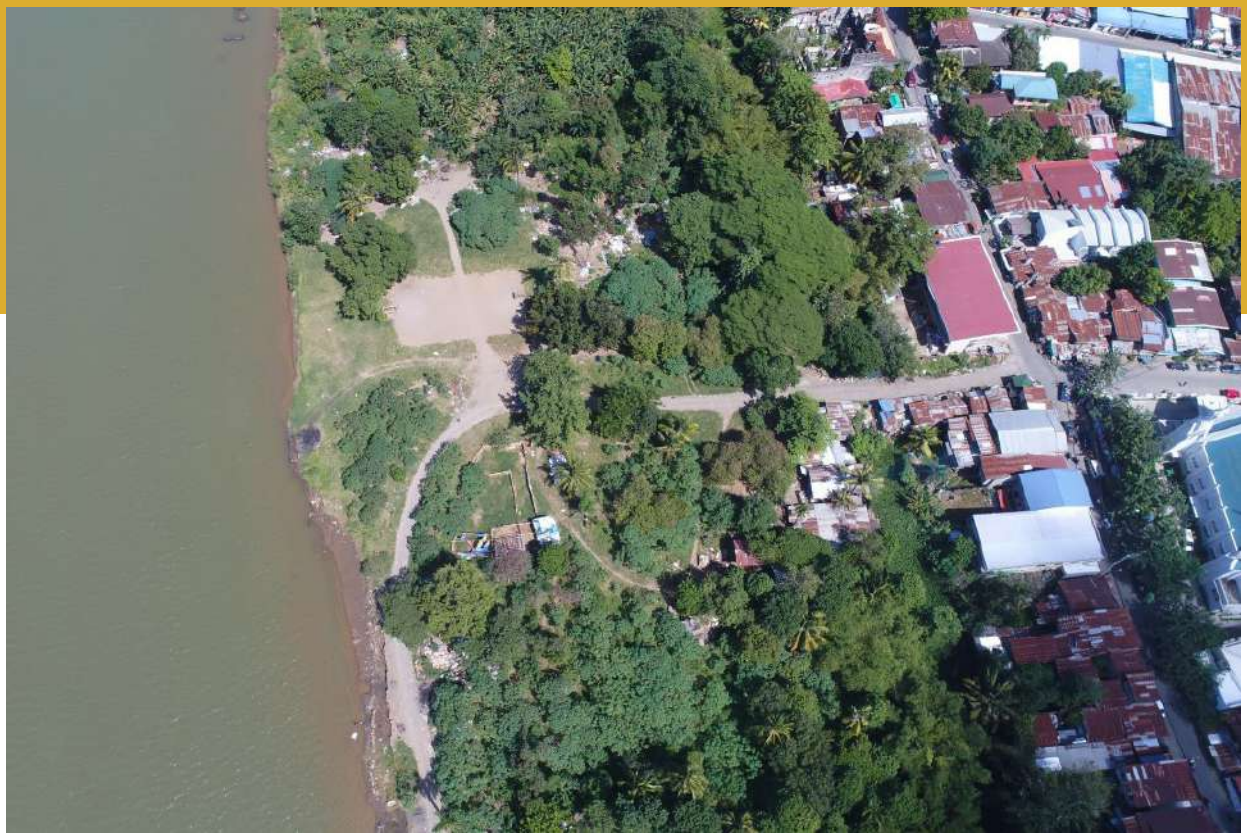
[1] As of 2020.

[2] About 30.81% of the total population belongs to the age group 0-14 years old. Productive population (ages 15-64 years old) comprises 66.86%, while 3.33% of the household population are elders (above 65 years old). The bigger portion of its workforce is composed of a relatively young population, with 16% coming from age range 20-24 years old, with both sexes equally represented.

[3] Board of Investments, 2018. (https://boi.gov.ph/setting-another-record-breaking-performance-boi-investment-approvals-breach-php907b-level-in-2018/)



CDO IN THE FACE OF CLIMATE CHANGE

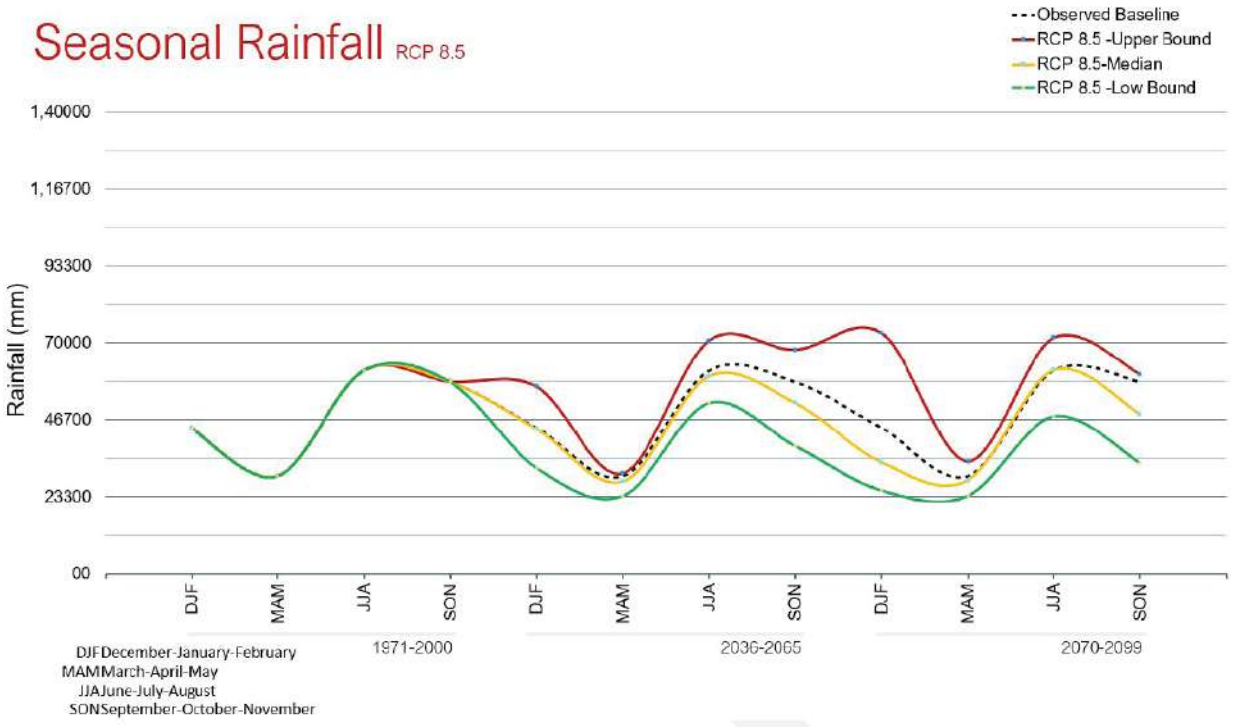
The city's experience with Typhoon Sendong was a clear indication of changes in climate, with potentially devastating effects on the city unless transformed into positive action.

Under the Coronas Climate Classification System of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), Cagayan de Oro's Climate falls under Type III and IV. The western portion of Cagayan de Oro is classified under Type III, which is characterized by a short dry season, usually from February to April. Type IV climate in the eastern part of the city, meanwhile, is characterized by an almost evenly distributed rainfall during the whole year.

Projections using Representative Concentration Pathway (RCP) 8.5[4], often regarded as the "worst case" climate change scenario based on the business-as-usual path of increasing GHG emissions, show a wide range of changes in rainfall volume for both mid-century and late-century periods. It could increase by as much as 28.1% from December to February, the highest increase for mid-century forecasts, but could also decrease by as much as 27.2% for the same period. The dry period from March to May would be even drier, as rainfall volume is estimated to decrease by 20% by mid-century. Meanwhile, late-century projections foresee a 64.8% increase in rainfall volume in the wet season of December to February, and a dry season with a plausible 236.7 millimeter (mm) of rainfall, compared to the current baseline of 296 mm.

[4] Representative Concentration Pathways (RCPs) are "scenarios that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover".

Figure 2: Representative Concentration Pathway (RCP) 8.5 Seasonal Rainfall Projections



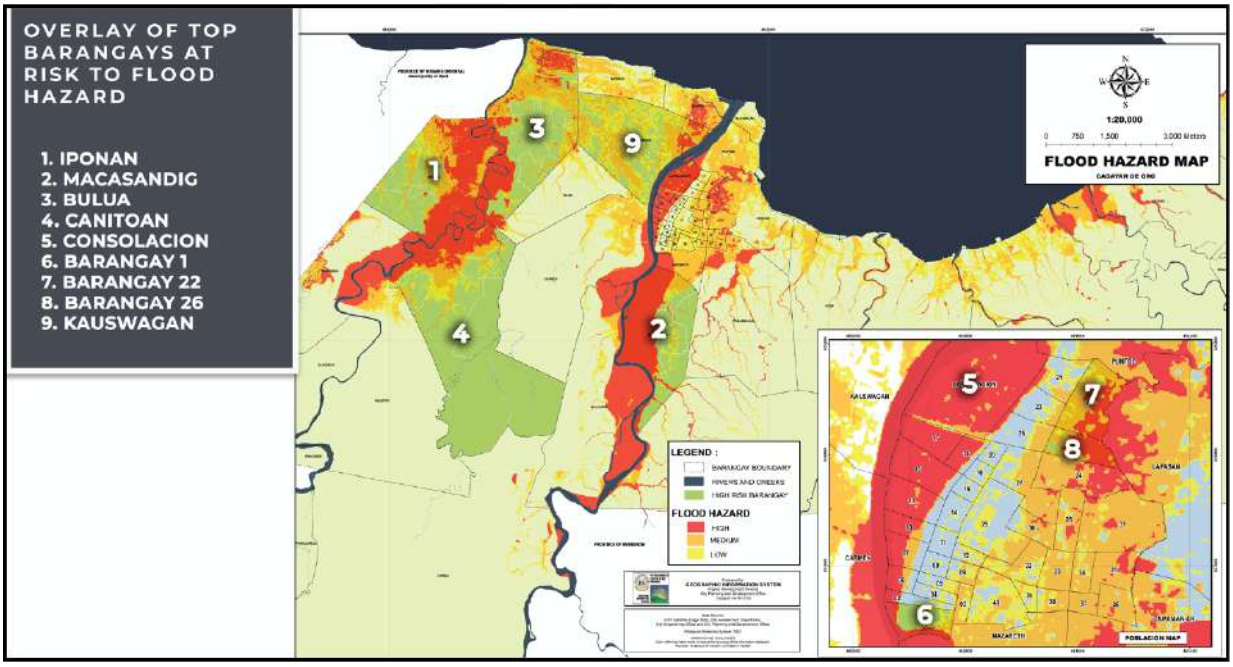
Note: For the Intergovernmental Panel on Climate Change (IPCC) 5th Assessment Report, four scenarios were selected as basis for climate change projections.3 On the other hand, the Special Report on Emissions Scenarios (SRES) projection for extreme rainfall events, reveal that more than 150mm will fall on around 13 days in 2020 and 9 days in 2050.

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration.

This wide range of scenarios compels the city to address and manage critical factors that contribute to the effects of climate change.

Externally, heavy rainfall at the watershed areas would result in runoff that drains into the Cagayan de Oro and Iponan rivers. This can be aggravated by a decrease in forest cover, caused by deforestation and the conversion of agricultural areas into banana and pineapple plantations, which do not absorb enough water. Excessive runoff will adversely affect flood-prone and low-lying *barangays* located along Cagayan de Oro River, Iponan River, and the coast. 74,399 people are currently exposed to 1.5 meter (m) flood depth, with 59 out of 80 *barangays* at high risk. At most risk are residential areas in Barangays 18, 17, Consolacion, 2 and 15, all of which have the highest risk scores for population based on their vulnerability to previous flooding incidents. Climate and Disaster Risk Assessment (CDRA) results show that while Barangay 18 has a high risk score, Barangay 22 has the highest vulnerability score.

Figure 3: Flood Hazard Map of Cagayan de Oro



Source: City Engineering Office and City Planning and Development Office, CDO

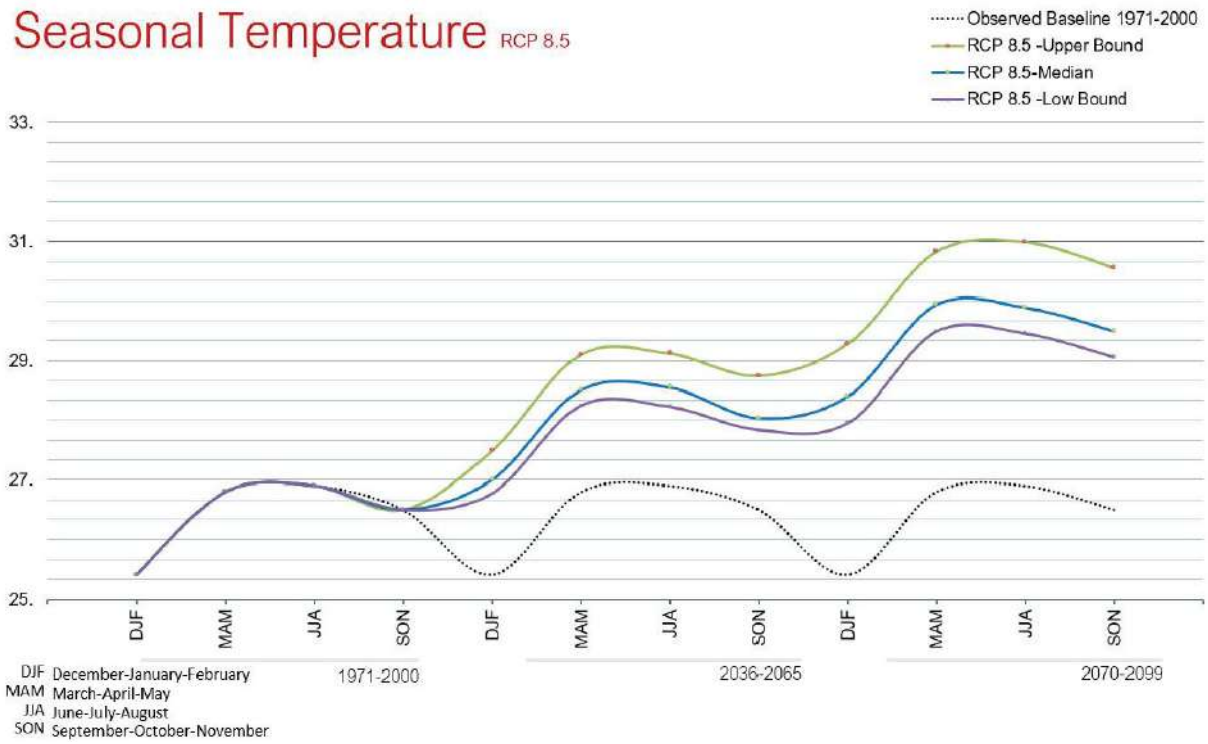
There is also a high number of households in these areas that live below the poverty threshold and in houses made of light materials, which further increase their risk to climate change-driven flooding. As of this writing, around 208 informal settler families (ISFs) living in these *barangays* have been profiled and included in the City Housing and Urban Development Department's list of ISFs to be considered for provision of adequate housing.

All in all, nine *barangays* are critically vulnerable and majority of the city's 80 *barangays* are highly vulnerable to flooding.

The city's critical facilities are likewise at risk, especially Barangay Carmen where a higher education institution is at high risk of flooding. Meanwhile, Cagayan de Oro Water District's production wells, which are some of the city's lifeline faclities located in Barangay Camaman-an, are also highly at risk, with potentially high cost of replacement in case of damage from flooding.

Aside from drastic changes in rainfall patterns, Cagayan de Oro also faces increased temperature. Projected mean temperature under RCP 8.5 scenario for mid-century could increase by as much as 2.3 °C. At the end of the century it could increase by 4.1 °C from June to August.

Figure 4: Representative Concentration Pathway (RCP) 8.5 Seasonal Temperature Projections



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration.

Such changes amid increasing commercial activitiy, especially in Poblacion (downtown area), result in heat stress. In fact, the city's heat stress map shows high to very high heat index in areas where there are more concrete buildings and less urban green cover. Particularly, heat stress affects 42 out of 80 *barangays*, including almost all of the 40 urban *barangays*. Most of these urban *barangays* comprise the business district with relatively high transport concentration and energy consumption. Increased temperature will thus further exacerbate heat island effect, or the significant warm temperature in built-up areas[5] that is evident in the city.

Increased temperature may not only cause discomfort to the residents but may also lead to illnesses. For instance, the city has an unprecedented record of over 1,500 cases of dengue in 2019[6], which resulted in eight deaths. Various studies have pointed to the strong influence of temperature on dengue transmission and the Aedes mosquito population.[7]

The CDRA conducted by the city in 2018 identified two other climate-related hazards: storm surge in the 14 coastal *barangays* and rain-induced landslides in the southern part of the city.

All 14 coastal *barangays* are highly susceptible to storm surge. Natural barriers such as mangroves are not dense except in areas where mangrove planting activities were regularly undertaken. Compounding this are several

[5] As defined by the United States Environmental Protection Agency (US-EPA).
[6] See https://pia.gov.ph/news/articles/1025613.
[7] See https://www.who.int/heli/risks/vectors/denguecontrol/en/.

big-ticket infrastructure, including bridges and a diversion road, that threaten critical habitats along coastal areas. These projects also forced the relocation of informal settler families, increasing their vulnerability. Around 200 families are affected by the ongoing flood risk project along Cagayan de Oro River. The City Housing and Urban Development Department is conducting profiling to obtain data for the housing database and planning purposes.

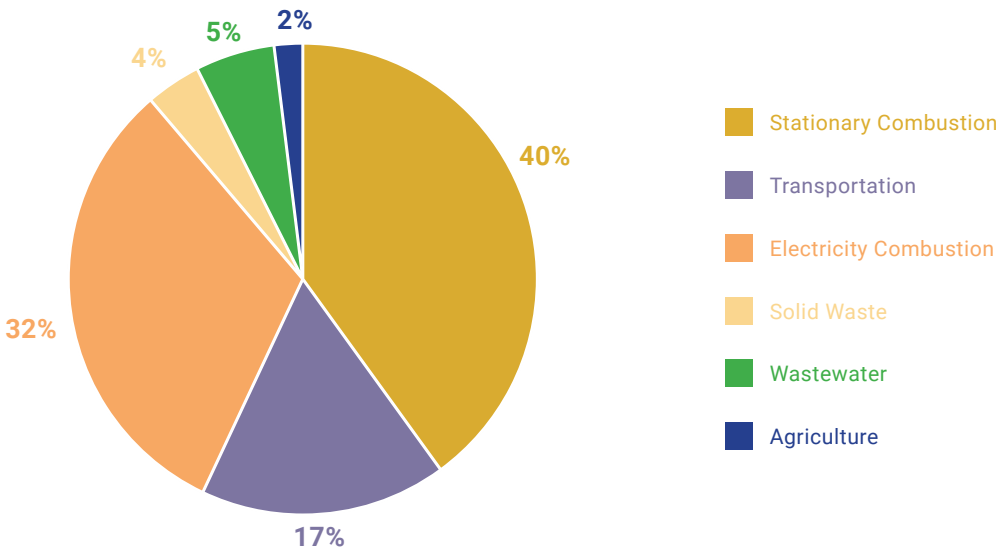
Most of the *barangays* at the southern part of the city have low to moderate vulnerability to rain-induced landslides. The exposure of these areas is not high, which is an advantage for production areas in the southern section. There are also opportunities to harness water for communities with limited supply.

Given climate change projections and technical findings of the CDRA, the city realized the need to address four climate change impacts: flooding, heat stress, storm surge, and rain-induced landslide.

The city government, together with the Climate Change Commission, implemented the Twin Phoenix Project in 2012 aimed at addressing the impact of climate change in the city. Mainly a response to Typhoon Sendong, the project focused on flood mapping and projection, new warning systems, and stream gauges. The project was also an opportunity to provide a new perspective on disaster risk management and dispel the notion of the city as being "typhoon-free".

In addition, the city also supported by an official development assistance on strengthening urban development, conducted its greenhouse gas (GHG) inventory. Done in 2016, this initiative aimed to shed light on sources of GHG emissions, and hopefully guide the city in implementing appropriate measures to reduce them.

Figure 5. Sources of Greenhouse Gas Emissions, Cagayan de Oro



Source: Cagayan de Oro's Greenhouse Gas Inventory 2016.

Community-level inventory revealed that stationary combustion[8] was the city's highest source of GHG at 441,251 tonnes of carbon dioxide (tCO2e) or 40.06% of the total emissions. The residential sector accounts for 88% of the total stationary combustion emissions, while the use of wood and biomass by both the residential and commercial/industrial sectors accounts for 98% of the stationary combustion emissions. Electricity consumption came in second at 348,460 tCO2e or 31.64%, while various transportation sources were the third largest contributor, adding 185,739 tCO2e or 16.86%.

The results of the inventory was an active prompt for the local government to arrest the increase of GHG emissions, by targeting its sources and prioritizing actions that can lead to emission reduction.

These past initiatives would fuel the city's continuing effort, and inform current plans and programs towards climate change resilience.

[8] Stationary combustion sources are energy systems that are fixed in place and GHG emissions are caused by the combustion of fossil fuels or biomass. They can be deployed in residential households (e.g., gas stoves) and commercial establishments (e.g., small-scale diesel generators), manufacturing/commercial industries (e.g., fuel-powered boilers) or power plants (e.g., gas-powered turbines).

CDO'S PURSUIT TO BUILD RESILIENCE THROUGH URBAN PLANS AND DESIGNS

The effect of climate change on the formation of typhoons became part of post-Sendong conversation as the city formulated its Vulnerability and Adaptation Assessment (VAA) in 2013, and consequently in the crafting of its Local Climate Change Action Plan (LCCAP), which was completed in 2017. The United Nations Human Settlements Programme (UN-Habitat) Philippines assisted in facilitating the city's teams through the processes in order to produce both outputs.

Another partnership was forged in 2017 as the city was chosen to be one of five partner cities of the Building Climate Resilience through Urban Plans and Designs (BCRUPD) Project.

Increased Capacity through the BCRUPD Project

One of the main objectives of the BCRUPD Project was to develop local government capacity. The project started by conducting a Capacity Needs Assessment (CNA) of the relevant local government staff. Through surveys, focus group discussions, and key informant interviews, the CNA identified existing knowledge and skills, and capacity gaps. It revealed that the local government did not have its own capacity development program on climate change, particularly on urban plans and designs. Majority of the respondents also acknowledged the importance of the building the capacity of the local government unit (LGU) since only 45% said they have a basic understanding of the concepts related to climate change. The survey also revealed a low level of knowledge on urban design, with few having relevant work experience and 22% needing advanced knowledge on the subject.

Across all the departments that participated, these were the identified priority learning areas: Multi-hazard Vulnerability and Risk Assessment,

Environmental Planning, Urban Planning and Design for CCA, Advanced Climate Change Adaptation, and Geographic Information System and Database Management.

Aside from completing the CNA, the city started updating the LCCAP. Attention was drawn to the Risk and Vulnerability Assessment. The updating process revealed a glaring gap that the multi-sectoral team composed of the local government, academe, professionals, and utility providers had to face: the city had incomplete or outdated data sets. This made data and technical analysis challenging because the Technical Working Group (TWG) members had to gather information first, mostly from primary sources. It took about four months to finish, with some data obtained after more than six months due to changes in the data requirements. On the upside, the TWG were able to gather the latest data for the CDRA. The project trailblazed what was to become a critical part of urban planning–conducting the enhanced CDRA, which became the basis for the LCCAP now being used by the city. The CDRA will also figure in the review and updating of the city's Comprehensive Land Use Plan (CLUP).

The city is now pushing to utilize the Community-Based Management System (CBMS), a household-level data gathering tool for evidence-based program implementation and impact monitoring, to gather the needed information for planning purposes. Enumeration is ongoing and once complete, the CDRA and LCCAP will again undergo updating using CBMS data.

The BCRUPD project has helped the city recognize the significance of data gathering in technical analysis. Moving forward, it will continue place paramount value on correct climate and disaster risk data as a takeoff point for climate-resilent urban plans and designs.

Another challenge in appreciating the LCCAP as an integral part of LGU-level planning was the difference in terminologies, specifically the definition of mitigation in the context of disaster risk reduction and in climate change. But through a series of capacity building activities, members of the TWG and other participants deepened their understanding of climate change, including nuances in climate change and disaster risk approaches, and used this knowlede to identify and take the next urgent steps that needed to be taken.

New Learnings

Urban design, particularly that which is geared towards climate change adaptation and mitigation, is important. Its integration into building guidelines helps in the development and management of a rapidly urbanizing city. It provides guidance in decision-making and prioritization, which is especially useful in LGU-funded projects. The adoption, localization, and customization of the Green Building Code through a local ordinance is an opportunity for sustained action towards climate resilience, This entails a lot of work, since adjustments in design need to be done down to the streetscape level.

Another significant learning for the TWG was using Excel pivot tables introduced by the project to help in the analysis and formulation of technical findings. The TWG used to work with innumerable sheets of data, making the process tedious and the analysis challenging. Since the old process was not efficient, the TWG even missed to include the scenarios and intersections of exposure units with the hazard or vulnerability on the first draft of their findings. The enhanced pivot tables enabled the TWG to shift to a more efficient process of analyzing and presenting data.

Aside from the CDRA, the LCCAP process also helped the LGU understand urban heat island effect, inspiring nature-based solutions such as urban forestry, urban container gardening, tree planting using endemic tree species, and development of policies and guidelines for heat-sensitive building construction.

Through improved assessment, the TWG ultimately gained a better understanding of the actual problems on the ground. The team used to prepare project briefs that only contained a simple list of projects on climate change adaptation and mitigation. After looking into the technical findings of the CDRA, the team began to see *barangays* as a bigger exposure unit, and customized the proposed climate change resilience initiatives based on local conditions and impacts.

Towards a City Adaptation Strategy

These proposed initiatives formed part of a larger city-wide strategy for climate change

adaptation. After a series of consultations with concerned stakeholders, the city government came up with Project Lunhaw.

"Lunhaw" is the Visayan vernacular for "verdant" or "lush". The word encapsulates the vision articulated by the TWG for Cagayan de Oro: a city filled with lush and green open spaces, which are accessible and convenient especially for senior citizens, pregnant women, children, and persons with disabilities. Lunhaw signifies a holistic approach to address the need for climate change adaptation and mitigation towards a more resilient population and city.

Lunhaw was initially planned as a project for the Poblacion area only, particularly Barangay 2, Divisoria Park, and the riverside portion of Barangays 2, 6, 7 and 13. However, after revisiting the CDRA and re-examining the technical findings, the LCCAP was adjusted, revealing additional priority areas areas: Barangays 22, 26, Bulua, Kauswagan, Iponan, and Macasandig.

The City-wide Lunhaw Strategy

With the LCCAP as basis and providing clearer direction, the city government realized that Lunhaw was not just a mere site-level project, but a broader climate change adaptation strategy that will help restore and protect critical areas in Cagayan de Oro.

The city-wide Lunhaw Strategy aims to achieve the following results:

- Improved watershed management for the area to benefit 2000 people living in and producing crops/livestock in the *barangay*: 10% by 2020; 20% by 2023; and 30% by 2025;
- Reduced GHG emissions of 10% by 2022 and 30% by 2030;
- Lowered ambient temperature by 1 degree by 2030;
- Improved resilience of all residential and commercial areas to flood impacts: 20% by 2020, 30% by 2022, and 40% by 2024 from the risk score baseline of CDRA;
- Lower number of populations living in critical flood prone areas by 80% in 2025;
- Improved *barangay* capacity to capture rainwater to avoid flood and introduce redundancy in water use covering 30% of the *barangay* area exposed;
- Increased property insurance coverage for residential, commercial, and institutional by 50% in 2025;
- Strengthened functionality of all reservoir/ pipes during and after flooding events where disruption will be 6 hours.

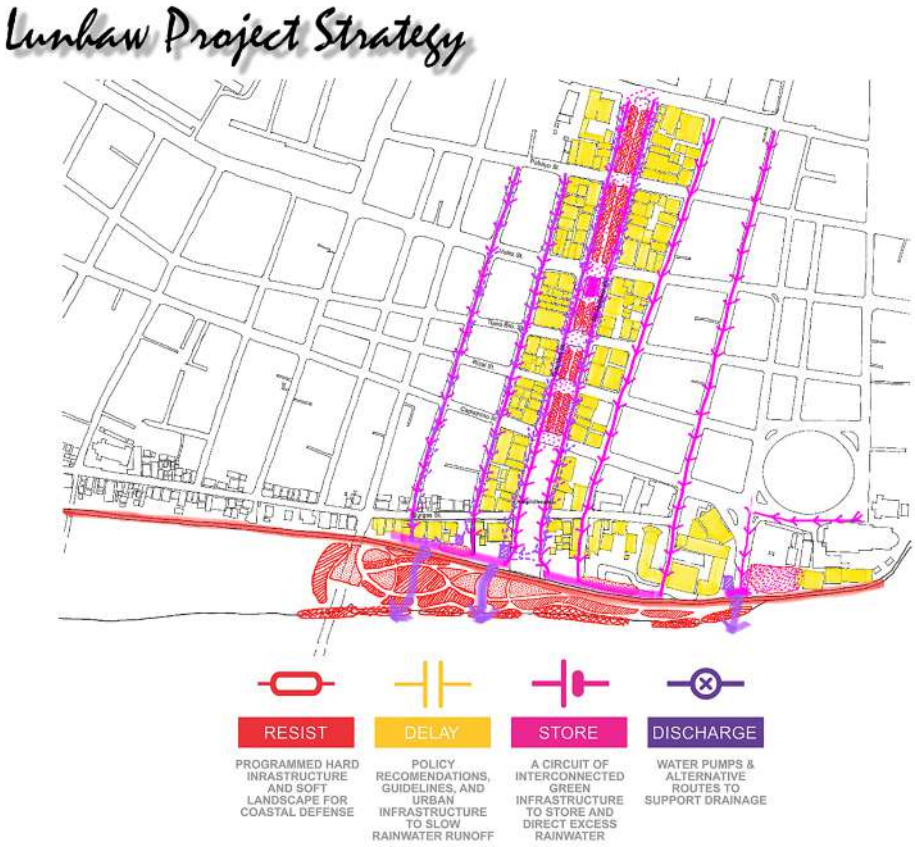
The Lunhaw Strategy focuses on utilizing urban elements to address the impacts of increasing temperature and to increase the volume of ground water recharge as a response to urban flooding. It emphasizes the ridge-river-reef approach in managing natural resources while facilitating urban development and delivery of urban services.

The strategy is conceptualized as three segments: Lunhaw Central (Poblacion area); Lunhaw West for Barangays Bulua, Kauswagan and Iponan; and Lunhaw East for Barangays 22, 26, Lapasan, and Puerto. Lunhaw Central will be designated as the entry point for the implementation of the all-inclusive Lunhaw Strategy.

Exsting multi-sectoral and spatial development strategies were considered in the identification of projects and activities under Lunhaw Strategy. As a result, the city's Urban Development Growth Areas correspond with Lunhaw, as within each growth area are high risk *barangays* that the project likewise seeks to provide interventions for. This way, climate action and urban development go hand-in-hand.

The Lunhaw Strategy incorporates the strategies of Resist, Delay, Store, and Discharge. Resist applies to the defense of coastal lines through a combination of hard and soft, nature-based infrastructure solutions. Delay refers to actions to slow down the run-off from accumulating in one area and thus causing flooding. It also pertains to the policies and guidelines that can be incorporated in building design and area development that will ensure more deliberate water flow. Store is the innovation in infrastructure that will direct the flow of water to a storage area, and allow the recycling or the repurposing of the stored water. Lastly, Discharge denotes the construction of drainage systems that will enable the flow of water away from areas prone to pluvial flooding by utilizing water pumps and drainage systems.

Figure 7: Four Major Strategies under the Lunhaw Project



Source: Cagayan de Oro Technical Working Group

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Lunhaw also follows the Blue-Green Framework. Besides managing water flow, it aims to improve the city's green spaces through watershed management, riparian reforestation, increasing green cover in urban areas, and promoting walkability. Doing so will develop and promote the city's "breathing

spaces" and address urban heat stress. Figure 8 below shows the natural flow of water in the city, along with the proposed water impounding area that can help alleviate flooding in the downstream.

Figure 9, meanwhile, shows a visual representation of Lunhaw's Green Strategy with the main objectives of reducing GHG level and improving water permeability and water recharge. The Green Strategy will also focus on preserving biodiversity, protecting forest reserves, and promoting walkability. Once implemented, this will help reduce the city's heat stress.

All these techniques will be applied to Lunhaw Strategy, particularly at the Lunhaw Central segment.

Figure 8: Natural Flow of Water in the City (Blue Strategy)

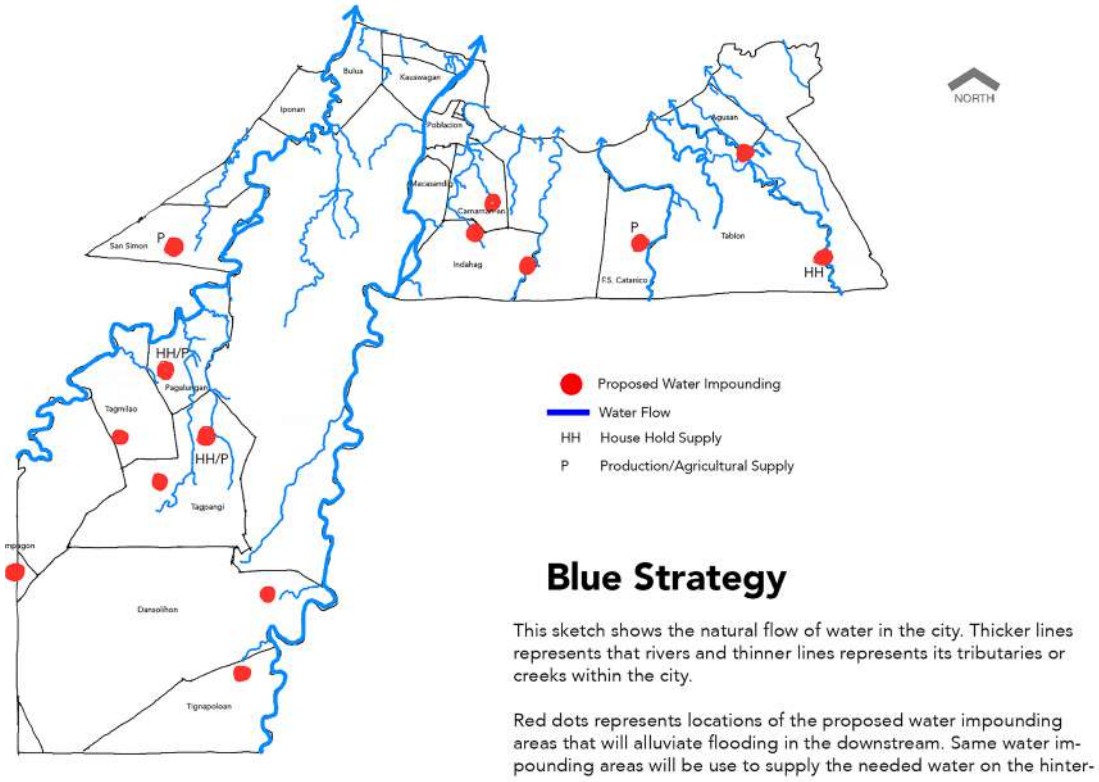


Figure 9: Lunhaw's Green Strategy

Lunhaw also closely aligns with the design elements provided by CLUP Guidebooks[9]. The urban design elements used to guide the conceptualization particularly of Lunhaw Central are the following:

Density + Mix

The Lunhaw Central segment along the city's Poblacion area will utilize density and mix, enhancing and maximizing the commercial, residential, recreational, and institutional uses of the area. Lunhaw Central will demonstrate the efficient mix of different uses of space, and will complement this combination with rainwater harvesting and impounding. It will also provide for the renovation and installation of infrastructure to ensure effective management of water run-off; the conversion of existing roads to pedestrian, non-motorized, and energy-efficient public transportation. More trees will be planted and water features will be included, both intended to give a cooling effect and counter the heat island effect from the surrounding built environment.

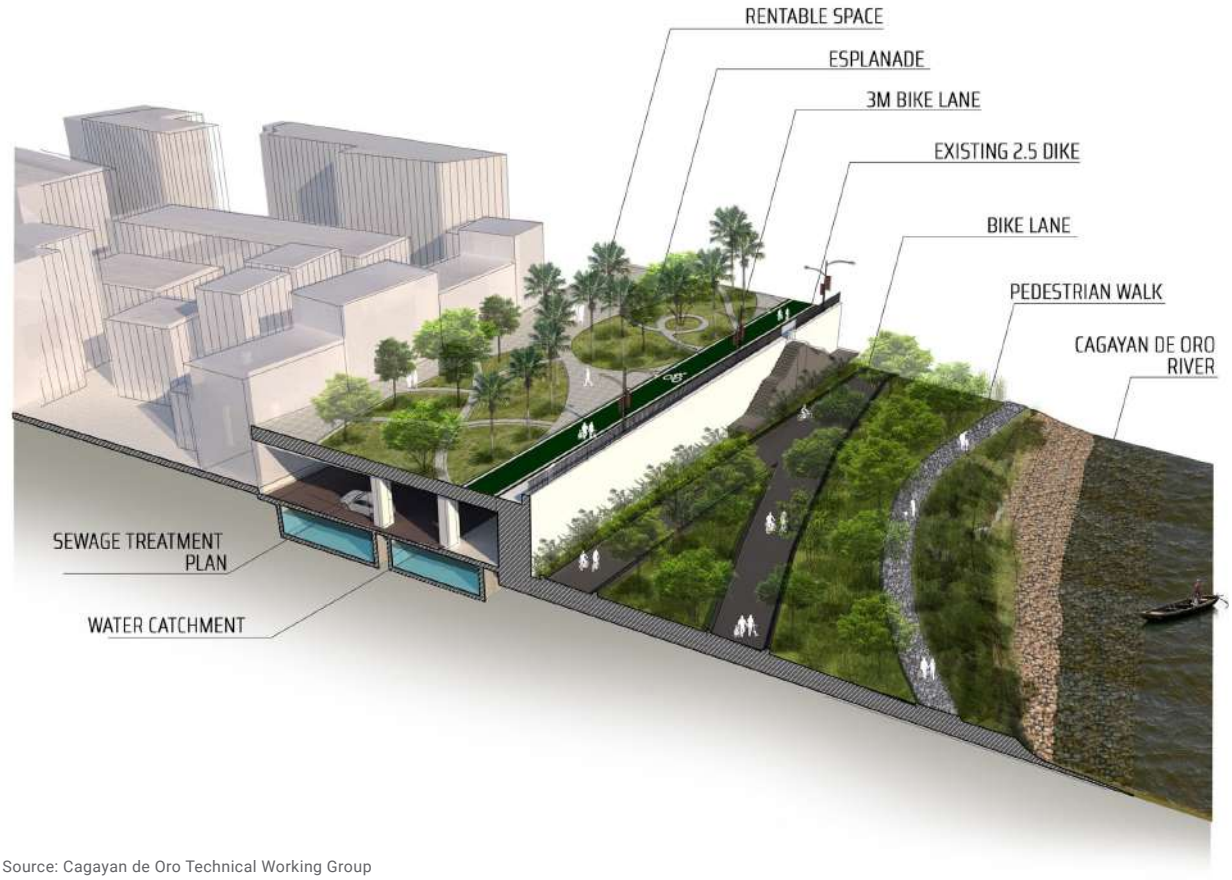
Details + Materials

Lunhaw espouses the use of sustainable and environmental-friendly materials in the design of buildings in the city. These include permeable materials, LED lighting, green roofing and walls, and rainwater catchment facilities. This will be especially useful to public institutions like schools in flood-prone areas.

The use of eco-friendly materials and promotion of greening of the built environment will be done in consideratiion of their impact on existing structures such as historical buildings. A wastewater recycling system will supply water to maintain public green spaces and help address urban flooding.

It is important to note that to operationalize climate-resilient deisgn, including specificities related to building materials, a local Green Building Ordinance must be adopted and institutionalized.

Figure 7: Four Major Strategies under the Lunhaw Project



Source: Cagayan de Oro Technical Working Group

[9] https://hlurb.gov.ph/services/local-government-unit/clup-guidebook/

Streetscape + Landscape

The city has allocated space for the “green loop”, which will promote walkability and green spaces, and reduce heat stress. This is especially beneficial for areas that experience both flooding and high temperature, as is the case in the western side of the city. The loop will feature streetscapes with increased greenery, pedestrian zones, and bike lanes.

Again, the Green Building Ordinance is key in the introduction, development, and management of such areas across the city’s landscapes.

Other Policy Support to Climate Change Resilience

The city’s Comprehensive Development Plan and Comprehensive Land Use Plan have identified the banks of Cagayan de Oro River as a “no build zone”. This policy is meant to protect the waterway and prevent risks associated with the build-up of permanent structures. Concurrent to this will be the safe resettlement of informal settlers curently located along the river, to a new site that is considered to be of lower risk. Meanwhile, the riverside will be transformed into an open, publicly accessible area. Septage and sewerage policies were also suggested to improve and prevent further contamination of the riverine ecosystem.

Another potential policy support is an increase in insurance coverage for agriculture, as well as for residential and institutional areas that are at risk of climate change impacts such as flooding.

To encourage effective implementation, the TWG considers creating a policy on providing incentives to stakeholders who will actively participate in project implemenation. It is also important to align the strategy and resulting projects with the city’s comprehensive land use and development plans, and ensure consistency between Lunhaw and the city’s spatial and sectoral policies.

THRIVING—AND NOT MERELY SURVIVING—IN THE FACE OF CLIMATE CHANGE

The BCRUPD process helped Cagayan de Oro City to focus on climate change in the context of its own urban conditions and growth. This was a critical step in moving towards the right direction. The project also helped the city arrive at strategies, projects, and policies that represent both its climate change adaptation goals and overall development vision.

The benefits gained from the project are not only in relation to climate change, but also to the overall sustainability of Cagayan de Oro. The effect of addressing climate change is not confined to improving environmental quality or lowering risks, but extends to economic development, such as women's groups, micro, small and medium enterprises that will now have opportunities to engage in Lunhaw-identified and designed areas. The Lunhaw design process was also undertaken with greater accessibility and inclusivity in mind; it ensures that persons with disabilities , the elderly, pregnant women, and otherwise marginanlized groups can find individual and community benefit from the project.

These, among other considerations, are aimed at encouraging and empowering local communities to actively play a role in the continuing drive towards climate change adaptation, in the same breath as overall local development.

Lunhaw will not only help resolve local challenges, but will try to contribute in the global efforts on climate change. Improving local legislation and implementing high-impact projects may send a ripple effect to neighboring cities, who can replicate these initial actions and induce wider transformation.

The city government focused on providing enabling infrastructure and policy to adapt to the effects of climate change while achieving the co-benefits of lowering GHG emissions and increasing carbon sink. But beyond this, the project is also designed to increase the resilience of Cagayan de Oro through citizen empowerment. Indeed, the city's track record for remarkable projects and programme implementation have been due largely to the active citizen participation. The LGU acknowledges that stakeholder buy-in and action are essential for any significant project to be sustainable.

Putting people at the heart of the climate-smart city initiatives is key, and Lunhaw can succeed only through the convergence of sustained efforts of the city government, civil society, and the private sector. Lunhaw's vision comes with the hope that the changes and improvements will inspire the people to contribute to the continuing advocacy for climate change resiliency not just as compliance with existing laws and city ordinances, but also in making it part of their norms and local culture.

The road to resiliency can be bumpy, but Cagayan de Oro is dedicated to becoming a city that can withstand shocks brought about by climate change. The city government hopes to set an example that will inspire other LGUs to take bold but calculated steps to address climate change, promote sustainable urban dvelopment, and empower their people.

LEGAZPI CITY

CASE STUDY ON THE PATH TO CLIMATE RESILIENCY

ABOUT LEGAZPI CITY

Legazp City, the capital city of Albay province, serves as the Bicol Region's hub for government services, education, tourism, and transportation. Aside from its inter-regional connection to growth centers such as Metro Cebu and Metro Manila, Legazpi City also serves as the gateway to surrounding provinces such as Sorsogon, Catanduanes, Masbate, Camarines Norte, and Camarines Sur. The Luzon Spatial Development Framework 2015-2045 and the Bicol Regional Development Plan 2017-2022 envision Legazpi City and Naga City as metropolitan centers that will anchor the urban growth of the Bicol Region. The Metro Legazpi Development Corridor (Legazpi-Daraga) will function as the regional government center and transportation hub servicing the provinces of Albay, Sorsogon, Catanduanes, and Masbate. With the establishment of an international airport in the adjacent Municipality of Daraga and the revival of the Philippine National Railways, the city is expected to attract tertiary industries, tourism-based investments and enterprises, and new migrants. Based on the Philippine Statistics Authority 2015 census, the city's population is estimated at 196,639.[1] It is projected that by 2028, Legazpi City's population will increase to 237,412.[2]

With a total land area of 16,165.05 hectares, the city is composed of 70 *barangays* (villages), 45 of which are classified as urban and the other 25 as rural. In terms of area size, total urban area is 2,628.57 hectares or 16.26% of the total land area of the city. However, 53% of whole city population resides in this urban space, which also caters to an additional 30% of the total population who either work or study in the urban center during daytime. Urban sprawl is evident in the northern and southern portions of the city, which are mostly rural residential areas mixed with agriculture and light industrial areas. The contiguous urban zones are concentrated in the central coastal, low-lying flat areas of the territory where the Central Business District, residential spaces, regional government offices, schools, and transportation facilities are located.

The city's urbanization context is a diverse ecosystem. Legazpi City has areas classified as forest land, which accounts to 15.84% (or 1,729 hectares) of the city's total land area.[3] The forest land encompasses seven *barangays*: Mabinit, Bonga, Matanag, Padang, Cagbacong, San Francisco, and Buenavista. Water resources like springs and water tributaries, which have the potential to become a potable water source for

[1] Philippines Statistics Administration. 2015. Albay Province 2015 Census. http://rsso05.psa.gov.ph/sites/default/files/Albay.xls.
[2] Legazpi City Government. 2019. Comprehensive Land Use Plan 2019-2028, p. 26.
[3] Department of Environment and Natural Resources. 2015. 2015 Land Classification.

areas south of the city, are found in Barangay Buenavista. Currently, these water sources supply low-lying communities of the *barangay* and will need significant investments if it will be distributed to the urban center. The forest areas are a likewise critical resource for the irrigation of agricultural lands, whichincludes 1,372 hectares of rice farms 2,542 households depend on for their income.

The city is also endowed with coastal and marine ecosystems making fishing a major livelihood for the people of Legazpi. It also has 26.92 hectares of mangrove areas, and the total municipal waters span 8,478 hectares. The coastal ecosystem supports the primary source of income of 3,825 registered fisherfolks. Of the total 70 *barangays* (villages) of the city, 17 are are located in the coastal zone, 9 of which are classified as urban areas.

Legazpi City was awarded as the Most Competititive Component City in 2018 based on the Cities and Municipalities Competitiveness Index, which is annually organized by the Department of Trade and Industry. In 2019, the city ranked 4th overall in the same component cities category. These recognitions for the city were due to the high scores it received on the following categories:Infrastructure, Government Efficiency, Resiliency, and Economic Dynamism.

The city's economy is dominated by tertiary level industries in the commercial sector. The city experiencees unprecedented commercial sector growth based on records of the City Business Licensing Office. From 2012-2017, the number of business establishments in the city has increased by 174% (estimated increase of 200 new commercial establishments per year). This increase, plus the continued public and private infrastructure investments, has been providing livelihood and job opportunities for the people that ultimately pushes the city's socio-economic development.

The local government is working to sustain its economic growth and attain the city's vision of becoming the international gateway to Luzon and Visayas offering world class tourism-related facilities and services.

Also part of Legazpi City's targets is complementing its progressive growth with technology-driven and suatainable solutions. Since the city is located along the eastern seaboard and typhoon belt, it is susceptible to the impacts of typhoons from the Pacific Ocean. Historically, these have triggered floods, storm surges, severe winds, rain-induced landslides, and lahar flows. Thus, achieving climate and disaster resilience is crucial for it to attain its envisioned growth.

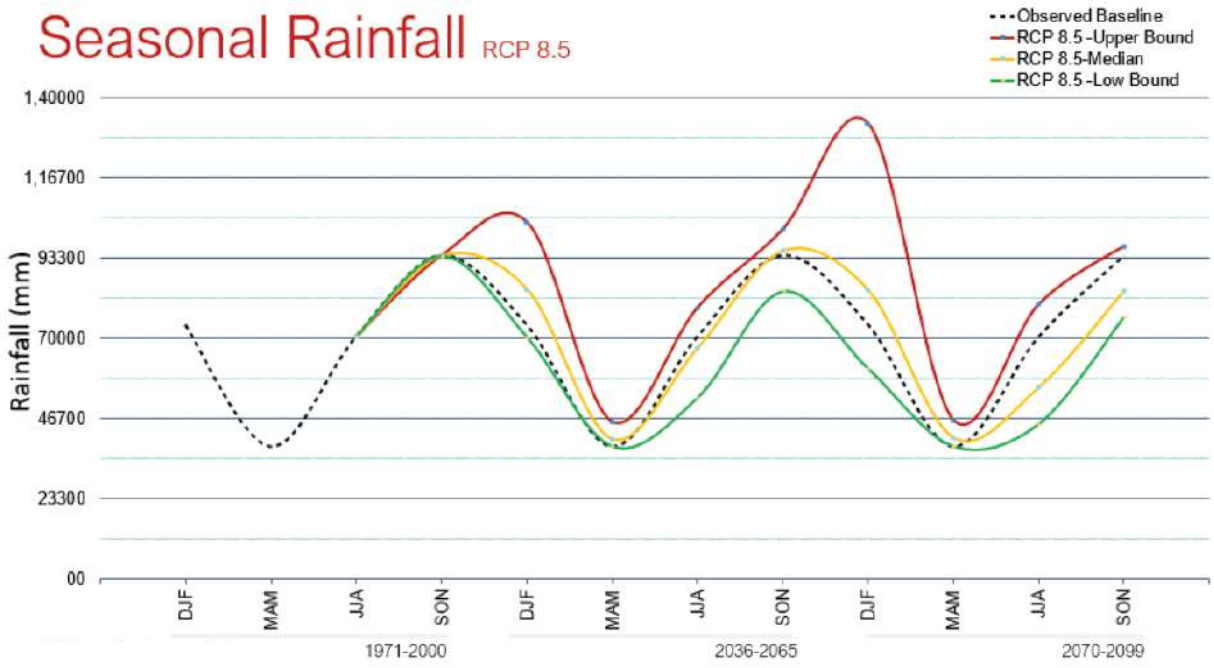
Previous disaster events and the changing climate scenario is compelling the city to continue its knowledge building for the implementation of transformative climate actions to help ensure that its people, economic growth, and environmental resources would remain competitive and sustainable while urbanization continues to rapidly unfold in the city.

Legazpi City in the Face of Climate Change

The national government, through The Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), provided the needed climate information that the city requires in order to plan and adapt to potential climate change impacts. PAGASA data reveals that it is plausible for the rainfall volume in Legazpi City to decrease under the low and median bound Representative Concentration Pathway (RCP) 8.5 projection (Figure 1). However, for high-bound scenario of the same projection, it is also likely for the rainfall volume during December to February to have an additional increase of 297.9 millimeter (mm) 2036-2065 and 585.2 mm in 2070-2099. These could be 40% to 79% increase from the current observed rainfall volume.

It is observed that the trend for mean temperature for Legazpi City is increasing. Projections of PAGASA show that there will be

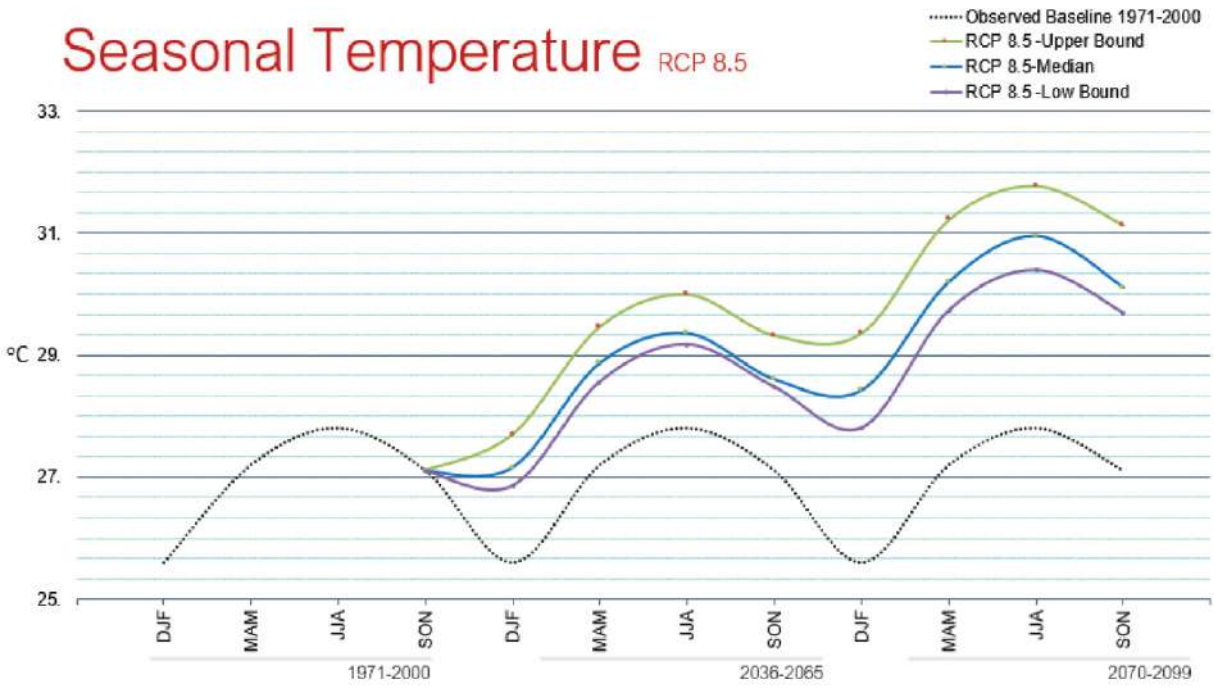
Figure 1: Representative Concentration Pathway 8.5 (Seasonal Rainfall Projections)



DJF = December, January, February; MAM = March, April, May; JJA = June, July, August; SON = September, October, November; mm= millimeter; RCP = Representative Concertation Pathway.

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration.

Figure 2: Representative Concentration Pathway 8.5 (Seasonal Temperature Projections)



DJF = December, January, February; MAM = March, April, May; JJA = June, July, August; SON = September, October, November; RCP = Representative Concertation Pathway.

Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration.

an increase in mean temperatures by as much as 2.2OC by year 2036 and 3.9OC by the end century. Presented by season, the temperature projections show that it will be hottest during June, July, and August (Figure 2). Apart from typhoons, which could bring storm surges, other extreme events are also projected to be a threat to the city. Extreme rainfall could trigger disastrous flooding and lahar flows. Moreover, low elevation areas, especially those below sea level, are facing risks from tidal floods and inundation from projected sea-level rise.

All the above climate trends and climate-related hazards are expected to challenge the sustainable development of the city—threatening its people, economy, and natural resources. To prepare for the anticipated challenges, the City Government,utilized the Climate and Disaster Risk Assessment (CDRA) tool issued by the national government for the development of its Local Climate Change Action Plan (LCCAP) formulation. The LCCAP process, which was supported by the Vertical Integration and Learning for Low-Emission Development (V-LED) project of the United Nations Human Settlements Programme (UN-Habitat), allowed evidence-based decision making. The process helped the city government to systematically generate crucial planning information, particularly on climate risks that affect the exposed population, land use, natural production areas, critical infrastructure, and lifeline utilities in the city.

From the CDRA and LCCAP process, the city government identified various decision areas[4] based on the levels of risks, including the underlying contributing factors. The city government validated that an estimated 60,710 individuals are highly at risk to floods, storm surges, and sea-level rise. These individuals mostly reside in riversides, low-lying flood plains, and coastal areas, and they currently represent approximately one-third of the total population of the city. Further investigation shows that of the total at-risk population, around 21% are informal settlers, 30% are living in housing units made from light to salvageable materials, and 49% are living below the poverty threshold. When these families are affected, as in previous disasters, the coping mechanism is to redirect household income for repairs and rehabilitation, further reducing their purchasing power for basic household needs and pushing them to extreme poverty. Moreover, the local government may be compelled to redirect public investments for financial aid and rehabilitation, which can consequently delay the implementation of crucial sectoral development programmes.

The projected decrease in seasonal rainfall could threaten water security in the city as it may affect the availability of water from surface run-off. Potable water supply in the city comes from harnessing the underground and surface sources. Decreasing rainfall also puts the natural ecosystem in the city at risk, which may limit the ecosystem services it provides to people. Climate impacts on natural ecosystems could affect the livelihoods of 169 forest resource-dependent individuals and 1,392 fisherfolks. Assessments also revealed that 2,542 rice farming dependent-households are at risk from the changing rainfall volumes. When rice farmers are unable to cope with climate change, the rice sufficiency rate of the city, currently estimated at only 30.76%, could further decrease and impact on the people's food security.

The urban ecosystem that performs a critical role in the city's socio-economic growth is likewise presented with climate risks: 43 hectares of Legazpi City's commercial areas vulnerable to floods, 61 hectares are exposed to storm surges, 28 hectares susceptible to sea-level rise, and 21 hectares are prone to lahar flows. The risk levels of the exposed areas range from moderate to low. Areas with low levels of risk could be attributed to: the resilient design employed by commercial building owners; high capacity to retrofit buildings, and access to insurance. However, potential damages to building contents and the duration to implement repairs after climate extreme events typically result in prolonged disruption of commercial services. The disruption significantly poses a negative effect on the local economy as it results in lower profits of businesses, loss of employment earnings for households, lower government revenue collection rates, and redirection of government funds intended for priority sectoral development programmes and projects.

Approximately 41 hectares of vital regional government- and education-related institutional areas in Barangay Rawis are moderately at risk to storm surges where potential wave heights may exceed 1.5 meters. The increasing frequency of extreme rainfall events may trigger lahar flows, which may affect 7.46 hectares of institutional areas within the Yawa River mouth areas. These areas were assessed as high risk to lahar flows mainly due to a lack of

[4] Identified high to moderate risk areas triggered by climate extremes and projected climate change variables.

proper resilient building design. These hazards may significantly disrupt essential government services, delay vital developmental processes in the region, and trigger the government to redirect funds for building repairs and rehabilitation.

The Rawis - San Joaquin - Dita - Pawa - Bogtong Road/Bogtong Pawa Bridge and DM Jct-Legazpi-Sto Domingo-Tabaco Road/Yawa Bridge were assessed to be highly at risk to lahar flows. These roads and bridges serve as vital linkage systems connecting the urban center to the northern *barangays*, and Legazpi City to other cities and municipalities along the Albay Gulf. A disruption of these vital linkage may isolate northern *barangays*; delay of response and relief operations and flow of goods; and limit access of rural areas to socio-economic support services located in urban areas.

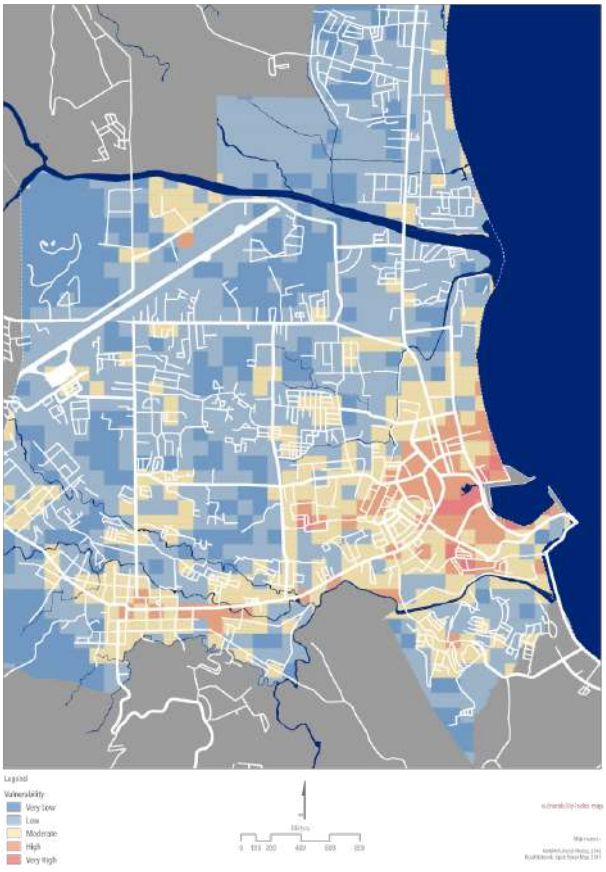
Springs and wells on the slopes of Mayon Volcano are the main source of water supply of the Legazpi City Water District (LCWD). To augment supply during peak hours, the LCWD sources water from the Yawa River. Potable water is distributed via pipelines to the urban area and two important water distribution pipes transect the Yawa River, which were assessed as high risk to lahar flows. It is unknown whether these distribution pipes are resilient enough to withstand the potentially damaging effects of large magnitude lahar flows. The prolonged submergence of pipes to floodwater may also affect water quality. Disruption of water services may threaten domestic water supply in the urban areas. Prolonged water service disruptions due to extremes triggered by climate change will have detrimental impacts on the health of the residents and operations of commercial establishments.

With a potential increase in accumulative annual rainfall using the Representative Concentration Pathway (RCP) 8.5 high bound projection[5], the city government is exploring strategies to encourage residential and non-residential water consumers to take advantage of the projected increase in annual rainfall amount. Considering the city's population growth, rate of urbanization, and potable water demand, harnessing rainfall will bring in long-term benefits and help augment existing piped water supply.

The increasing temperature due to climate change will create impacts on households and business alike. For instance, areas in the Port Area Central Business District and Old Albay district are highly vulnerable to urban heat stressdue to its highly built-up characteristic, lack of tree cover, and limited open spaces. There is also not enoughurban greening along roads. These roads, especially east-west oriented roads, absorb heat during the daytime and emit the stored heat during nighttime.

At the household level, increasing temperatures will also mean increased power consumption for cooling and increased demand for motorized transportation due to hot, unsuitable pedestrian walkways. Vulnerable individuals—young and old, and those with heat-related illness—are presented with high risk from temperature increase given the urban heat stress experienced in the city (Figure 3).

Figure 3: Urban Heat Stress Mapping



Source: Local Climate Change Action Plan 2019-2028, City Government of Legazpi.

[5] Representative Concentration Pathway (RCP) 8.5 is the highest emission scenario leading to a radiative forcing of 8.5 W/m2 at the end of the century. High bound refers to the wettest plausible scenario for seasonal rainfall.

Based on anecdotal observations, hot ambient room temperatures, especially from June to August, make classrooms not conducive for teaching and learning. There is a growing concern if school buildings can accommodate the projected increase in temperatures due to climate change and its impact on indoor temperatures. Apart from classrooms, the same indoor temperature conditions are observed in government offices where workers are dependent on air conditioning to make rooms conducive for office work.

Increased dependence on airconditioning systems may consequently lead to increased GHG emissions. Through the LCCAP process, the city also conducted an inventory of its GHG emissions with 2017 data as the base year.

The initial results from the inventory revealed that the activities in the city generated around 108,300 tonnes of greenhouse gas (GHG) in 2017[3] . The major contributor to GHG emissions is purchased electricity that is 79% of the total. Agriculture crop areas have a 9% share, and mobile combustion contributes 7% to the total gross GHG emissions.

The inventory also identified the existing carbon sinks of the city. The sinks are composed of forests, mangroves, and grasslands that totals approximately 807 hectares or 4.9% of Legazpi's total land area. Based on date, the sinks can only sequester an estimated 4,700 tonnes or 4.33% of the annual emissions recorded for the base year. It could be gleaned from the GHG inventory that there is a wide gap between the GHG emissions and sequestration capacity in the city.

At business as usual development, the city anticipates a further increase in GHG emissions over the next 10 years as it plans to pursue an agri-ecotourism and commercial development thrust. The proposed additional 300 hectares of commercial and residential land use will result in additional GHG emissions overtime. The Philippines, as signatory to the Paris Agreement, has committeed to pursue national actions to address climate change through both adaptation and mitigation, although the latter as of 2019 is all conditional to the extent of financial resources, including technology development and transfer and capacity building, that will be made available to the Philippines.

While the national commitment is conditional, the city government will try to initiate a 61% reduction of its GHG emissions by 2028. This will be achieved by instituting policies and strategies to reduce the electricity consumption of buildings; investing and encouraging in green transportation and non-motorized mobility; and increasing its GHG sink capacity. Legazpi City's commitment to mitigate emissions come from the understanding that the mitigation actions are going to likewise build people's resilience to climate impacts (e.g., temperature and heat risk management) and are good investments for the cities sustainable and green development.

Legazpi's Pursuit to Build Resilience through Urban Plans and Designs

As Legazpi City values the importance of partnership in its pursuit for sustainable development, the city government has been working with UN-Habitat Philippines and the Housing Land Use Regulatory Board for the Building Climate Resiliency since 2017 through Urban Plans and Designs (BCRUPD) project. According to the city's Technical Working Group (TWG) organized for the project, climate-resilient urban planning and design is a relatively new concept and topic for the city. The project capacity needs assessment reveals that there is a low level of awareness on urban design approaches in the context of climate change adaptation and sustainable development as there are limited to no trainings at all on the topic for city technical personnel. Also, the assessment revealed that members of the TWG have average competencies on climate financing, geographic information system, multi-hazard vulnerability and risk assessment, urban policy and strategy development, and climate-resilient urban design.

These average capacities reflect on Legazpi City's 2013 Disaster Risk Reduction and Management-Climate Change Adaptation and Mitigation (DRRM-CCAM Plan), which contains data gaps on ecosystem and sectoral impacts of climate change and indicators to measure risks, vulnerabilities which can guide local policy and allow the city to pursue systematic disaster risk reducation (DRR) and CCAM. The plan also does not present climate trends and projections and mainly focuses on sudden onset hazards and have yet to fully assess potential impacts of seasonal seasonal changes in temperature and rainfall.

Upon reviewing the 2009-2018 Comprehensive Land Use Plan (CLUP) and Zoning Ordinance, the Local Government Unit (LGU) recognized the need to further develop local capacities to better understand the implications of climate change to medium- and long-term spatial development planning and determine the necessary policies and strategies to address emerging challenges and opportunities.

Through BCRUPD project, the city government had the opportunity to improve its capacity to adapt to climate change through the promotion of climate-responsive and sustainable urban development plans and designs. The Local Climate Change Action Plan (LCCAP) enhancement was the entry point of the project. The formulation process helped the TWG members to increase their knowledge and understanding of climate change, especially all the plausible climate scenarios they will encounter in the future. The ecosystem-based approach also helped them better appreciate how the projected climate scenarios may impact various elements across different ecosystems and how these ecosystems are closely linked. Through the process, the concerned LGU staff also learned to anticipate future implications of the city's current urban development strategy and its long-term climate resilience aspirations. With the improved risk assessment process introduced during the course of the project, the city government now has an improved understanding of the concept of risk and recognized that reducing the level of risk can be done by addressing exposure, vulnerabilities, and adaptive capacities.

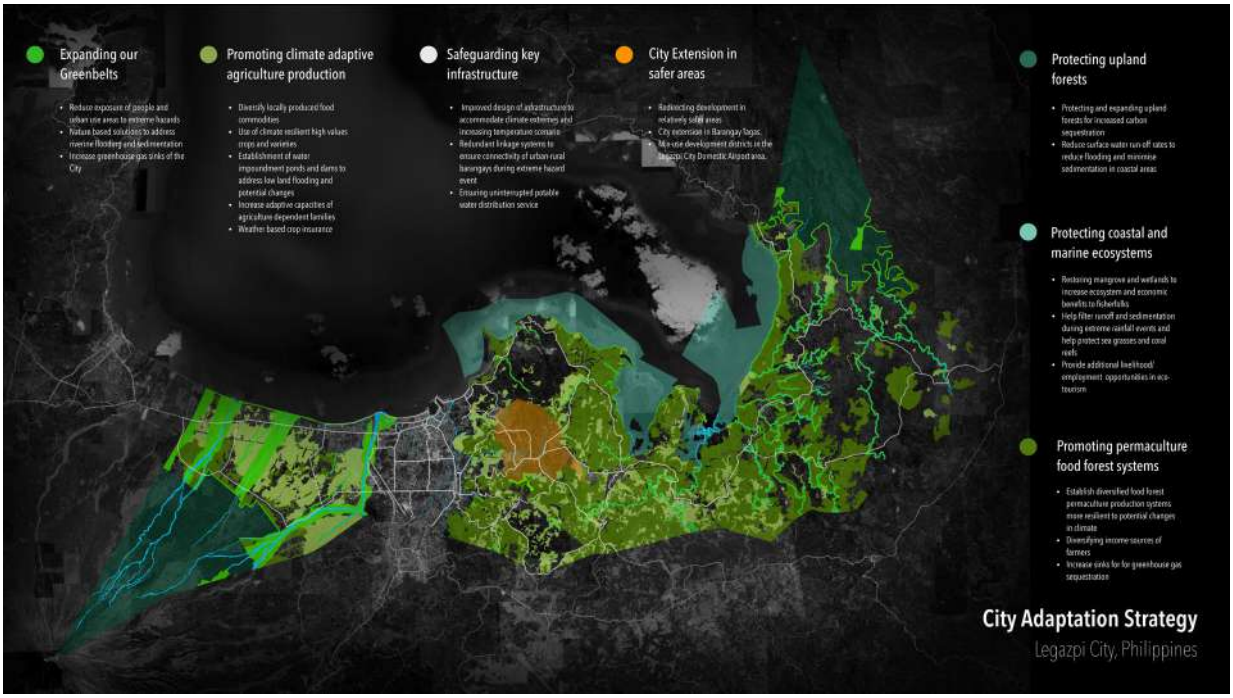
[6] Legazpi City. 2019. Local Climate Change Action Plan 2019-2028 pp. 123-133.

Enhancing the City's Climate Adaptation Strategy and Overall Climate Action Plan

With new information derived from the CDRA and GHG inventory, and relating these findings with the city's CLUP and Comprehensive Development Plan (CDP), the TWG analyzed the different climate issues and opportunities the city is facing. The adaptation strategies and policy framework as well as its climate adaptation goals, objectives, and targets were developed and are now contained in the city's enhanced LCCAP.

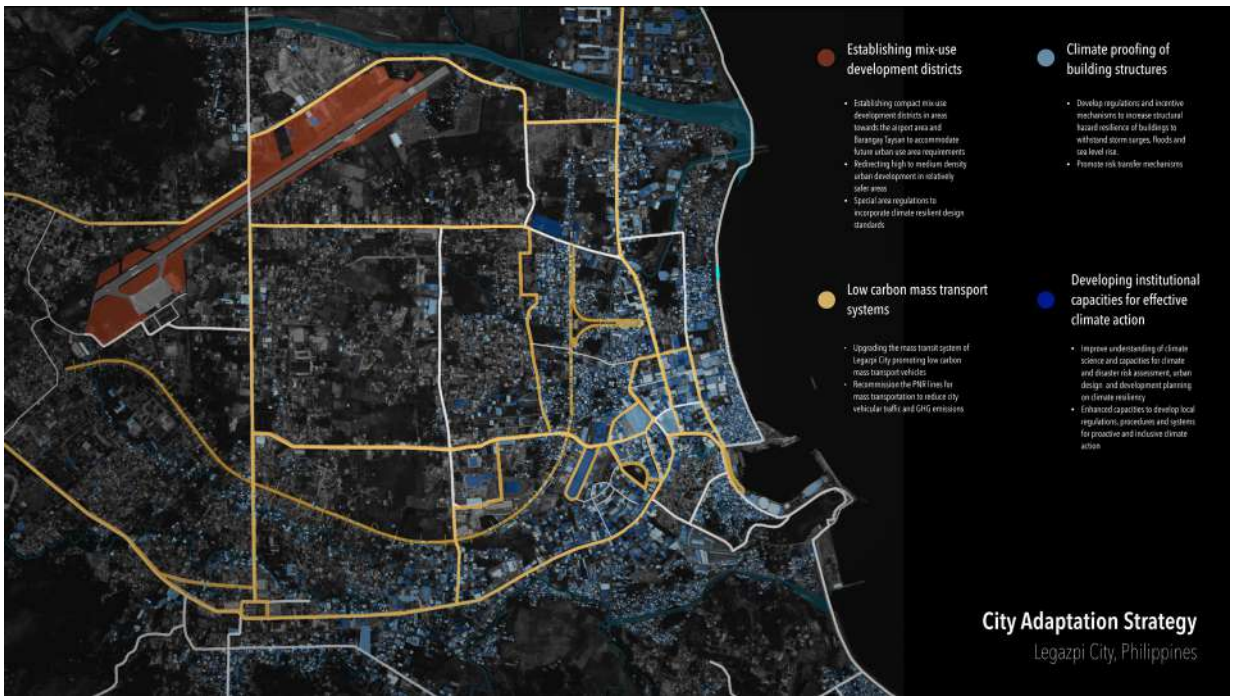
The city adaptation strategy (Figures 4 and 5) and policy framework was formulated through consultation workshops with partner agencies, which include the Department of Human Settlements and Urban Development (DHSUD) and local chapters of the United Architects of the Philippines and Philippine Institute of Environmental Planners. ARCADIS-Philippines, a consultancy firm for natural and built assets, presented their urban design recommendations as well. The strategy and framework is a testament to the city's improved understanding of the urban design strategies and approaches to climate change adaptation, humanizing climate issues, and application of ecosystem-based approaches for resilient plans and design. . A paradigm shift towards alternative green solutions rather than merely relying to infrastructure-based interventions while also a stronger campaign to emphasize the co-benefits for both climate and sustainable city development from proposed interventions.

Figure 4: City Scale Adaptation Strategies



Source: City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

Figure 5: City Adaptation Strategies in Urban Areas



Source: City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

Inspired by learnings from technical inputs and workshops on the cumulative risks associated with sea level rise, storm surges, lahar flows, and floods affecting institutional, commercial, and residential areas in the coastal areas, the city is leading its new urban growth areas in relatively safer places such as the Uptown Legazpi District in Barangay Taysan and a mix-use district in the domestic airport area, while maintaining its strategic advantages as an urban growth center in the region. These areas will serve as alternative sites for the regional government center, and accommodate future land requirements for commercial, residential, and education- and government-related institutional areas. This change in urban structure supports institutional resilience, which was one of the identified objectives of the city. It is expected to increase climate resilience of the economic sector to floods and storm surges and reduced population risks associated with floods, storm surges, and lahar.

Addressing Flooding and Lahar through Urban Planning and Design

To ensure the connectivity of the urban and northern *barangays* during lahar and flood events and safeguarding the potable water supply and distribution systems, the Legazpi City is establishing redundant north-urban linkage and distribution systems. This involves building additional bridges transecting Yawa River and ensuring infrastructure design can withstand expected hazard intensities. Also, new potable water sources in the southern portions of the city will be explored and will serve as an alternative source of potable water as the city expands towards the south. This strategy also anticipates the potential supply interruptions since the current primary water source and distribution systems are concentrated in the northern parts of the city susceptible to lahar flow and floods.

To increase the resilience of coastal and marine resources-dependent families, areas with coastal and marine ecosystems will be part of the city's non-invasive eco-tourism sites. This strategy hopes to provide alternative livelihood opportunities, prioritizing the most vulnerable families. To increase the resilience of farming and inland fisheries-dependent households, the city will promote and support climate-resilient agriculture production, including the establishment of water impoundment ponds and dams to address low land flooding and and ensure continuous water supply.

To reduce the flooding in the urban center and future damages and disruptions to business establishments, the city government recommended urban designs such increasing the permeability of the landscape to allow rainwater to soak in the landscape by using permeable surface materials; establishing dual purpose parks capable of detaining and delaying water; putting up water impoundment facilities in adjacent agricultural areas within the Macabalo river basin; redesigning drainage to temporarily delay water surface flow and increase recharge of ground water; and exploring additional design standards for the construction of rainwater harvesting systems, where the capacity is relative to the non-permeable surfaces of the property and rainfall levels.The city government also recommended to treat creek and riversides as property frontages to provide better justification of expanding river and creek easements and setbacks to prevent future encroachment along riverbanks and accommodate future pedestrian access systems.

The ridge to reef concept and its applications to land use planning was also applied in the Taysan City extension area. The LGU recognized that the business as usual urban design[7], if applied in the Taysan City extension area, will only increase surface water flow rates, which may affect flood patterns in the in low-lying areas. Sponge city approaches such as rain water harvesting of structures, unpaved surfaces, tree cover, urban swales, and river side linear park were some of the proposals being explored to be applied in the Taysan City Extension District to ensure that the planned urban expansion does not affect low-lying areas of the Macabalo River Basin. The LGU also saw the need to increase the rain water absorptive capacity of the proposed land uses in upper areas of the Macabalo River Basin, which includes developing peripheral agriculture areas as food forest systems and encourage the establishment of agriculture water impoundments that can also serve as fresh water fish production. Also, the city government realized the need to interface these strategies with the Municipality Daraga which is part of a common river basin boundary.

To increase the adaptive capacities of 1,940 individuals along the Macabalo and Sagumayon Rivers, the city government recommended to transform creek and riverside areas as new urban development corridors. This can be done through urban design adjustments such as changing the land use mix from purely residential to mixed use zones to provide additional economic opportunities; allowing private sector participation in upgrading business operations to support the formal economy and securing loans that will allow them to setup viable businesses;

and increasing financial capacities to build or retrofit their building to accommodate flood hazards. Incorporating additional open spaces that can function as flood management facilities to reduce flood levels affecting property owners was recommended as well. In the development of the creek and riverside corridors, the city realized that fine-tuning zoning regulations such as minimum lot sizes, floor area ratio, maximum allowed percentage of site occupancy (MAPSO), and imposing unique building code regulations covering structural resilience design, firewalls and property fences can be further reviewed.

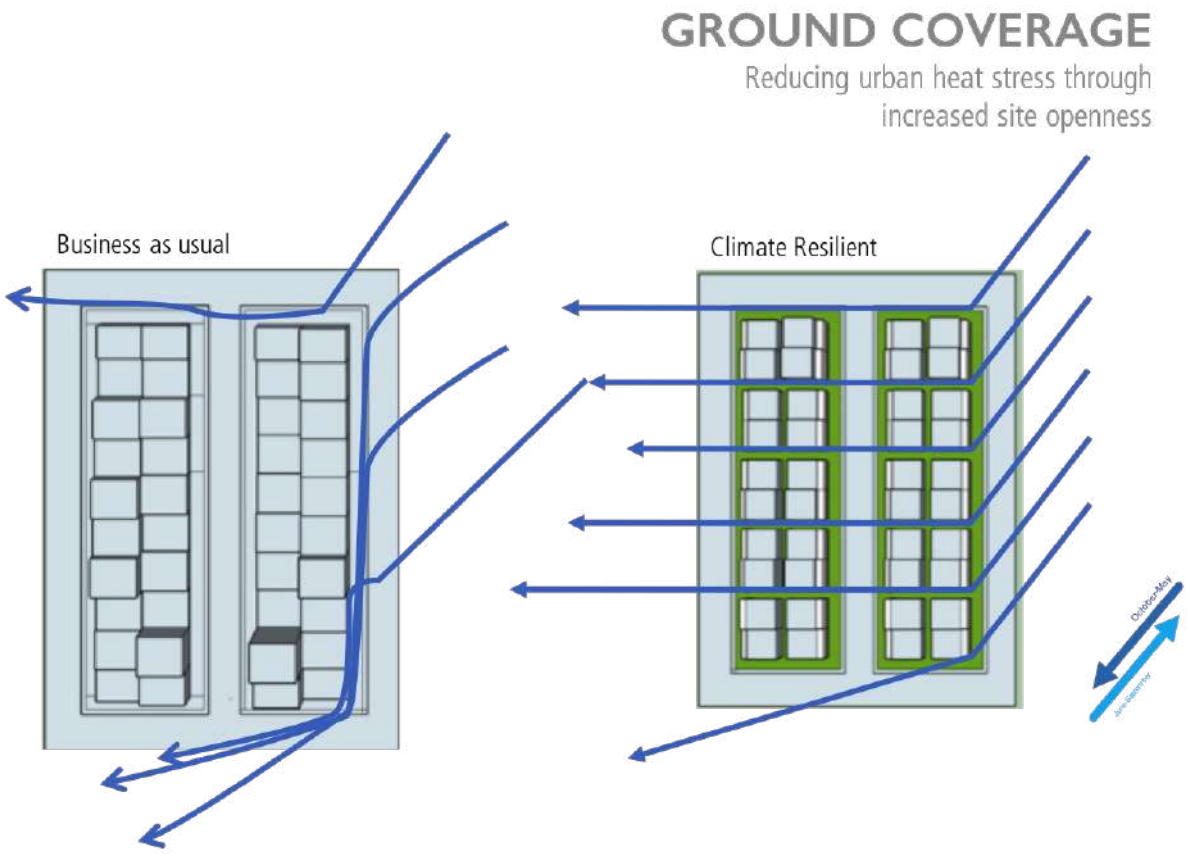
Although no specific regulations were included in the zoning ordinance, the intention of these recommendations are to ensure the safety and lives of the people, ensure buildings are structurally capable of withstanding floods, reducing potential damages to building contents and prevent future subdivision of lots into smaller plots to allow future flexibility for interventions and other regulations. Also, road orientation should be predominantly perpendicular to the creek and riversides and/or provide perpendicular human access systems to facilitate emergency evacuation.

Using Urban Planning and Design to Address Urban Heat Stress

Through the CDRA, the city managed to determine potential areas susceptible to urban heat stress and targeted the reduction of urban area temperatures. The LGU also recognized that further planned expansion of its urban areas using the business as usual approach (e.g., designs that do not consider wind flow) will only further contribute to the future warming of the urban center, mindful of the projected increasing seasonal temperatures. To prepare for this, the city recommended appropriate urban design approaches, including building height and orientation relative to the sun path to provide ground level shading; increasing site openness (Figure 6); adjusting to the floor area ratio and MAPSO; and maximizing roads and parks and open spaces as breezeways that provide ground level airflow, wind tunneling, and passive cooling effect of the prevailing wind flow patterns of the city. Design recommendation on tree cover or green building facades, and solar reflectance regulations of buildings and roofs will supplement the mentioned urban design approaches. The city is also looking into augmenting tree cover along streetscapes and parks, using solar reflective materials and/or materials with a lower thermal mass to reduce heat absorption.. These recommendations can also contribute to reduced GHG emissions by lowering electricity consumption and encouraging non-motorized mobility. However, the city is still in the process of translating these into detailed statutory regulations subject to consultations with stakeholders and will influence future iterations of the CLUP, and Zoning Ordinance, and related ordinances.

[7] The business as usual design approach is characterized by heavy use of concrete materials and absence of hybridization with natural elements (e.g., trees, grass, vegetation).

Figure 6: Proposed Adjustments to Ground Coverage for Reducing Urban Heat Stress through Site Openness



Source: City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

While there is already a Philippine National Green Building Code (Presidential Decree 1096), the city recognized limitations in its coverage. The said building code applies to the construction or alteration of buildings that are 10,000 square meters (sqm) and above and majority of the buildings in the city are below 10,000 sqm.

The city is planning to implement its local green building code to regulate the retrofitting of structures and guide the construction of new buildings. This is in parallel with capacity development of local personnel engaged in the review and approval of building permits. With new learnings on urban design principles and approaches, this should allow the TWG and relevant decision makers to elevate the discussions when deliberating certain urban design provisions of the local green building code to promote resource efficiency and climate change adaptability of the buildings in the city. Furthermore, city recommended to develop incentive mechanisms for proponents implementing green building interventions and renewable energy generation systems through the local investment and incentives code and local revenue code to further promote the low emission development strategy of the city.

Translation and visualization of proposed designs (see Figure 7) can be better illustrated to LGU using available computer rendering software such as SketchUp and Lumion. In the case of Legazpi, the local United Architects of the Philippines Chapter provided free assistance to the TWG in visualizing policies and strategies for streetscapes. The coty government also engaged the academe, particularly Bicol University and the University of the Santo Tomas, to participate in urban design workshops with the hope that key learnings will influence their respective research agenda and increase research on climate-resilient urban planning and design in the region.

Figure 7: Visualization of Greening Interventions Along Streetscapes

Source: United Architects of the Philippines, Legazpi City Chapter, City Government of Legazpi, and UN-Habitat Philippines.

Legazpi's Plans to Lower Greenhouse Gas Emissions

To reduce GHG business as usual emissions by 61%[8], the city recommended increasing greenhouse gas sinks though the expansion of green belts, buffer zones, restoration of riparian forests, and the rehabilitation, conservation and protection of existing upland and mangrove forests. Also, mono-cropped coconut areas will be diversified into food forest systems which can produce additional key food commodities, with the added benefit of sequestering greenhouse gases.

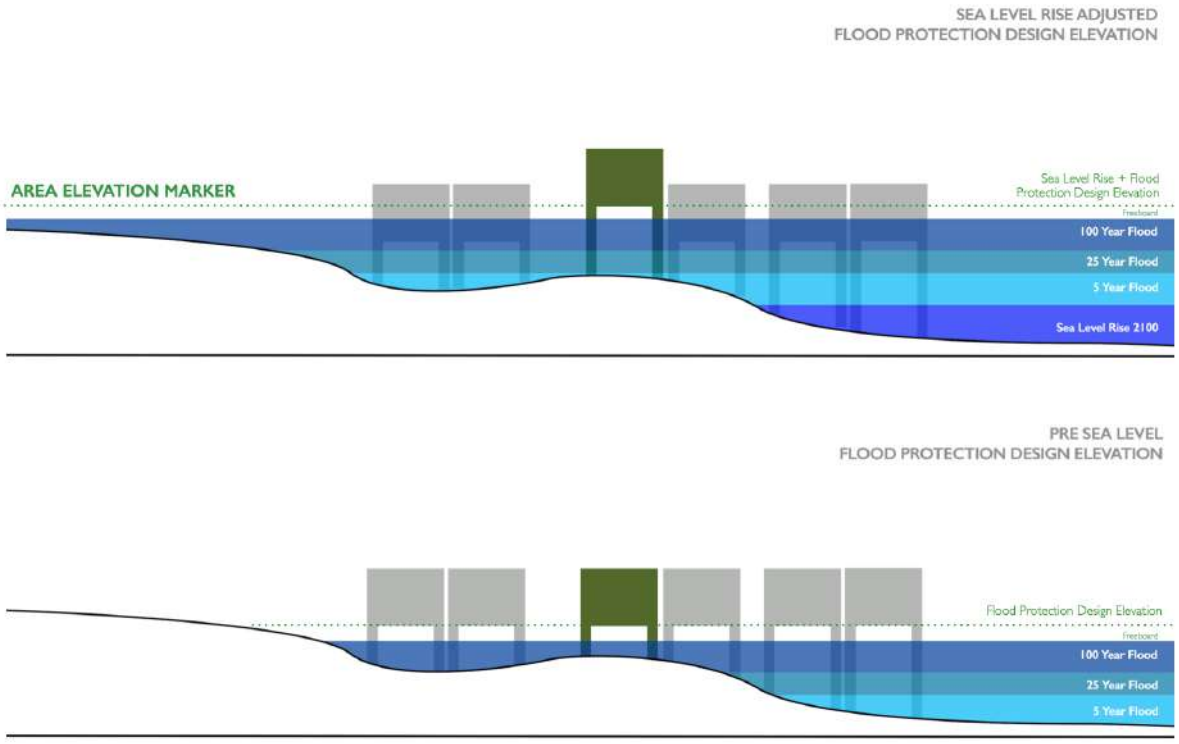
The city also sees the opportunity to modernize the mass transport system by using alternative hybrid buses, jeepneys, tricycles and explore reviving the Philippine National Railroad lines that will connect Legazpi City and Daraga. It also recognized that need to redesign its streetscapes and opening new pedestrian networks to encourage non-motorized mobility to further reduce GHG emissions levels of the transportation sector.

[8] Legazpi City Government. 2019.Local Climate Change Action Plan 2019-2028, pp.131.

Using Urban Planning and Design to Adapt to Sea-Level Rise

Based on sea-level rise (SLR) projections, sea levels will increase by approximately 1.1 meter by the end century, affecting 79 hectares of urban use areas mostly commercial and residential. The city also recognizes the potential effect of rising sea levels to flood patterns along coastal and low lying areas. To increase the resilience of buildings to combined impacts of SLR and floods, the city recommended conducting further hydrological studies. Results of the study will inform possible adaptation pathways covering SLR areas and guide future land use decisions in succeeding iterations of the CLUP and Zoning Ordinance. It will also help the city determine area elevation markers, which will serve as basis for future statutory regulations such as the flood protection and SLR design elevation (Figure 8) to facilitate retrofitting of existing structures and guide future building design and infrastructure systems to withstand the combined impacts of floods and sea level rise. Recognizing the limited information available, the LGU adopted a cautious approach by initially expanding the urban coastal easement, establishment of greenbelts and public open spaces andparks to prevent future exposure of built areas.

Figure 8: Proposed Sea-Level Rise Design Elevation



Source: City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

One of the objectives of LCCAP is to increase the adaptive capacities of 7,310 affected individuals. Recommendations include provision of livelihood opportunities, job placement and priority in terms of local employment, and increased participation of vulnerable groups to small and medium scale enterprises. Also, the city is exploring various options such as retaining and re-development of sea level rise potentially affected areas by

redesigning building structures that can adjust to changes in sea levels and accommodate climate extremes such as storm surges and tsunami, and providing spaces for inclusive tourism. It should be noted, however, that the area is prone to storm surges, floods, liquefaction, and tsunami. Thesaid areas used to be part of the wetland and mangrove areas as well. Thus, the city governments needs to carefully consider if onsite redevelopment is feasible. Another option being considered is the development of socialized and subsidized tenement housing areas in a suitable site within the urban center. This socialized housing concept will provide housing and incorporate commercial spaces for employment and opportunities for leasing commercial spaces to potential locators to augment and subsidize housing loans of potential beneficiaries.

To increase the resilience of buildings and people to storm surges, the city is recommending orienting roads or access systems perpendicular to the coast (Figure 9) to facilitate emergency evacuation; formulatingresilient building design standards relative to the expected storm surge wave height which will be based on future storm surge modelling; and expanding coastal setback requirements to accommodate coastal parks as natural protection to storm surges as an alternative to the traditional infrastructure solutions such as sea walls. Another recommendation is to promote property insurance instruments to provide post disaster economic protection or relief to potentially affected property owners. The identified urban design recommendations also contribute in addressing urban heat stress by channeling winds emanating from the coast towards the Central Business District, especially during the Amihan season.

Figure 9: Urban Design Recommendations Along Coastal Areas

Source: City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

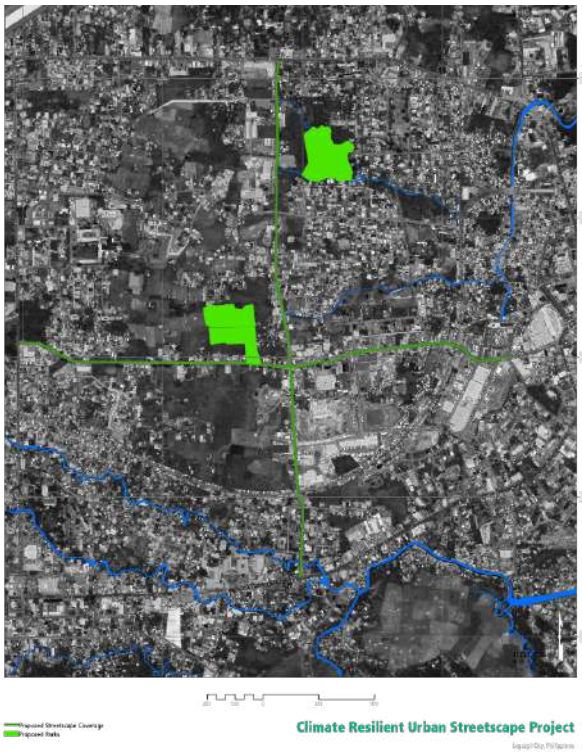
Piloting Climate-Resilient UPD through Urban Streetscape Project

The multi-criteria decision tool recommended by the BCRUPD project facilitated the selection of the urban design project. Based on the project prioritization workshop, the TWG applied a mix of criteria or considerations, which includeed: stakeholder acceptability, technical feasibility, urgency, effectiveness, mainstreaming potential, and multi-stakeholder relevance. The TWG received technical guidance to assess three priority projects: the Yawa River Edible Forest Park, Climate-Resilient Urban Streetscape (CRUS), and the North-South Don Miguel Lopez de Legazpi Boulevard Coastal Linear Park. Proposed projects were assessed depending on technical feasibility, multi-sectoral relevance, stakeholder acceptability, and relative cost.

In hindsight, an additional criterion can be included: the number of potential beneficiaries, specifically targeting the most vulnerable individuals or groups. Other small community-scale projects targeting the most vulnerable groups could have been shortlisted to cover areas at risk to both sea-level rise and floods.

The CRUS project (Figure 10) was eventually selected due its relevance; potential to address both urban heat stress and floods; potential to contribute to the city's GHG emissions reduction targets; and replicability in other urban streetcapes of the city. Through the pilot demonstration project, the city government also saw the opportunity to assess the attitude and acceptance of the residents of the shared responsibility approach in addressing climate issues since the chosen project involves property rights of landowners.

Figure 10: Site Boundary Map, Climate-Resilient Urban Streetscape Project



Source:City Government of Legazpi and UN-Habitat Philippines. 2019. Building Climate Resiliency through Urban Plans and Designs Project.

Thriving—and Not Merely Surviving—in the Face of Climate Change

With better understanding of its climate-related issues and opportunities, the city government realized that it could stir its local development in a better pathway towards a more resilient future for its people. As Legazpi City pursues an agri-ecotourism and commercial development thrust, the city government further qualifies that it should be achieved through a low emission development strategy and one that is climate-smart and resilient.[9] Climate change and its potential impacts greatly influenced government policies, medium and long term spatial and development plans, and spatial regulations through the zoning ordinance.

The city government also realized that urban design elements could be included in statutory instruments to facilitate the climate adaptation process. Among the urban design elements which were already included in the zoning ordinance are the use of the solar reflectance index in the design of buildings[10]; providing zoning incentives for proponents implementing climate change adaptation and DRRM technologies or innovations (i.e., use of solar panels, rainwater harvesting, smart urban drainage systems, green architecture or building systems)[11]; expanding setbacks along major rivers[12], implementing vertical garden requirements relative to the concrete surface area of buildings orstructures along major roads and urban corridors; encouraging open parking spaces to use unpaved surfaces and incorporate tree cover to contribute in addressing urban flooding and minimize site temperatures[13]; transforming the Central Business District into a pedestrian-friendly area with urban shading and proper observance setbacks; and using sustainable drainage systems to include rainwater storage tanks green roofs that can decrease the flow and make productive use of storm water run-off for areas within the Tourism Circuit Overlay and Flood Overlay Zones.[14] The city also sees the need to craft urban design guides to implement these recommendations and strategies. Furthermore, additional local legislation is being crafted specifically the local green building code, and the local investment and incentive code that would contain regulations and provide an incentive mechanism to facilitate the adoption of climate-resilient urban design among residents and business establishments.

Legazpi City demonstrated a paradigm shift in addressing climate risks by emphasizing "no regrets", nature-based and integrated solutions.[15] The city government realized that these alternative strategies can be more economical and sustainable in the long term compared to conventional infrastructure-based risk management approaches such as coastal storm surge protection nature coastal parks, hybrid flood management parks, and lahar greenbelt nature and tourism parks. Also, it realized that current road network designs (i.e., designs with minimum area required, no integrated plan for connectivity and walkability, and an absence of greeneries and permeable design) only contribute to the further heating of the city and that streetscapes can be further enhanced using urban design approaches such as incorporating natural elements and alternative materials to influence pedestrian behavior, minimize electricity costs towards a low emission future.

While climate change brings negative impacts to the city, the local government also sees other potential benefits that can be explored and maximed for local development. The realization that the city might experience changes in seasonal rainfall triggered win-win interventions,

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[9] City Government of Legazpi City, Comprehensive Land Use Plan 2019-2028, pp 108, 118.
[10] Legazpi City Zoning Ordinance 2019, p. 38
[11] Ibid, p.20
[12] Ibid, p.25
[13] Ibid, p.9
[14] Ibid, p. 15, 19
[15] "Low or no regret" measures are climate change measures whose direct benefits are not easily quantifiable and/or not immediate but has co-benefits that are significant enough to justify implementation (Source: Climate Change and National Urban Policies in Asia and the Pacific. 2018)

such as the establishment of water impounding systems to provide water to agricultural areas and also serve as flood management interventions especially in agricultural areas sharing the same river basin boundary with the urban center. Also, to adapt to all plausible rainfall scenarios and extreme rainfall events, the city is promoting the harvesting of rain water and increasing ground permeability in urban areas to augment potable water supplies and recharge groundwater, as well as reduce surface flow volumes to contribute in addressing floods. With better flood modelling information, the city is reviewing the rain-water harvesting ordinance to provide clear design regulations pertaining to the required capacity of the rain water storage that they will impose to significantly address urban flooding and reduce flood levels in low-lying coastal river and creek areas.

The inclusive and climate-resilient economic strategy, which the city is pursuing, offers long term social benefits as it will increase the adaptive capacities of vulnerable families. The strategy will also promote a culture of self-reliance in dealing with climate challenges. The city considered these climate issues and came up with adaptation strategies such as providing economic and employment opportunities by opening up new commercial development corridors to benefit the informal sector; giving technical and infrastructure support to augment incomes of farming-dependent families; and opening new eco-tourism development areas to provide alternative sources of income to forest and coastal and marine resource-dependent communities. The proposed strategies aim to uplift the social well-being of the residents by increasing heir purchasing power. This is crucial for them to cope with the future challenges of climate change.

The city government considers housing as a fundamental right and contributes significantly to increased adaptive capacities of at risk families. Embedded in the Comprehensive Development Plan (CDP) is the provision of decent, resilient, and quality homes for the most vulnerable groups or severely affected population by 2028. The CDP stresses the need to identify and develop 200 hectares of land suitable for housing and resettlement. The city is now looking at innovative solutions to the housing backlog such as socialized-subsidized tenement housing schemes. Such schemes will allow the city government to combine housing and commercial spaces, helping defray the high cost of purchasing lands in urban areas. This also allows flexibility in choosing sites relative to the workplace of the target beneficiaries and provide loan subsidies helping ensure affordability. Anticipating the future climate scenario, the city also hopes to apply resilient urban design by incorporating resource-efficient and climate-resilient design principles.

Since majority of the proposed solutions to address the climate change impacts are beyond the current financial and technical capacities of the city government, private-public partnerships are being explored for interventions on capacity and capability development. Some of the identified LCCAP projects have already been incorporated in the medium-term investment plan of the city subject to availability of funds and commitment from the private sector and potential donors. The LGU is also rolling out capacity building activities on preparing project proposals to secure climate financing for the city. In preparing future project proposals, the city government will strive to uphold social and environmental safeguards, while quantifying social, economic, and environmental costs and benefits.

To sustain its local climate action, the city sees the importance of further building its local capacities on climate science, climate and disaster risk assessment, urban design, structural hazard resilient design, project proposals preparation, and mainstreaming these into their participatory planning and decision-making processes. This will also allow them to inject urban design elements, especially for projects initiated by regional and national government agencies.

Investing in resilience means protecting the economy, the community, and the people. The city government is committed to transform Legazpi into a resilient and thriving city and welcomes assistance from potential partners and funders to realize this vision.

PHILIP
ZONING MAP (Urban
2009 - 2018
Legazpi City

ORMOC CITY

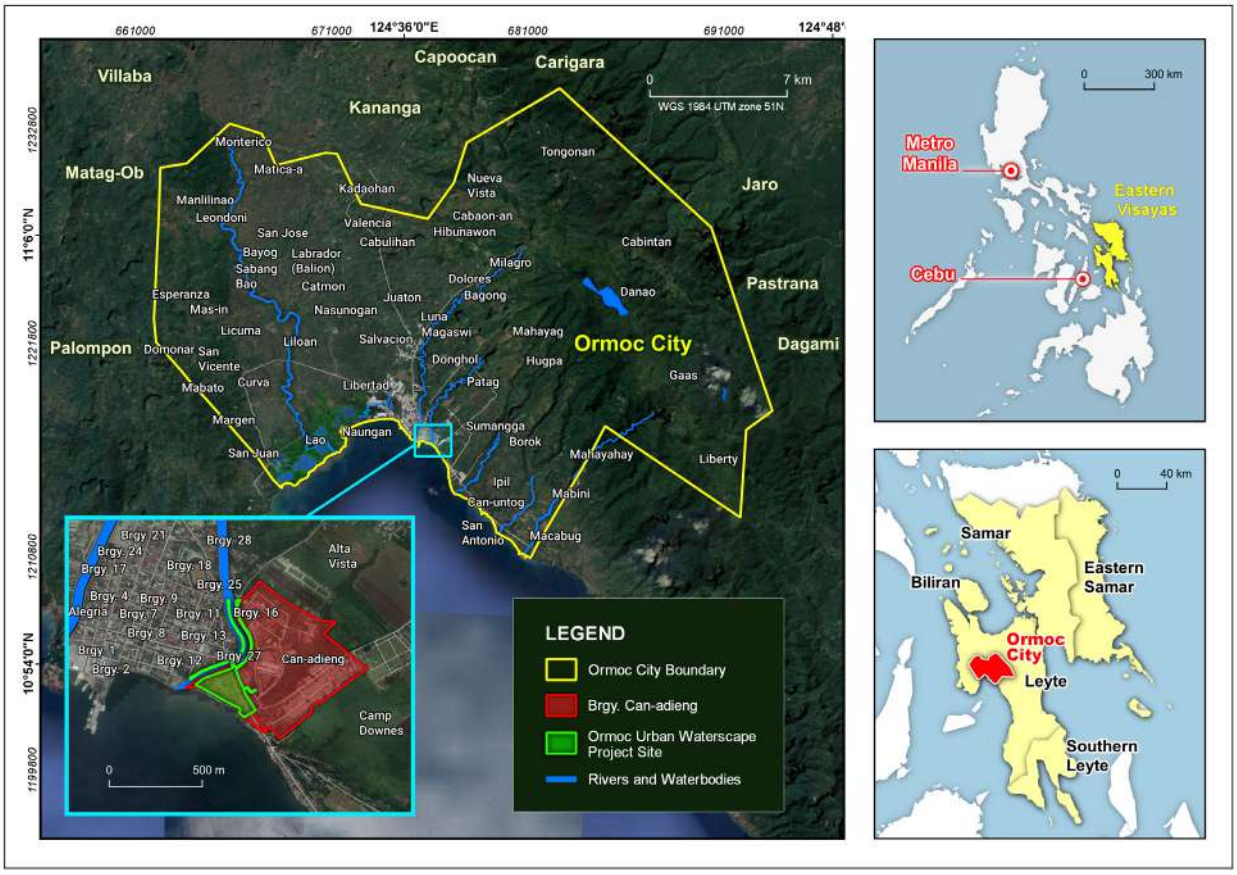
CASE STUDY ON THE PATH TO CLIMATE RESILIENCY

ABOUT ORMOC CITY

Ormoc is a first class, independent component city and a key regional center in Eastern Visayas[1]. With a total population of 215,031[2] and a population growth rate of 2.6%[3] that is higher than the national average, the city is identified as a growth center, primed for major development and support from national government. By 2030, the population is expected to increase to 300,688, and the figures could double by mid to late 2040s.

The city has 110 *barangays*, 31 of which are classified as urban and 63 rural. There are 10 urban and six rural *barangays* located along the coast of Ormoc. Thirty five percent of the population is currently living in the urban center, where commercial and institutional spaces are also concentrated.

Figure 1: Map of Ormoc City



Source: Building Climate Resiliency Through Urban Plans and Designs (BCRUPD) Project

[1] The Local Government Code (1991) has three legal categories for all cities in the Philippines: (i) highly urbanized independent cities, which are those that meet the minimum income and population; (ii) component cities, which are those that do not meet the minimum population and income thresholds; and (iii) independent component cities, which are those that are considered independent from the province where they are located.

[2] Based on the 2015 Census of Population (Philippine Statistics Authority, 2017). A parallel census through the Community-based Monitoring System accounted for 212,563.

[3] Population growth rate from year 2010 to 2015. Philippine Statistics Authority. 2017. Highlights of the 2015 Census Results for the City of Ormoc. http://rsso08.psa.gov.ph/leyte/special-release/popcen/ormoc (accessed on 10 May 2020).

The city's economic base is transitioning from agriculture to commerce, in accordance with the CLUP's spatial development strategy. In 2017, 6,779 businesses were registered, including new registrations for 16 banking and financing institutions, 46 manufacturing, 522 retail, and 789 service businesses.[4] The service sector alone is valued at PhP 40.6 billion in capital assets, with retail, manufacturing, and banks contributing PhP 7.7 billion, PhP 5.8 billion, and PhP 754 million respectively. The service sector also employs largest population, followed by retail.[5]

Economic activity, particularly the flow of goods, services, and people is facilitated with the presence of commercial and transportation facilities such as the Ormoc Port and and the Ormoc Airport, which is currently under renovation.

While Ormoc has experienced significant urban and socioeconomic development over the years, its exposure to climate-related hazards such as flood, storm surge, and rain-induced landslides, combined with people's vulnerability, places the city at risk to climate change impacts and threatens future development.

For instance, the forest land covering the critical watershed of Bao River, which is connected to Anonang-Lobi Mountain Range of the Eastern Visayas Biodiversity Corridor, is susceptible to landslide. Meanwhile, production lands suited for seasonal and permanent crop production, are susceptible to flooding. The old urban center and its development expansion in the southwest towards the coastal *barangays* are considered prone to flooding and storm surge. The whole city is also susceptible to earthquakes[6], which may lead to liquefaction and tsunami, and compound the effects of climate-related hazards.

Upland Ecosystem: Dayhagan

Production system: Rice fields in Liloan and Lao

The city also has several dendritic river systems or those that have several contributing streams, such the Pagsangaan, Malbasag, and Anilao Rivers. In Ormoc, these systems often interact with the built environment, as settlements are erected along their tributaries. Flooding has and may again occur when such structures prevent water from draining into the river, especially during typhoons when these areas experience excessive water runoff.

In November 1991, Typhoon Thelma (international name: Uring) hit the city that caused flashfloods claiming 4,000 lives and leaving 3,020 residents injured. Around 2,500 residents were also recorded missing. The floods damaged PhP 35 million (USD1.3 million, 1992 figures) worth of agricultural crops, poultry, and livestock, PhP135 million (USD5.3 million) in private property, PhP 230 million (USD9 million) in public facilities.[7]

In November 2013, Super Typhoon Yolanda (international name: Haiyan) hit the city's agriculture sector, with a total loss of

[4] Business Permits, Franchising and Licensing Office.
[5] The service sector employs 8,140 males and 3,542 females, while retail employs 2,943 males and 2,821 females.
[6] Categorized at intensity 8 in agricultural production zones, urban center, and highlands around Danao Lake down to the midland, while the remaining areas at intensity 7 as mentioned in LCAAP.
[7] Environmental Research Division of the Manila Observatory. 1992.

Some areas in Ormoc City experience excessive water runoff during typhoon causing floods and affecting residents nearby.




PhP2.059 billion or USD48.5 million (2013 figures). PhP 1.862 billion (USD43.9 million) were damages on standing crops; PHP 15.3 million (USD360,456) on infrastructure; PhP 22.9 million (USD599,507) on fishery; and PhP 158.491 million in milled stocks.

These and other disasters challenge the way Ormoc City has developed relative to its environmental conditions, but more importantly how such development is being planned. Current spatial strategies and land use regulations have, intentionally or not, allowed urban development in areas exposed to climate change impacts. For instance, the concentration of various land uses in the fringes of the old city center has led to the eventual extension of the latter, with little consideration for potential risks that such expansion brings. Spatial strategies have become a function of the mere presence of critical utilities such as the airport, seaport and geothermal plant, of the obvious economic value of tourism and agro-commercial centers, and of legal constraints in land management, with about 40% of land privately owned and currently used as plantations. Incidentally, these are also the areas with the lowest risk, leaving the greater part of the city with limited supply of and access to safe and adequate land for public use.

These circumstances played a significant role in forming the current vision of the city as the agro-commercial and industrial gateway of the region, and transitioning its economic base from agricultural to commercial. However, they also show how existing uses can precede and sometime overwhelm deliberate urban policies and actions, sometimes to the detriment of more resilience-focused strategies.

There is now a need to revisit the city's existing development pathways and determine if an approach founded on climate resilience can lead to enhanced strategies not only as a way to address climate change impacts, but to influence the city's overall urban development.

ORMOC CITY IN THE FACE OF CLIMATE CHANGE

Considering the geographical character and development trajectory of the city, projected increases in temperature by +2.3°C and precipitation by +220 mm will bring significant changes to the environment and the economy. The city's main concern, however, is how climate change is going to affect its people.

The gravity of climate change impact is evident across the city's ecosystems, mainly affecting fisherfolks, farmers, and urban dwellers. Climate change also threatens to push more of its people below the poverty line. Currently, the poverty incidence in Ormoc is 52.23% or 24,319 out of 50,341 households[8], while 36.33% live below the food threshold. Dependency ratio is at 67.55%, which is higher than the national average. The numbers could worsen if the no actions will be done to address the socioeconomic impacts of climate change.

Thirty five percent of those are directly involved in open sea fishing (1,686 fisherfolks) will be greatly affected by the increase in temperature, which will likely cut their daily working time by five hours. This translates to a decrease in monthly income from approximately PhP14,300[9] to PhP8.580[10] well below the poverty threshold.

This economic impact will also extend to 16,854 households under the food threshold, and 311 households experiencing food shortage due to the insufficient food supply. The projected decrease in fishing periods will also exacerbate existing restrictions, such as an ordinance prohibiting off-season fishing for six days, or three days before and three days after a full moon. It should be noted that regular fishing activities are intermittent from July to October due to the Southwest Monsoon (Habagat), leaving fisherfolks with active income for only eight months. Further, increase in number of fisherfolks is also restricted due to over carrying capacity of Ormoc Bay.

Meanwhile, 4,540 rice farmers will experience a decrease in net monthly income of rice production from PhP 13,750/month[11] to PhP 11,137.5[12], based on two cropping seasons per year. With the anticipated temperate increase of 2.3°C, the income of 974 corn farmers in 961 hectares will decrease from PhP30,000/ha down to PhP25,725[13]. This pushes farmers further below poverty line. Also, there also 32 *barangays* that have been identified as at high risk to flooding. This area covers 3739.95 hectares and will be valued at PhP 202.58

[8] Community-based Monitoring System (CBMS), 2015.
[9] 5 kgs/day at P130/kg for 22 days.
[10] 3 kgs/day.

million by 2030. A remaining 10% of farmers, with an average land ownership of 1.5 ha, are not covered by crop insurance.[14]

In the urban ecosystem, increased rainfall, and more frequent and stronger typhoons will increase the risk of flooding in 71 villages, affecting about 109,000 people in 27,300 households. Excessive rainfall across the city will place in greater danger the 46,564 households that live in inadequate housing, 7% (2,687 households) of which are informal settlers and 8% live in makeshift housing[15]. It would also worsen health conditions in these areas.

Meanwhile, rain-induced landslide will impact 96,496 people or 22,564 households in 41 *barangays*, and storm surge poses a risk to 83,628 people or 19,110 households in 21 *barangays*.

Overall, there are 23,390 families below poverty line and around 8,000 workers in the informal economy that rely heavily on street-level businesses exposed to climate-related risks, who will pushed further into poverty if they will not have access to social and economic safety nets.

These anticipated impacts of climate change and the urgent need to address them compelled the local government unit (LGU) of Ormoc to craft its Local Climate Change Action Plan (LCCAP), the first iteration of which covered the period 2016-2025. The LCCAP outlined the city's programs and strategies to adapt and mitigate climate change for the next 10 years.

However, the city understood that more work needed to be done to deepen its knowledge on climate change, and rethink its approaches on resilience-building. Thus, the LGU worked closely with the Department of Human Settlements and Urban Development (DHSUD), and the United Nations-Human Settlements Programme (UN-Habitat) through the Building Climate Resiliency Through Urban Plans and Design (BCRUPD) Project, in an earnest bid to make the city more livable and responsive to the challenges and opportunities that a changing climate brings.

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[11] PhP 165,000 annual income.
[12] PhP 133,650 annual income, based on 10% decrease in yield per 1°C increase in temperature.
[13] Each global temperature increase will decrease corn production by 7.4%.
[14] PhP10,000 per hectare.
[15] According to the Community-based Monitoring System, 2,687 informal settler families and compromise safety structure of 3,448 makeshift houses.

BUILDING CLIMATE RESILIENCE THROUGH URBAN PLANS AND DESIGN

The BCRUPD Project aims to strengthen the capacities of national government agencies to promote and integrate urban adaptation planning and design in their institutional policies and regulations. This is intended to support local government actions and enhance the skills of LGUs in developing resilient urban plans and designs. Ormoc City was selected as one of the project's five partner cities, to be guided by the national government with assistance from UN-Habitat.

At the onset of the project, a capacity needs assessment (CNA) was conducted by UN-Habitat to identify existing technical capacities and knowledge, and determine gaps and challenges that may hinder the city from developing plans and designs geared towards climate resilience. The CNA revealed that the city, particularly the TWG, needed to have a deeper understanding of the impacts of climate change, as well as tools and approaches that would aid in addressing these impacts, such as greenhouse gas inventory, local climate change action planning, climate and disaster risk assessment, and urban planning and design. Based on these findings, UN-Habitat developed and implemented a capacity-building plan for the city. Through workshops, training sessions, mentoring, intercity exchanges, and other activities, the identified gaps were addressed and local capacity was enhanced.

Having a clearer understanding of how climate change affects people, the environment, and the economy helps the city to develop rational, targeted, and programmatic solutions. Through the BCRUPD Project, the LGU improved its Local Climate Change Action Plan (LCCAP), and utilized urban design to provide innovative solutions to climate change impacts. This contributed to the goal of increasing the city's adaptive, allowing it to take advantage of the opportunities that climate change can bring.

Towards an enhanced local climate change action plan

The project introduced the Intergovernmental Panel on Climate Change Assessment Report 5 (AR5) risk framework. This was a welcome advancement, as the city had previously been using AR4 in its climate change assessments. Moving forward from AR4[16], AR5 discusses impact as function of exposure, hazard, and vulnerability, with the latter as a comparison of sensitivity and adaptive capacity. This allows hazard-specific analysis using a climate lens, with risk at the end stage of analysis.

The project also helped the city obtain new data sets from Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), as well as learn about current methodologies on Climate Disaster Risk Assessment (CDRA) by the DHSUD, and GHG inventory by the Climate Change Commission.

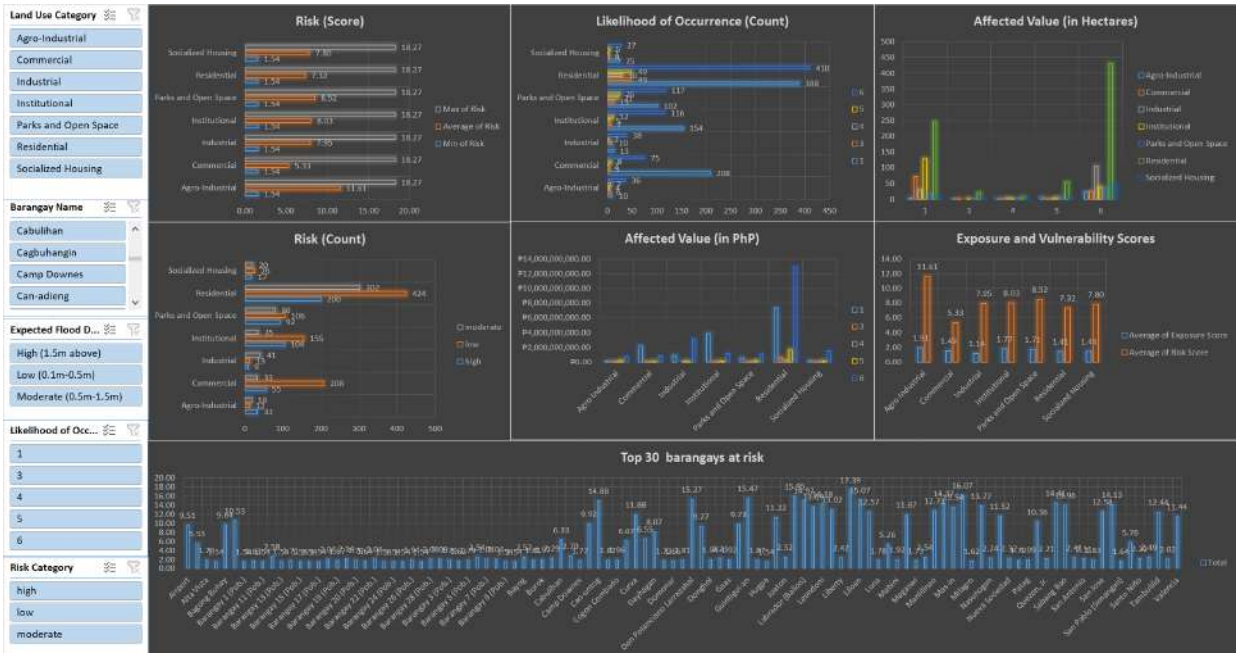
These new learnings convinced the TWG of Ormoc to enhance the city's Local Climate Change Action Plan.

Deepening understanding of climate change, impacts, adaptation, and resilience

Prior to the project, the TWG automatically equated climate change with flooding and other observable impacts and perceived disasters. This perspective changed upon reviewing concepts and frameworks with UN-Habitat. It helped the city to better understand climate change drivers such as temperature, rainfall, and extreme weather events, and differentiate these from impacts.

The recalibration guided the TWG in analyzing the root causes of climate change impacts, and therefore identifying more appropriate actions. This was made even clearer when the city enhanced its the impact chain analysis for the LCCAP. It also helped in evaluating the proposed programs, projects and activities (PPAs), as either business-as-usual or direct climate action. It helped the City Disaster Risk Reduction Management Office (CDRRMO) focus its Disaster Risk Reduction and Management Plan on responses, protocols, and initiatives to lower the casualties and damages before, during, and after natural and man-made disasters. The LCCAP, meanwhile, remain focused on establishing climate scenarios and addressing anticipated climate-related impacts.
Using the climate lens in discussing impacts and disasters was a critical step for the city. It gave the TWG members an opportunity to deepen their understanding of resistance, recovery, and adaptation. Some members of TWG consider Ormoc as resilient after the city recovered from the onslaught of Typhoon Uring (international name: Thelma) in 1991 and Super Typhoon Yolanda (international

Figure 2: CDRA Dashboard Analytics for Flood Risk



Source: Department of Human Settlements and Urban Development.

[16] Discusses "potential impact" as function of exposure, sensitivity, and adaptive capacity. End stage of analysis is "Vulnerability", which is the comparison of "potential impact" with adaptive capacity.

name: Haiyan) in 2013. The technical sessions helped the TWG members to understand further that resistance and recovery are not the only measures of climate resilience; sustained urban adaptation is a necessary element in achieving the city's climate change goals. The process also extended the city discussion on observed flooding and urban heat island effect.

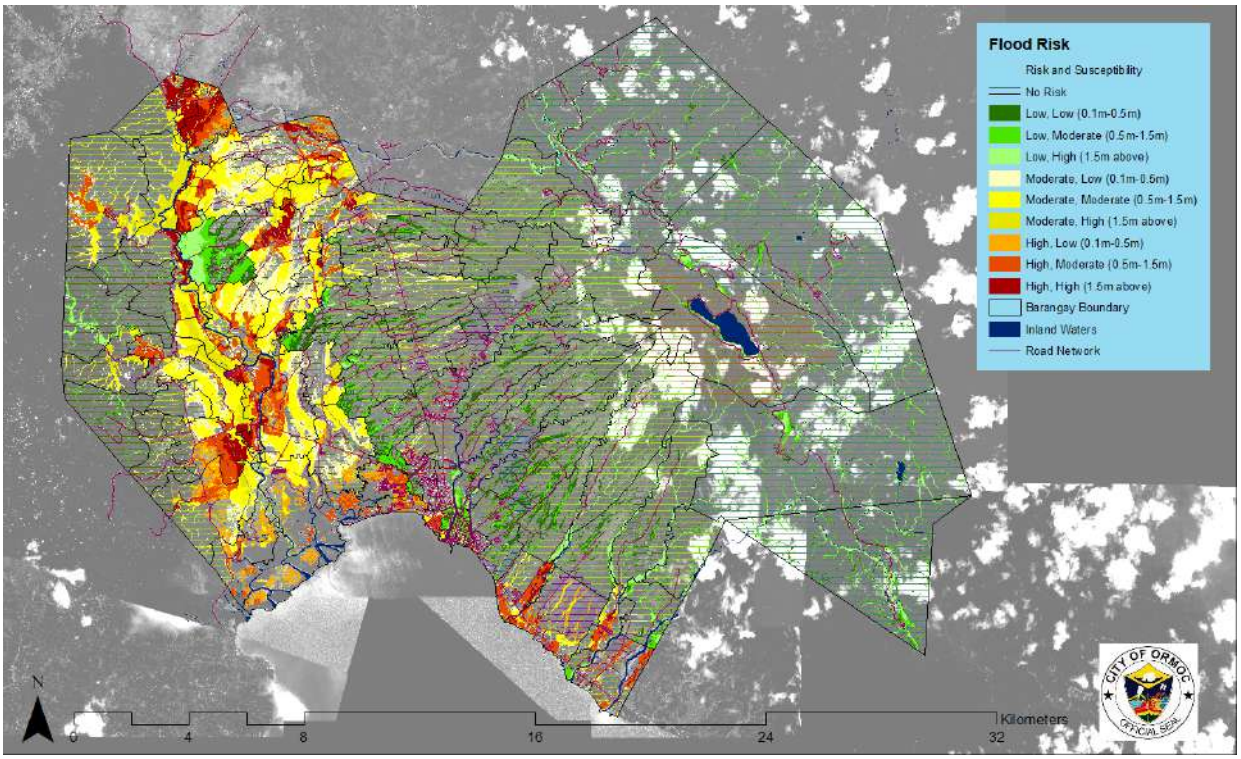
Using climate data to make informed decisions

The city used to depend on hazard maps to identify "risk" areas without assessing the actual exposure of people, structures, and resources or people's capacity and vulnerability. This incomplete picture of risk was corrected when the project introduced the climate and disaster assessment (CDRA) tool developed by the DHSUD.

The CDRA enabled the city to identify and assess at the site level the presence of exposed units. The tool also allowed risk determination based on the likelihood of occurrence, sensitivity, and adaptive capacity. Since the tool also provides for analysis of hazards relative to land use, the city was able to act on projects based on more accurate data. For instance, assessments revealed that a total 61.56 hectares of socialized housing zones in 14 *barangays* were at risk to flood. These results were mainstreamed in the Comprehensive Land Use Plan (CLUP), which sets the city's spatial strategies, and in urban design guidelines, which cover housing.

The CDRA's enhanced Excel tables or "dashboard", coupled with the exposure map and its derivative risk map, also allowed easier processing of data and results. The usability and versatility of the dashboard was demonstrated when it was shared with *barangay* officials for the risk assessment itself, and for their use in *barangay*-level planning and action. The assessment results were also used in the Comprehensive Development Plan, particularly in the vision-reality gap assessment or situational analysis.

Figure 3: Flood Risk Map

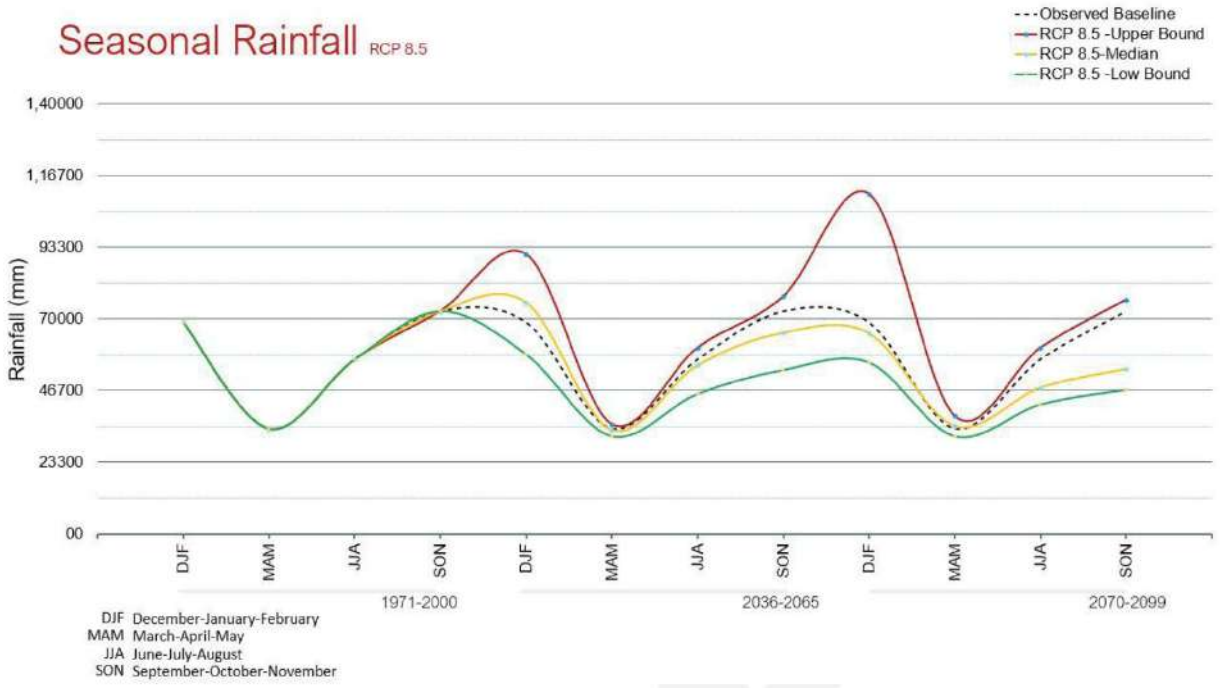


Source: City Government of Ormoc.

Meanwhile, the PAGASA datasets and the city's climate data between year 2015 and 2017[17] enabled the TWG to make better projections, which was crucial in identifying the next steps. For instance, the annual rainfall in 2017 was already greater than the projected rainfall for 2050[18], while remaining close below 2020 projections (1892.9 mm).

[17] January to October, 1867.14 mm, RCP 8.5 lower limit.
[18] 1767.9 mm, RCP 8.5 lower limit.

Figure 4: RCP 8.5 Seasonal Rainfall Projections



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration

These variabilities confirmed the necessity of coming up with a wider range of adaptation measures over different time periods, and ensuring their flexibility and robustness so that investments are optimized and remain beneficial even in the long term.

Also proving useful for the city was the greenhouse gas (GHG) inventory tool developed by the Climate Change Commission. The city baseline GHG inventory in 2017 showed that Ormoc had a total GHG emission of 151,493.20 tonnes carbon equivalent dioxide (CO_2e), 35.8% of which was from purchased electricity. Agricultural activities mainly contributed to the remaining 64.2%. The inventory results also dispelled notions that the city is carbon negative due to the presence of the Tongonan Geothermal Plant. A capacity building session on climate mitigation, specifically reviewing concepts of GHG capture and renewable energy generation, further clarified that the plant does not capture or eliminate GHG. Forestlands, meanwhile, can sequester about 53,277.46 tonnes of CO_2e. With these numbers as basis, the city decided to target 10% emission reduction from this baseline that will be highly influenced by reducing electricity use and expanding natural carbon sinks. The city did not consider limiting agricultural activities since it will affect Ormoc's food supply.

Risk-based objectives, strategies, policies, and initiatives

The city's 2017-2027 Comprehensive Development Plan contains 79 sectoral goals or strategies and four overall development goals, which the TWG considers feasible and relevant for overall sectoral development. The LCCAP, as a thematic action plan, has 19 adaptation objectives aligned with these higher development goals, and aimed primarily at increasing the adaptive capacity of its people and ecosystems, and addressing climate change risks. In particular, it intends to reduce the vulnerability of fisherfolk affected by increasing temperatures. It also aims to improve the conditions of urban communities through climate-adaptive urban housing, public facilities, and urban infrastructure, to better adapt to increasing rainfall and excess water runoff. Meanwhile, rehabilitating and increasing the stability of flood-prone mangroves in coastal areas, and an improved forest cover in landslide prone areas will not only serve as adaptation but also as a mitigation measure, maintaining the city's carbon sink.

From these objectives, the city developed adaptation and mitigation initiatives, and major activities. These include capacity building activities for government agencies

and target sectors, information and education campaigns, and delivery of regular functions such as comprehensive listing of farmers on crop insurance, lot acquisition for housing, and climate-related disease surveillance.

Adaptation projects include knowledge base development, a climate monitoring system, biodiversity and hydrology studies, forest land use plan, and sewerage and drainage master plan. Projects in coastal and production ecosystems aim to increase agricultural and fisheries yield, enhance post-harvest processing through technological and structural support, and provide economic support to fisherfolks and farmers. Forest ecosystem initiatives are mainly on protection and rehabilitation to support flood management, while projects in the built environment include redesigning streets, sidewalks, and drainage systems to absorb more rainfall, and enhancement of building designs to include water harvesting facilities and green walls. The LCCAP also focuses on redesigning open spaces for water capture, storage, and reuse, transforming storm water into a resource; and promoting low-emission methods in all structural construction.

Developing the city's urban adaptation strategy

The next challenge for the city was translating the objectives, strategies, and projects of the LCCAP in spatial terms. Harmonizing and integrating the various climate change interventions into the urban fabric, and describing how these actions relate to the overall spatial development of Ormoc, was crucial if the city wanted climate change resilience to inform and influence its future urban development.

The city urban adaptation strategy echoes the LCCAP's appreciation of water as a resource. It promotes a combination of natural, nature-based and engineering approaches to capture and store excess water for use, and to delay before discharging for flood management. These approaches are evident across the urban design elements and scale–from urban grain, streetscape and open spaces, façade, and down to buildings and materials.

Taking off from an existing city ordinance requiring the inclusion of water harvesting facilities in new buildings, the city adaptation strategy proposes neighborhood scale water harvesting. Capturing water helps diversify sources intended for consumption, while decreasing underground water extraction. Done at the neighborhood scale, it promotes collective climate action and a sustainable community lifestyle.

To help regulate temperature, the city identified open spaces in the city that can be dedicated to tree-planting. As well as reducing heat index and providing shade in urban areas, trees can also help in GHG sequestration, achieving mitigation co-benefits for the city. This urban strategy can be implemented at the community and household levels.

Low emission development (LED) approaches are also encouraged within the built environment. This includes streets, buildings, and infrastructure. LED entails the application of construction methods that require low energy use, designs that utilize maximum utility of natural light and wind, and materials that allow passive cooling and water absorption.

City-wide climate-resilient urban design

Based on the LCCAP and emanating from the city's urban adaptation strategy, a citywide urban design was conceptualized and developed by the TWG. Taking their cue from the city's mandated plans, the proposed urban designs are comprehensive, covering the city's total land and water area, and consider land use and zoning. The designs are likewise anchored heavily on climate change risks established in the CDRA and LCCAP. As in the urban adaptation strategy, the following design ideas implement natural, nature-based, and structural engineering methods in managing water and regulating heat, as they transform spaces for social and economic benefits and provide measures to protect the natural environment.

Designing riverbanks and easements for riverine flood management

Riverine floods put people, houses, and crops in urban and agricultural *barangays* at risk. River banks should then be designed to resist, absorb and utilize the water outflow. This will be the case for the main watershed of Pagsangaan River, and the sub-watersheds of Panilahan in Macabug, Bagongbong in San Antonio and Danhug, Malbasag in Can-adieng, and Haubon River in Tambulilid.

The design will include a series of slit dams that serve as water retention or impounding areas, with no full concrete barrier[19] along the river slope. This will help control water velocity and restore river capacity. It will use gabions as main materials it will allow seepage. The retention structures are connected to agricultural canals, expanding irrigation water source and coverage.

A water hydrology study could best determine the dimension and expected water volume in designing these structures. A geological survey is also needed.

River easements[20] will be enforced, after which they can be transformed into linear parks in urban areas, and greenbelts in agricultural areas. This is consistent with the city's CLUP, which has declared these easements as part of Ormoc's parks and open spaces network.

Integrated design of streets, sidewalks, and drainage systems for water management and heat regulation

The city will pursue the establishment of a street network that incorporates trees and plants to regulate heat, sidewalks made of permeable material to better absorb surface water runoff, and drainage that collects water and integrates it into water treatment plants for reuse. This is to be implemented primarily in city-managed streets such as Hermosilla Drive, Lilia Cogon Street, Real Street, Rizal Street Extension, and Veloso Street. The design is also proposed for implementation in national roads within the city led by the Department of Public Works and Highways (DPWH).

Urban canals will be designed to address the projected volume of water, location, and design scale, particularly in low-lying areas. These are strips of roads that allow catchment of water, to be directed towards urban drainage facilities, or openly to the river or coast. In relation to this, drainage systems will be upgraded to include water detention structures, based on projected rainfall and potential use.

Bioswales will also be introduced in road sections with large spaces, ideally the national roads. As opposed to concrete and enclosed drainage systems, bioswales allow vegetated landscapes that serve as natural filtration and aid underground water recharge.[21]

All of these designs will serve as inputs to the Drainage and Sewerage Master Plan to be formulated by the city. Moreover, the city recognizes the need for these roads, sidewalks, and drainage facilities to be planned and constructed as a system rather than as individual parts. These intended to be developed, budgeted, and programmed as "integrated development".

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[19] Full concrete flood dikes disintegrate as the soil beneath loosen, either it is sinking or being wiped away.

[20] 3 meters in urban areas, 20 meters in agricultural areas, and 40 meters in forest lands, as mandated in the Water Code

[21] Sustainable Urban Drainage Systems (SUDS) are made up of one or more structures built to manage surface water runoff; they tend to mimic natural drainage. SUDS often incorporate soil and vegetation in structures that are usually impermeable (e.g., green rooftops); the uptake and passage through soil and vegetation reduces runoff velocity and improves water quality. Surface permeability in urban areas can be increased by using permeable paving where appropriate (e.g., footpaths, car-parking areas, access roads), thus reducing surface run-off and increasing groundwater recharge. The harvesting and use of rainwater can reduce the pressure on drinking water resources. Infiltration devices, such as "soakaways", allow water to be drained directly into the ground; basins, ponds, and urban infrastructure such as children's playgrounds can be designed to hold (excess) water when it rains. Measures for rainwater utilization for non-potable uses and design of urban public spaces can help meet water efficiency targets and improve environmental quality.

Designing coastal settlements and public space networks for multiple uses and community benefits

Ormoc Bay is seeing rapid development, including an increasing number of settlements and parks requiring management. Possible storm surges during strong typhoons should be considered in designing the communities for the 16 *barangays* along the coast. In view if this, enhanced coastal zoning is proposed to define and provide design guidelines for areas where settlements, parks, beaches, and wetlands can be developed.

For settlement zones, the city is encouraging low- to mid-rise housing structures in mixed use developments. While maintaining a view of the coast, the structures will be elevated as much as 1.5 meter to absorb surge water, as well as allow water to flow freely from higher elevations. This applies to currently dense settlement areas of Naungan, Linao, Punta, Alegria, Can-adieng, Camp Downes, Ipil, Danhug, and Macabug.

For other coastal sections, proposed linear parks will serve as barriers from storm surge, with water retention structures underneath. The parks are to be designed to follow the natural shape of the coast.

Viewed from the sea, the city will be appear as a network of green spaces and parks that converge at the City Plaza Complex. This will be complemented by mangrove parks, developed either through constructed wetlands or natural rehabilitation[22], that serve both as natural storm surge barriers and habitat for marine life. These forest beach projects are planned in San Antonio and Macabug.

These actions will influence the structural design of the city public market, Ormoc Port, and the private ports in Ipil and Linao serving the industrial zones.

Redesigning existing structures and establishing open spaces in mixed development urban center

The spatial development strategy under the CLUP identifies the existing urban center and its adjacent *barangays* as major development nodes to be supported by industries, transportation facilities, and agro-commercial activities. This pushes new residential and commercial development towards the central north sections of the city, which are considered to be at lower flood risk due in higher elevation. These sections of the city are more accessible as these are located along major highways.

These new developments, including those with major repair work[23], will have to comply with a city ordinance on inclusion of rainwater harvesting in building design. The city is also set to craft its local policies on the adoption of the green building code that promotes passive cooling strategies, low emission development principles, and disaster resilient approaches. An ordinance on the green roof can complement the existing water harvesting ordinance.

For existing structures, the private sector will be encouraged to redesign their properties. The city will work to reclaim sidewalks, and redesign them to improve drainage and public space. Building design will also be guided to include arcades or trellis to help provide shade for the sidewalks.

Government buildings and facilities will take the lead in developing urban vertical gardens, as is now being practiced in the city hall, Ormoc City Central School, public market complex, and the proposed commercial-parking building (old Gaisano building).

[22] One is currently being developed in *Barangay* Naungan.
[23] Major repair involves 1) expansion of the building and building of a new space and 2) alteration of structural integrity. All existing buildings without proper permits are also considered new under this ordinance.

Cascading the city urban adaptation strategy to the *barangay* level

For a citywide strategy to be effective, it needs to be understood and operationalized at the smallest unit of planning and implementation, the *barangay*. It also entails multi-stakeholder engagement, to ensure wide public participation and ownership, leading to more implementable actions and viable public and private investments.

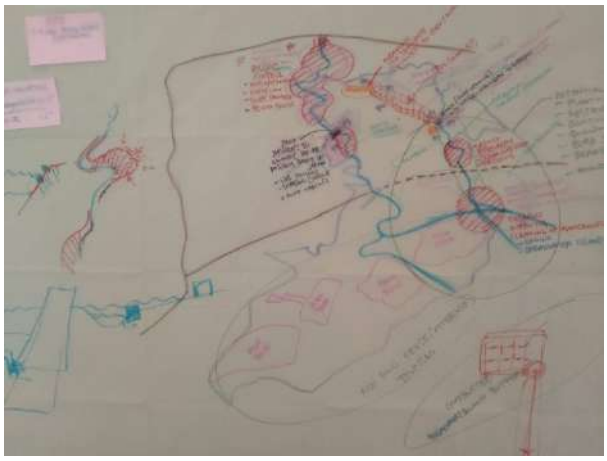
In this regard, the TWG first narrowed in on Barangay Can-adieng and the neighborhood in Lower Malbasag River. Based on CDRA results, Can-adieng was prioritized due to high flood risk. Actions at this level will therefore address flooding. Beyond this, the city also aims to address urban heat stress and storm surge that endanger fisherfolks, farmers, and urban dwellers.

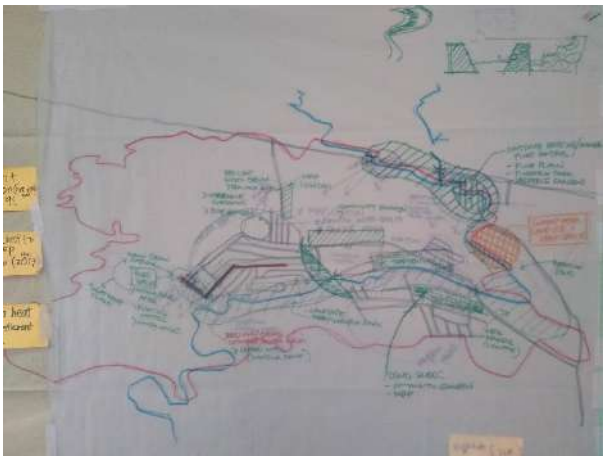
The TWG prepared design guidelines with visual interpretations and three design studies that considered social and legal conditions such as private ownership of land. Upon initial consultation with *barangay* officials, the design scheme that include small private lot ownership and ensured minimal resettlement and expropriation was selected. This option was presented to and discussed with the direct beneficiaries: the 68 informal settler families in Purok 1. The TWG, *barangay* officials, and the beneficiaries agreed that the onsite housing project will be designed with the following features: elevated dwelling units, rainwater catchment, solar roofs, and wind and sun pathways with trees. Further, the neighborhood design must also ensure rainwater catchment, network of parks, enhanced drainage and sidewalks, spaces for street-level economy, access to rivers, permeable materials, good connectivity, compliance to national laws, and limited private lot expropriation.

Extending this initiative to a larger area, the TWG also conducted design charrettes with representatives of two *barangays*: Lao and Tambulilid, which are similarly at risk to flooding. For both *barangays*, the process started with presentation and validation of CDRA results, followed by discussion issues and concerns related to climate change, and the development of the designs with the *barangay* officials. The TWG provided inputs on climate change adaptation and urban design. The semi-structured discussion allowed the free flow of ideas among the participants.

For Lao, an agricultural community, *barangay* representatives considered flood control through hard and soft approaches as the top priority, and tourism development as the lowest. In Tambulilid, a conglomeration of housing projects and considered the largest *barangay* in the region, *barangay* officials were keen in restoring natural flood plains and reclaiming waterways, especially in often-flooded riverine areas. The results of the design charrettes for both *barangays* can be considered in the project development and programming.

Facilitated by local architects of the city, urban design methods are identified in Lao and Tambulilid.





Neighborhood scale climate resilient design: The Ormoc Urban Waterscape Project

This initial work with the community in Can-adieng was further deepened and detailed, applying climate-resilient urban design methods to develop what is now the Ormoc Urban Waterscape Project.

The project site is composed of the linear park located along Lower Malbasag River, and Puroks 1, 5, and 7 in Barangay Can-adieng, a mixed-residential settlement along Ormoc Bay with population of 1,856 in 361 households. The *barangay* is in the urban center and identified as a major node of development. Sitting within 1 m to 5 m above sea level, it is a natural flood catchment area with an immediate rise in topography at the northeast section of the settlement. The current land use is residential, while Lower Malbasag Linear Park is considered an easement. Its immediate adjacency to the city proper suggests an increase in tempo of urbanization in the site.

Can-adieng is a densely inhabited settlement, with houses made both of concrete and light materials. These houses are closely built, without setbacks and sufficient ventilation. Concrete road networks surround small blocks of houses, with only a few pockets of trees. Given these built environment coupled with current and projected temperatures, Can-adieng will likely suffer from a hotter microclimate.

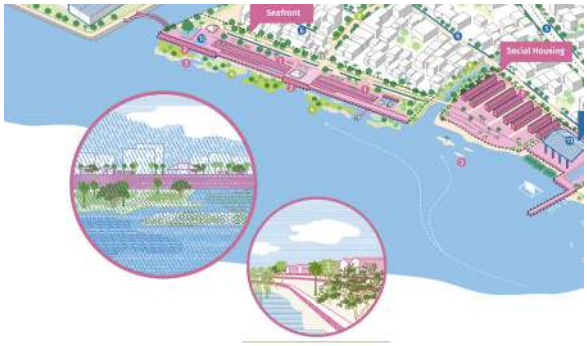
Projected increase in rainfall also places the site at high risk to flooding. In fact, the area was flooded during Super Typhoon Yolanda, resulting in the destruction of houses. Moreover, a creek in the center tends to overflow with large volumes of water coming from the upland.

The increasing frequency and intensity of typhoons also increases the risk to storm surge in the area. As it is, sea water already seeps into houses during strong typhoons; a surge event above 5 meters will leave the neighborhood devastated.

The project will directly benefit 49% of the *barangay* population, including all 68 informal settler families, 441 youth, nine persons with disabilities, and 125 senior citizens. The northwest section is a resettlement area built in the 1970s called New Society Village. Most of the lots are privately owned, while the 68 informal settler families are living in concrete houses, densely packed in a 5,940 m² piece of land that is almost entirely surrounded by water. It faces Ormoc Bay, is traversed by the creek, and bounded in the west by Malbasag River.

Lower Malbasag Linear Park measures 3 to 5 meters from the banks of Malbasag River, along a flood control project constructed from 1998 to 2001 with the assistance of Japan International Cooperation Agency.[24] Lower Malbasag River is currently filled with sediments. The project will cover at least 700 meters on both sides, from Carlos Tan Bridge down to river mouth in Can-adieng and Ormoc Plaza. The space is currently being utilized by Can-adieng residents as access road, while other sections by the general public, particularly the youth, for socialization and recreation.

[24] The disaster risk reduction project was a response to the Ormoc Flashflood in 1991 due to Typhoon Uring (international name: Thelma). The site is jointly managed by the Department of Public Works and Highways and the city government, through the Flood Mitigation Technical Committee. The committee is mandated to provide a budget for maintenance, repair, and rehabilitation of the access roads as per memorandum of understanding in 2000.



Managing water, regulating temperature, and creating co-benefits

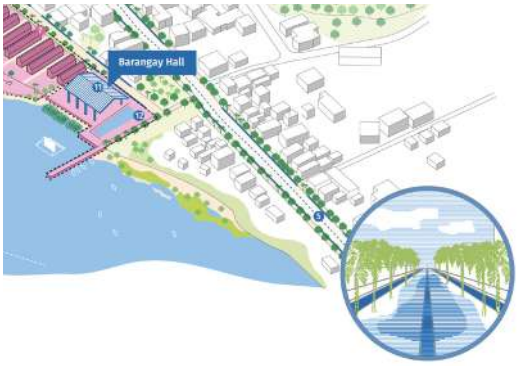
Water management is key in designing the area for climate resilience. A component of this is resistance to the surge of water during extreme weather events. The project aims to develop the coastline into "terraces" that conform to natural topography, allowing protection while ensuring minimal disturbance of the ecosystem. The combined natural, nature-based, and engineering approach entails upgrading seawalls up to 1.5 meters, while constructed wetlands and breakwaters will create as barriers to minimize or eliminate the physical impact of surges on land. These wetlands will also increase biodiversity marine life, encouraging the growth of phytoplankton, macroinvertebrates, coral reefs with sea anemone and sea urchin, and 17 species of fish.

Rainwater collection and storage will also be demonstrated in public structures and government buildings. The *barangay* hall complex will be redesigned as such, with collected water to be used for the maintenance of the building, complex and pocket parks. Doing so will decrease water demand and secure the supply of potable water for drinking and domestic use, resulting in financial savings. With baseline rainfall of 54.11 liters/m², and projected changes ranging from 51.32 liters/m² (2020) up to 55.45 liters/m² (2050), respectively, the project aims to collect about 80% of rain. Following the city-wide urban design concepts, wide roads like the Ormoc-Albuera National Highway north of Can-Adieng will be transformed to urban canals. These will store water during typhoons, after which it will be released into water bodies, allowing soil recharge. The city-managed water supply system depends on surface water level upstream of Malbasag River.

Delaying water outflow, or slowing the time water takes to before discharge, will also be used in this design project. To do this, the city will implement riverbank protection using vegetation, to preserve existing size and capacity of the river. It will also pursue riparian forest conservation upstream to avoid movement of sediments downstream.

Linear parks and rain gardens will also function to delay flood waters. Linear parks will be designed with graded surfaces and varying topography, providing pockets for water to flow into and rest. Meanwhile, rain gardens along the streets will serve as additional layers for water absorption. These gardens will be constructed with permeable materials that allow water seepage into the soil, and vegetation to hold and prevent excessive water runoff. They will be connected to the proposed water storage facilities. They will also act as filtration before water is released to the coast or river—a much needed action given that water quality in Ormoc Bay falls below the acceptable standards. [25]

[25] Due to presence of coliform.



Across these designs, natural and nature-based solutions are prominent: the use of trees, natural vegetation, and working with natural topography and forms, among other design aspects. The city seeks multiple benefits from these actions while ensuring flood management. The project will also enhance environmental health and increase GHG sinks in the city. Street and park fixtures will follow LED principles, using solar panels to lower energy demand from fossil fuels, and promoting sustainable building materials such as blended cement. The design itself enhances the connection of road networks, increasing walkability and accessibility. The parks and other open spaces that can also be designed as rentable spaces for vendors, guaranteeing that urban design supports and benefits the community itself, particularly the informal economy that is characteristic of the affected neighborhood.

Designing houses, sustaining adaptive capacity, and ensuring housing for all

The project will pursue onsite housing redevelopment that complements the community-level design. More than just designing houses that resist, store, and delay water to manage flood risk, the project will pursue the development of inclusive, adequate housing. Combined, these aspects of housing act as a measure of the people's increased capacity to adapt to climate change impacts.

The housing design complies with the minimum requirements for row houses under the socialized housing scheme of Batas Pambansa Blg. 220 or BP 220. Each shell housing unit will have a floor area of 24

m², with 16 m² mezzanine area, standing on an individual lot area of 30 m². The houses will be elevated by at least 1.1 meters. This elevation allows the flow of water, and transferred to gravel absorption beds. It also provides additional air circulation. The provision of windows on front and back walls allows air circulation inside the house and source of light.

The walkways are designed with permeable materials connected to bioswales. Each house will have rainwater storage connected to a clustered cistern. Water will flow further into clustered sewage treatment plants, then to natural reed beds, before it reaches the creek. The clustered cisterns are also connected to the bioswales.

Each unit is designed with plot and trellis planned for urban vegetable gardening. The rows of the houses are positioned perpendicular to the coast, allowing water to drain and wind to pass through. Structures follow the shape of the coastline, tree-lined and in a terraced form to allow access to the sea. The road network will be rationalized, more clearly defining housing blocks and improving urban grain.

The Ormoc Urban Waterscape Project is a testament to the city's commitment to community-driven, climate-resilient urban design that is based on sound analysis and a coherent city adaptation strategy. It responds to several climate change impacts specifically affecting the community, including flooding, storm surge, and urban heat stress. It also acts as an anchor to wider climate change action across Ormoc City, influencing approaches to climate change adaptation and overall urban development.

THRIVING–AND NOT MERELY SURVIVING–IN THE FACE OF CLIMATE CHANGE

The city recognizes that urban design must not only address the structural or technological gaps in managing climate impacts, but above all put people at the center of development.

Apply the increased capacities of the LGU

The TWG's experience in CDRA and GHG inventory equipped them with the knowledge and skills to formulate a well-informed, in-depth climate change action plan. Moving forward, this enhanced capacity can be used for further planning and project development. The LGU, through its Environment and Natural Resources Division, will continue updating its GHG inventory. Meanwhile, the City Planning and Development Office (CPDO), together with the CDRRMO will continue to engage the city's *barangays* in updating the CDRA.
Climate action planning will be further institutionalized through a proposed local ordinance establishing the Climate Change Action Council. The proposed council will manage climate data monitoring and assessment, identify current and future impacts, and implement and monitor the LCCAP. The creation of a permanent body for climate action reaffirms Ormoc City's strong commitment to achieving climate resilience.

This commitment resonates not only in one of two offices, but the whole LGU. For example, the Office of the Building Official, the CPDO, CDRRMO, and other executive office will sustain and transfer their technical understanding of climate-resilient urban plans and designs by developing technical guidelines, training programs, and establishing institutional linkages, all to ensure that climate change knowledge and approaches are up to date and relevant. The local legislative council, as the body that provides policy impetus and support, will continue to review and improve city legislation such as the local building code and zoning ordinance. These and other initiatives, along with positive collaborations with the city's partners, will help preserve the city's position as a leader in local climate change action and resilience-building.

Implement the action plan with realistic financing options

The entire process of enhancing the LCCAP and developing climate-resilient urban plans and designs has highlighted the importance of funding, and the need to come up with a realistic and appropriate budget for implementation. The city's training on pre-feasibility studies and experience in investor engagement has given Ormoc an edge in tapping local and international climate financing windows. The city has also learned the value of innovative partnership strategies including with national government agencies, such as the DPWH for the implementation of linear parks and roads and NHA for housing design. Beyond this, consistent monitoring, reporting, and validation will ensure that the policies, programs, projects, activities are moving. Project reports should be accessible, available, and transparent to the public.

Enhance the urban adaptation strategy

Climate change is characterized by dynamism and variability, and its impacts are felt at ever intensifying degrees. These conditions necessitate the constant monitoring and enhancement of the city's newly formed urban adaptation strategy, so that it remains responsive to climate change issues. The LGU will invest in regular monitoring, reporting, and verification of the strategy's contents and resulting projects, ensuring that they are robust and flexible.

Replicate and scale up design through policy

The Can-adieng urban design project has been conceived with scaling up in mind. Notwithstanding the different contexts across the city's urban fabric, the principles and general strategies employed in Can-adieng can be replicated in other areas, and towards an integrated citywide resilient urban design. Doing so will not only help achieve the city's climate objectives, but also close gaps in housing and poverty. Developing resilient settlements will positively impact 3,147 informal settler families, by improving their housing conditions with minimal movement, and increasing their adaptive capacity. Providing secure tenure and safety allows families to achieve their housing goals, invest their resources to other priorities, and alleviate their socioeconomic situation. This will benefit 24,319 families that are currently under the poverty threshold. [26]

Finally, the design approaches used in Can-adieng can be fully integrated into the Comprehensive Land Use and Zoning Ordinance and the Local Shelter Plan. This assures the continuity and sustainability of climate resilient urban design.

[26] Community-based Monitoring System, 2015.

Put people at the center of urban design

The TWG learned that urban design projects must not only solve flood or urban heat, but must ultimately benefit the people, the environment, and the economy.

The city's experience with Can-adieng highlights the role of housing and public spaces in addressing climate risks. This was evident in the integration of livelihood and local economic considerations in the urban adaptation strategy, and manifesting these in urban design as street-level spaces for commerce and community activities. Likewise, the interplay of the natural and built environment and its related human activities is a defining factor in climate resilience. This was also manifested in the urban design process and output, which involved preserving the biodiversity of Ormoc Bay while supporting necessary human activity in the area.

All these taken together, it is clear to Ormoc City that people are not only beneficiaries of climate action, but also active contributors to building climate resilience. The city's next steps will involve the continuous pursuit to uplift the people of Ormoc—from marginalized communities to those managing the planning and design process—ensuring that the collective efforts of the people contribute to climate resilience and genuine sustainable urban development.

TAGUMPAY CITYWALK

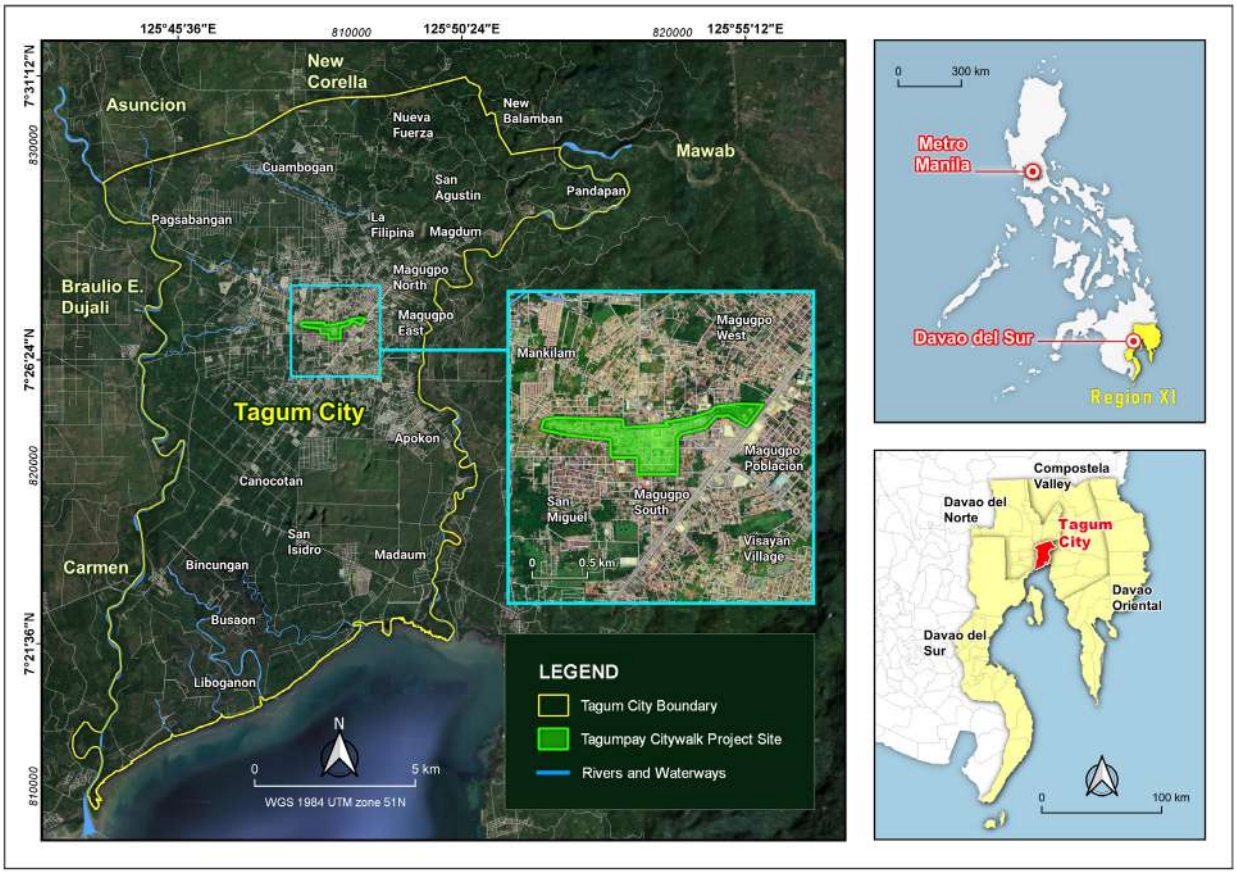
INCREASING THE CLIMATE RESILIENCE OF TAGUM CITY

ABOUT TAGUM CITY

Dubbed as the "booming future city" of Davao Region in Mindanao, Tagum City lies between two major rivers—Hijo River in the west and Tagum-Liboganon River in the east. These river systems serve as primary channels of runoff water from upland areas and to the city, both draining into Davao Gulf that bounds Tagum in the south. 90 percent of its 195.8 square kilometers (km²) total land area has a generally flat topography, with some rolling portions in the northern section.

Of the city's 23 *barangays*, nine are classified as urban and 14 are rural. The total population of the city as of 2015 was 259,444[1], 66.19% of whom are part of the work force and contributing to diverse socio-civic and economic activities. The rest of the population, mainly children and elderly, are considered dependent and vulnerable. Influenced by high internal migration over the past decade, Tagum's growth rate is 1.27%, driving the continuous population increase.

Figure 1: Map of Tagum City



[1] Philippine Statistics Authority, 2015.

While Tagum is the third smallest city in terms of land area in Davao del Norte, it remains an ideal hub for regional trade, commerce, and government services due to its strategic location. Initally developing along the banks of Hijo River, Tagum's settlers at the turn of the century transferred to Magugpo, a river basin that has now transformed into the city urban core. From this location, the city developed into a center of exchange among different cities and municipalities. The city is now tagged as the sub-regional center by the Regional Development Council, Region XI (DRPFP, 2015-2045)[2]. Tagum is also recognized as the center for regional commerce, finance and trade, and public and private services.

Tagum City aims to continue on this development path, boosted by its diverse and robust economic activities, largely from the agricultural and commercial sectors. Sixty percent of the city's total area is allocated to agricultural production and produces at least 117,754.34 metric tons of crops[3] per year. Tagum is home to one of the biggest banana plantations in the country, supplying local and export markets, and providing a daily income of PhP 335 for farming households.

The city is also known for its flourishing business and commercial industry. Forty nine percent (3,928) of businesses in the city are engaged in wholesale and retail activities. The availability of economic opportunities also draws more people to the city and especially in urban areas, influencing real estate and translating to a 12.33% share of the renting and boarding in real estate establishments.

Tagum also openly hosts its informal economy, made up of an estimated 5,000 ambulant vendors and food kiosks in high density areas like the Old City Hall, Rotary Park, and streets near schools. This economic activity is supported by the city, which has designated public spaces for their trade activities.

These social and economic activities add vibrancy to the city's built environment, especially its commercial districts, open spaces, residential and institutional areas. Open spaces and residential use comprise 11% and 10% of land use, respectively.[4] Tagum City has a population density of 1,325 per km², higher than the national average of 337 per km² for the same year.[5] Its urban *barangays* are are considered resource-intensive areas, with higher demand for utilities such as energy, water, and sanitation, putting pressure on critical point facilities and the urban ecosystem in general. In 2016, only 75.63%of households had water supply and 87.26% had access to electricity. Magugpo Poblacion, the city central business district (CBD), is highly congested during the day and in the afternoon. Due to the increasing demand for land development in the CBD's limited space, the city has identified *Barangays* Madaum, Mankilam Canocotan, and La Filipina for urban expansion and development.

Urban mobility currently depends on tricycles and single motorcycles, which also provide daily income for drivers. Few buses, jeepneys, and mini cabs enter or cross the city's borders. Nonetheless, growth and expansion will heighten the demand for services and resources such as transportation, along with electricity, water, and food supply. It also strengthens the case for big ticket infrastructure projects such as the Mindanao Railway and convergence roads.

Urban development has brought immense benefit to the city. However, it has also highlighted significant challenges. The increasing demand for residential and commercial spaces has resulted in land conversion of agricultural and open spaces. This has limited the availability of green and open spaces in the city, which now comprise only 10% of total land area, compouding the effects of increasing temperature in an urban setting that is progressively becoming more concrete. Constant demand for space has also led to building practices that sometimes ignored environmental aspects of design and construction, leading to buildings that block natural wind paths and contribute to urban heat.

With constraints in the capacity of the local government unit (LGU), past approaches to city development have also somehow overlooked its natural endowments such as streams, waterways, mangroves, and forests. For instance, covering creeks ostensibly protected them and expanded public space. However, because of this, waterways were spontaneously converted into sewer ways that lacked proper waste management and could result in pluvial flooding.

Despite the rapid development of businesses and commercial establishments, the city remains predominantly agricultural, with farmers and fisherfolk depending on the sector for their livelihood and survival. With agriculture-dependent *barangays*[6] situated along the two major rivers and already prone to flooding, risks related to excessive rainfall have become an increasing concern. On top of this, drought has also been a recurring phenomenon, drying out crops and irrigation, and increasing the occurrence of pests and diseases.

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[2] Also identified in the Mindanao Spatial Development Framework; sub-regional center means secondary urban growth and trade center.
[3] Coconut, rice, corn, durian, mango, cacao, and banana.
[4] Agriculture, open space and residential form the majority of the land use, occupying 61%, 11%, and 10%, respectively.
[5] See https://psa.gov.ph/content/philippine-population-density-based-2015-census-population.
[6] Libuganon, Bincungan, Busaon, and Pagsabangan.

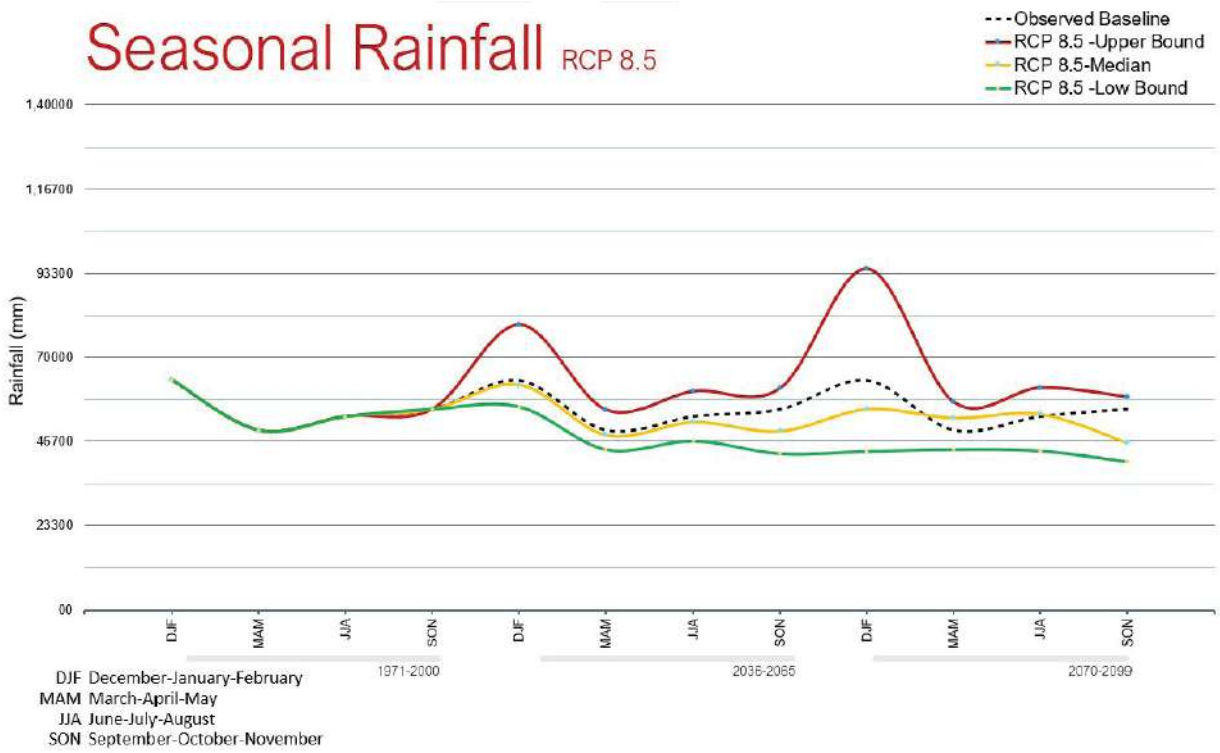
TAGUM CITY IN THE FACE OF CLIMATE CHANGE

Flooding and urban heat stress are just some impacts that pose risks to Tagum and its people. As the city strives to remain as an economic driver in the region, it must be able to address climate change, namely increasing rainfall and temperature, which will inevitably affect its economy and communities.

Based on the Representative Concentration Pathways (RCP) 8.5[7] used in the 5th Assessment Report adopted by the Intergovernmental Panel on Climate Change of the United Nations Framework Convention on Climate Change (UNFCCC), Tagum City is projected to experience varied changes in ranfall over the coming years. There will be a slight increase in rainfall during amihan season in 2020 which can result in intensified flooding. However, by 2050 the amount of rain projected may be less compared to 2020. Although there will be a slight increase on the amount of rain projected during March-April-May (MAM) season, which is 485 millimeter (mm), this is still observed to be lesser than the June-July-August (JJA) season projection which is 520.8 mm.[8]

Aside from the changes in rainfall, the frequency and intensity of the typhoons and even monsoons are also projected to happen.

Figure 2: Seasonal Rainfall Projections for Tagum City



Source:Philippine Atmospheric, Geophysical and Astronomical Services Administration.

[7] Representative Concentration Pathways (RCPs)
Scenarios that include time series of emissons and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover (Moss et al., 2008). "Representative" signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasises that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome (Moss et al., 2010). RCP8.5: One high pathway for which radiative forcing reaches greater than 8.5 W m-2 by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250).

[8] Tagum City Local Climate Change Adaptation Plan.

The city is already facing perennial flooding given its topography and river system. Water run-off from the rivers and streams makes the city susceptible to flooding, while *barangays* in elevated areas are prone to rain-induced landslides. In November 2017, Typhoon Tembin (international name: Vinta) incurred PhP 1.175 million worth of damages to the city's infrastructure. It also triggered flashfloods, affecting 6,260 families and their settlements. In 2012, Typhoon Pablo (international name: Bopha) gravely affected the city. The entire province lost about PhP 4 billion worth of crops to the strongest typhoon that ever hit Mindanao. A year after, Typhoon Zoraida (international name: Podul) also hit the city. Residents of 11 *barangays* in Tagum had to the endure waist-deep flood water.

With climate change, flooding is likely to increase and intensify. The effects would be devastating to the city as a whole, but particularly to the most vulnerable. At present, 13,993 households live below the poverty threshold, and least 2,434 households live in informal settlements. 1,603 of these informal settler families (ISFs) are in urban poor communities, some along the creek or living in makeshift houses made of light materials, which can be easily damaged by strong winds. Access to potable water and sanitation are also compromised during intense rainfall events. Such unfavorable living conditions push these communities to greater risk.

Also potentially affected are 35,775 individuals identified as young and old dependents. This dependent population is naturally vulnerable, with limited mobility during emergency situations as well as various health conditions. Flood events pose risks not only to their immediate safety but to health, especially children who may be exposed to diarrhea, skin diseases and dengue, as what happened in some *barangays* in the past.

The number of people to be potentially affected by climate change impacts will grow as Tagum City continues to urbanize. Just as urban centers have become platforms of socioeconomic opportunity, they can easily transform into centers of risk. At present, about 1,984 hectares of built area in the city's urban *barangays* are exposed to flood hazard. The largest exposed areas are the residential, tourism, institutional, commercial, and open spaces in Brangays Apokon, Madaum, Magugpo East, Magugpo North, Magugpo South, Magugpo Poblacion, Visayan Village, and Mankilam. These same *barangays* are identified as CBDs and growth nodes. The replacement cost of the structures and buildings alone in these areas is almost PhP31 Billion. There are at least 10,000 businesses exposed to rain-induced hazards. Aggravated by poor urban infrastructure, increased rain will limit access to basic services and economic activity, and consequently lead to loss the people's income.

In total, 176,855 individuals are directly exposed to flooding, with 111,027 or the overwhelming majority of them are in urban *barangays*.

Projected rainfall increase affects not only economic activities in urban areas. Agricultural production, trade and commerce are also expected to suffer. In fact, agriculture is one of the most affected sectors since crops are sensitive to climate, water availability, and soil conditions. The sector currently employs 39,579 families.

Strong and continuous rainfall can also soften grounds in highly elevated areas. Highland *barangays* susceptible to rain-induced landslides could face potential damages in coconut plantation and production. This is even more worrisome as only 3% of the production areas are covered by post-disaster economic protection in the form of crop insurance.

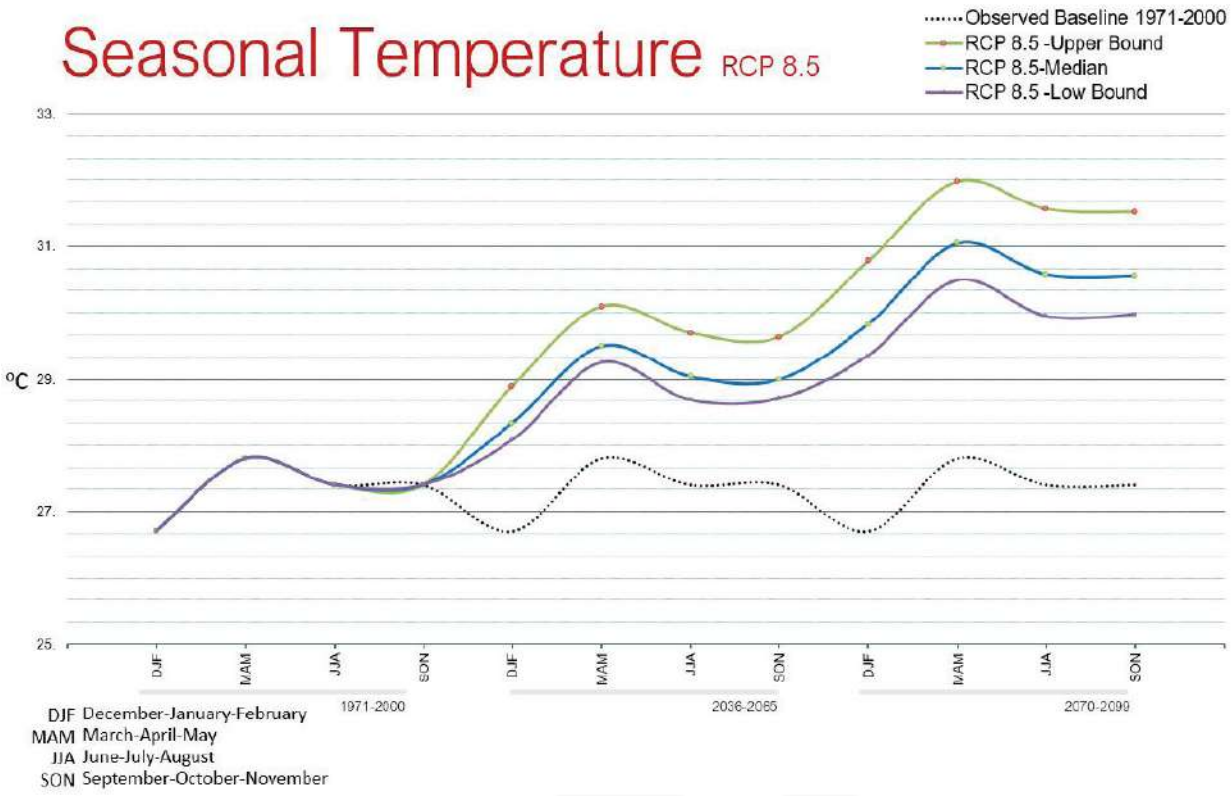
Besides changing rainfall patterns, the city is also experiencing and will continue to face increasing temperature. By 2036-2065, temperature increase will range from 1.4°C to 2.3°C. The projected average annual temperature will range from 27.8°C to 30.1°C across seasons. The data below shows high increase of temperature in 2036 to 2065; there will be 1.6°C warming in DJF season, 1.1°C warming in MAM, 1.9°C warming in JJA season and 2.3°C in SON season.[9]

The projected increase will directly impact urban *barangays*. Urban heat stress is already prevalent in these high density areas, where structures have been built with heat-absorptive concrete, and less than 15% of the areas have tree cover.

Urban heat stress will put 17,834 ambulant and street vendors at risk since they are more exposed to concrete roads, buildings, and vehicular traffic. Prolonged exposure to heat may also cause health problems such as stroke, respiratory ailments, exhaustion, and heat cramps, affecting not only urban dwellers and workers but also farmers.

[9] Tagum City Local Climate Action Plan.

Figure 2: Seasonal Temperature Projection for Tagum City



Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration.

Tagum's largely agricultural character is also threatened by the risk of drought. Based on the CDRA, four of the city's rural *barangays* are highly vulnerable to drought given the sensitivity of its crops and and the absence of crop insurance.

Based on past experiences of banana farmers, high temperature can bring in pests and crop diseases, impacting production yield and prices. inadequate irrigation facilities also worsen the conditions especially during the dry season.

TAGUM'S PURSUIT TO BUILD RESILIENCE THROUGH URBAN PLANS AND DESIGN

Prompted by these existing and projected climate change impacts, Tagum City has embarked on its pursuit of climate resilience with the help of the Department of Human Settlements and Urban Development and United Nations-Human Settlements Proramme (UN-Habitat) through the Building Climate Resiliency Through Urban Plans and Designs.

Knowing Where To Begin

Through the years, the City Government of Tagum has initiated environment-related projects such as street landscaping and park maintenance, including the city's "Grand Palm Entrance" and its enormous parks. Solid waste management is also a priority; all *barangays* are equipped with waste recovery facilities. The city also has engaged in the propagation of coral and mangroves.

However, the city soon realized that much more could be accomplished if climate change resilience is considered at the onset. Traditional planning and action are not enough and could even lead to disaster, for instance in *barangays* that are identified as growth nodes. Investing in climate-resilient plans and designs can offer alternative solutions that are efficient as much as they are effective in addressing risk and preventing climate-related disasters.

A Capacity Needs Assessment (CNA) was conducted to understand how climate change can be integrated into the planning process and local culture. The CNA helped the city government, particularly the Technical Working Group (TWG), identify the skills and knowledge needed to be able to incorporate climate-resilient methods in the local planning. This is crucial as city planners, engineers, architects, agriculturists, and other relevant technical staff should recognize their competencies and identify areas where they need to improve on, particularly in the context of climate change and urban planning and design.

While the TWG members have had trainings on Climate and Disaster Risk Assessment (CDRA),

Enhanced Comprehensive Land Use Plan (CLUP), and Comprehensive Development Plan, they admit to having insufficient knowledge of climate change and how to mainstream it into planning and design. The assessment also revealed that a lack of knowledge in climate finance and greenhouse gas inventory.

After the CNA, the TWG underwent capacity building activities that helped them understand climate science vis-à-vis development planning. This includes updating the risk framework to be used in the CDRA, matching climate change impacts with city development trends, and as a result enhancing the Local Climate Change Action Plan (LCCAP) to introduce climate resilient urban strategies and actions.

Enhancing the LCCAP

The LCCAP updating process began with a review of the city's existing CDRA and LCCAP. Done in 2017, the CDRA was initially intended for the enhanced CLUP but due to timing, was used for the LCCAP instead. During this time, the city was unable to validate the CDRA results and only managed to partly integrate them into the LCCAP.

The LCCAP and CDRA review under BCRUPD was a crucial step that helped the TWG to further understand how the CDRA is used in analysis and identification of local climate actions as well as in differentiating climate change and disaster risk activities. It also highlghted the value of the LCCAP as a derivative plan of the CLUP and CDP, and as a tool for more focused strategies towards climate resilience.

The TWG then worked to update the CDRA and the LCCAP, which gave them a better understanding of how climate change affects different ecosystems. This was clearly shown in the impact chain analysis, which explained the links between climate drivers like rainfall and temperature, and varying degrees of impact on the environment, people, and activities. The TWG was also able to contextualize climate change by associating it with the city's experiences with typhoon, drought, and rain-induced landslide. Equally significant was the realization that climate change not only presents risks, but also opportunities. This shift in perspective allowed the city to view rainfall and temperature as potential resource, such as water to be harvested for additional supply, as well as a driver for sustainable urban development.

Mentoring sessions with the Department of Human Settlements and Urban Development[10] (DHSUD) together with the UN-Habitat gave the TWG a better understanding of climate change risk and its elements. What used to be unusual jargon became common language, which the TWG used to navigate the path of climate action.

Another enhancement done for the LCCAP was to match the city's urban growth trends and development pattern with climate change projections. It enabled the city to look at possible futures through a climate change lens, and comprehend its impacts not as a static feature but progressing throughout the city's development. Operationally, it also allowed them to better match the 10-year LCCAP with the long-term vision of the city.

The BCRUPD Project also helped the city understand the role that ecosystems played in determining and managing climate-related risks. For instance, a closer assessment of the city's production and urban ecosystems provided clarity in how to manage urbanization: by prioritizing the city's blue-green network, ensuring that waterways, protected areas and agricultural areas are considered in planning and developing the built environment. Weaving these interconnected systems in a more rational manner promotes adaptation while assuring sustainable production that benefits the whole city.
The enhanced analysis thus gave a fuller picture of the city's experience with climate change and a deeper appreciation of the CDRA. This in turn guided the review of the CLUP. Updating both the CDRA and LCCAP was instrumental in improving the CLUP's goals and objectives, ensuring that they are aligned with climate change principles and informed by proper analysis. The strategic goals and objectives in the LCCAP were also later translated into specific projects, which were then incorporated into the city's spatial and sectoral plans.

In the following months, the city undertook its Community-Based Monitoring System (CBMS)[11]. The results of the CBMS validated and in some cases provided more nuance to the CDRA findings. It was also timely that the BCRUPD team introduced the CDRA Dashboard, a tool to help interpret and analyze climate and disaster risk data. The dashboard helped the TWG to develop a scale-specific assessment of

[10] Then Housing and Land Use Regulatory Board (HLURB).
[11] Developed by the Department of Interior and Loal Government, the CBMS is an organized process of data collection and processing at the local level and of integration of data in local planning, program implementation and impact monitoring. It is a system that promotes evidence-based policy-making and program implementation while empowering communities to participate in the process.

population, critical points and land use affected by climate change and to better determine risk levels. It facilitated informed decision-making and more appropriate, evidence-based, and measurable climate actions.

With these inputs, the city finalized the LCCAP with enhanced Strategic Goals and Objectives, and Programs, Projects, and Activities (PPAs). In identifying the PPAs, the TWG immediately saw the importance of open spaces in the city. This prompted the Local Chief Executive to allocate budget for upgrading of the city's streets and parks, aligned with the LCCAP's strategic objectives. The enhanced LCCAP also surfaced the need to prioritize the central business district and other urban *barangays* at risk, as they are the crucial drivers of economic and settlement growth.

This deepened understanding of the interface of climate change action and spatial development guided the TWG through the next step: the development of their City Adaptation Strategy.

City Adaptation Strategy Formulation

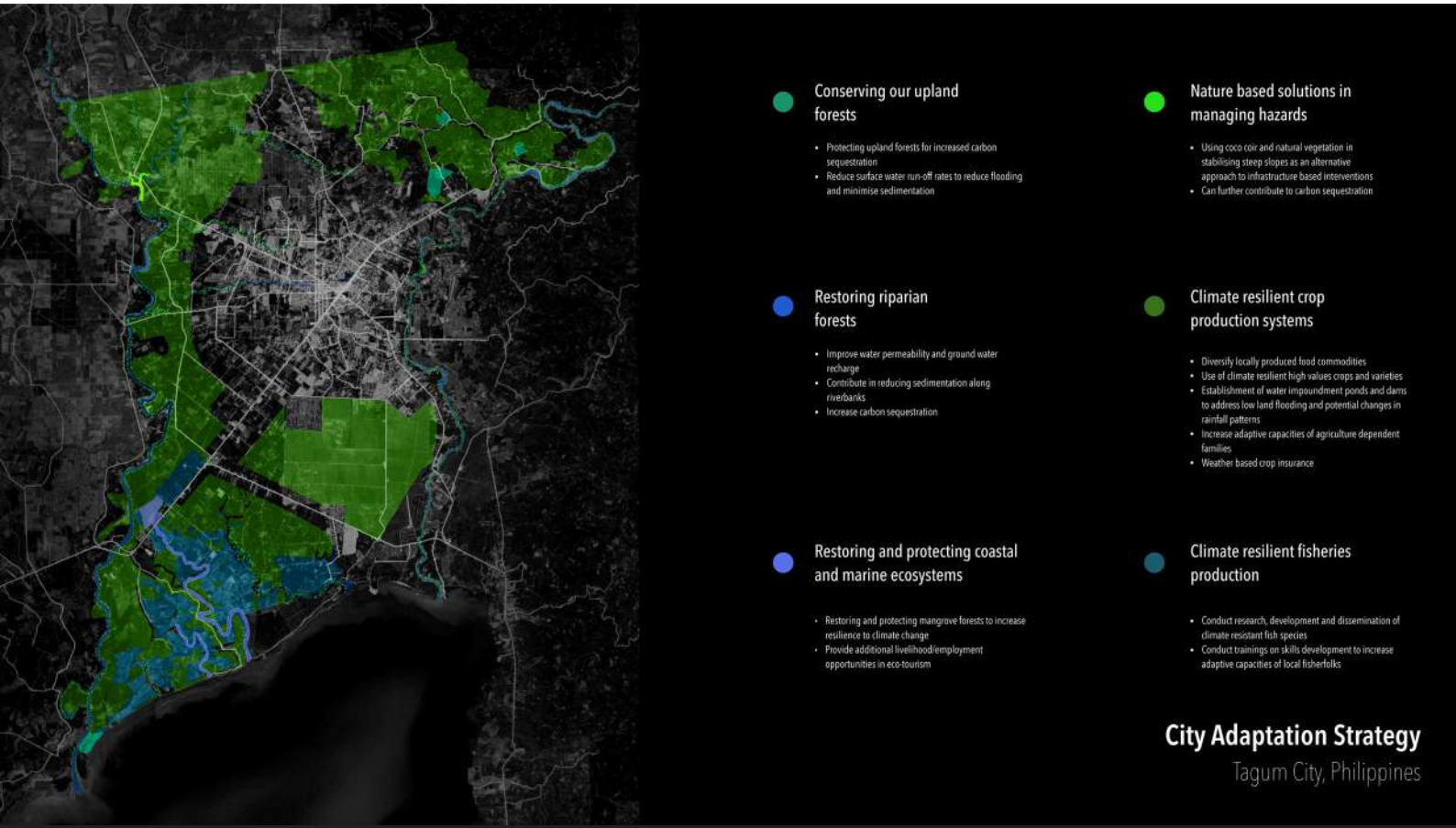
The Tagum City Adaptation Strategy lays down the city's climate change goals and strategies in a spatial dimension. Introduced by the BCRUPD Project, the strategy presents responses to climate change risks across ecosystems as well as land and water uses while considering the socioeconomic activities within these spaces. The Tagum City Adaptation Strategy aims to achieve:

- resilience and stability of natural and built environment though ecosystem-based approaches;
- green, climate resilient, and inclusive economy;
- sustainable and climate-resilient natural resource production;
- climate-adaptive and low-emission built environment; and
- climate-resilient and self-reliant communities.

The city adaptation strategy specifically addresses risks related to increased rainfall and temperature, such as prolonged and extreme flooding, urban heat stress, and drought.

To address the potential impacts of increased and more intense rainfall, the city focused on its blue and green networks, identifying and protecting waterways that support irrigation for the agricultural use, and forests and watersheds for groundwater recharge and supply. The strategy incorporates nature-based design solutions that absorb, retain, recycle, and convey water, in order to curb flooding and

Figure 4 and 5: An Overview of the Tagum City Adaptation Strategy



Source: City Government of Tagum.

develop these areas sustainably. Meanwhile, to address the impacts of increasing temperature, the city sought to transform urban design by incorporating climate resilience principles and methodologies. Increasing tree cover along streetscapes, expansion of green and open spaces, use of natural ventilation and sunlight in buildings are just some of the ways to tackle urban heat stress.

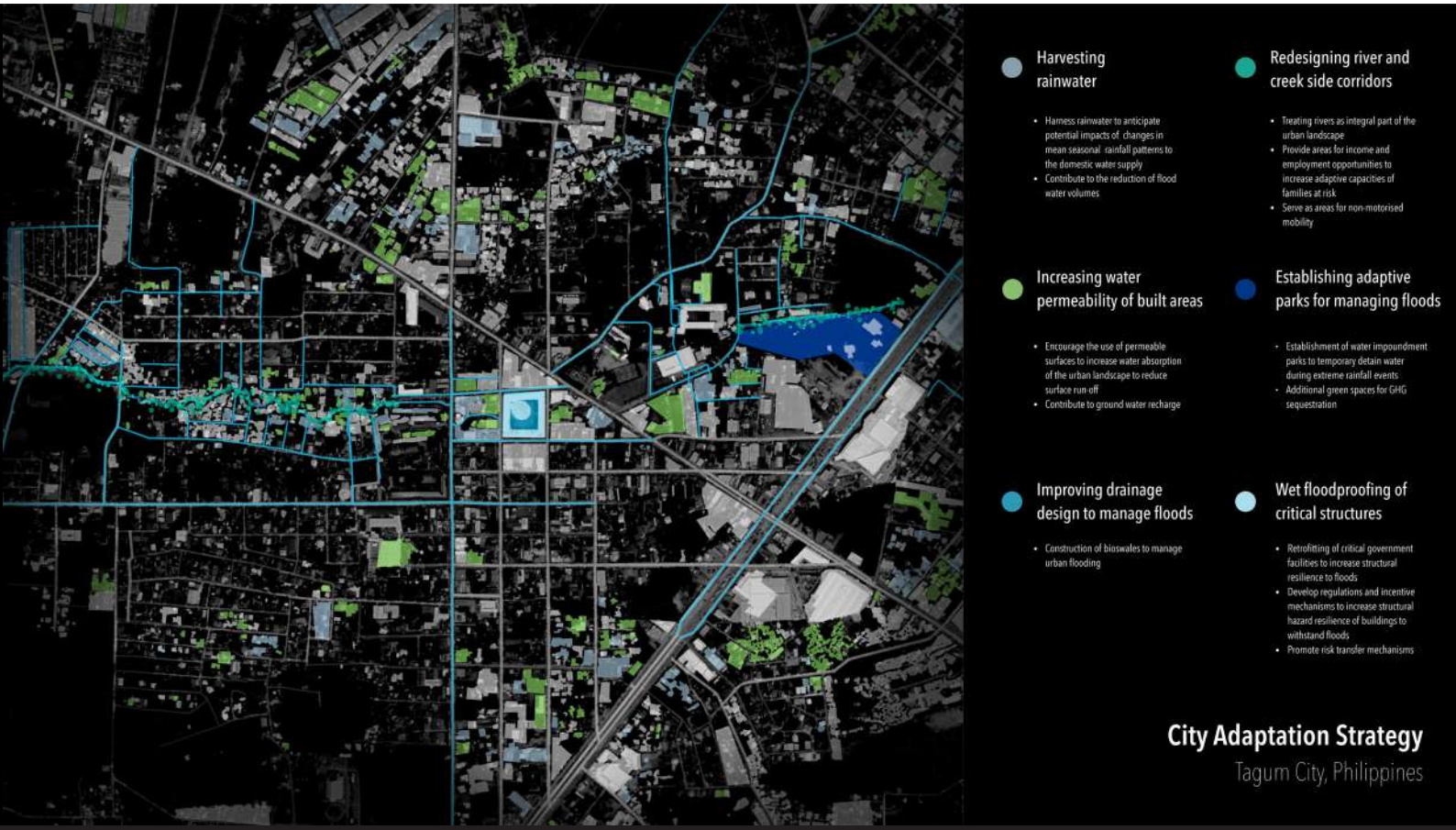
The strategy also aims to increase the community's capacity for climate change adaptation. The city's urban fabric is tightly formed by the people who use open spaces, public facilities, and street networks. The strategy will therefore pursue the design and provision of resource-efficient and climate-adaptive facilities, such as kiosks and vending stops for ambulant vendors and small and medium enterprices. This will ensure people's safety from the effects of heat and humidity, and promote more sustainable socioeconomic activities.

Policy Framework and Design Guidelines

For the adaptation strategy to be successfully implemented, the city needs a coherent, consistent, and climate-sensitive policies to facilitate, support, and promote climate action. The city, assisted by the BCRUPD team, developed this policy framework by thoroughly reviewing and enhancing existing legislation and policies with climate change as consideration.

The TWG mapped out existing and pending local ordinances and resolutions related to climate change and urban plans and designs, identifying those that would provide legal bases and entry points for the PPAs enumerated in the LCCAP. While existing relevant ordinances were identified, such as those for streets and park maintenance, landscaping, and schools' vegetable gardens, the TWG noted that the city lacked local legislation that directly supports climate change adaptation and mitigation. The CLUP's Zoning Ordinance also revealed that a number of ordinances demonstrating urban design that were not followed or effectively implemented. The Zoning Ordinance then became a vital entry point for urban design and climate change action. The TWG also considered updating the city's localized building code, specifically the use of open spaces, renewable energy, and rights of way, and is also looking into providing incentives to businesses that will implement climate-smart practices.

After developing the policy framework, the city crafted its climate-resilient urban design guidelines. These policy-based technical guidelines focused on design elements that need to be promoted, and design actions to



be avoided. It covers a wide array of design contexts, including commercial establishments, residential areas, public and government centers, open spaces and streets, among others. Practical applications are included, such as advice on natural lighting, location and orientation of buildings, maximizing wind direction and sun path, building heights, and other guidelines.

The policy framework and design guidelines proved useful both in conceptualizing designs and assessing existing projects and proposals of the city. For example, a planned train station by the national government may need to be re-examined because *Barangay* San Miguel, where the project site is, has been found to be at risk to flooding. Enhanced designs that incorporate rainwater and surface runoff now need to be discussed to improve the project.

Meanwhile, addressing heat stress and flooding would require designs that integrate green spaces and waterways, with the latter to be considered as a natural cooling and rehabilitated so as not to block water flow. Riverbanks and easements must also be considered as buffer zones and enhanced flood protection. Public spaces and non-motorized transport should be considered as well.

Considering the socioeconomic profile and vulnerability of Tagum, the local government is also looking into policies on risk transfers and risk communication.

Urban Design Pilot: Tagumpay Citywalk

With the adaptation strategy, policy framework, and design guidelines in place, the TWG identified priority areas for the pilot implementation of climate-resilient urban design. Through a multi-criteria analysis coupled with onsite assessments, *Barangays* Magugpo Poblacion and Magugpo South were chosen. Being the center of Tagum's socioeconomic activities, these *barangays* are also pivotal in determning the overall success of the city adaptation strategy. The impact is not lost on the city: the project will stand to benefit 739 informal settler families; 3,278 ambulant vendors; 1,823 children; 113 persons with disabilities; and 1,034 senior citizens residing within the citywalk alone.

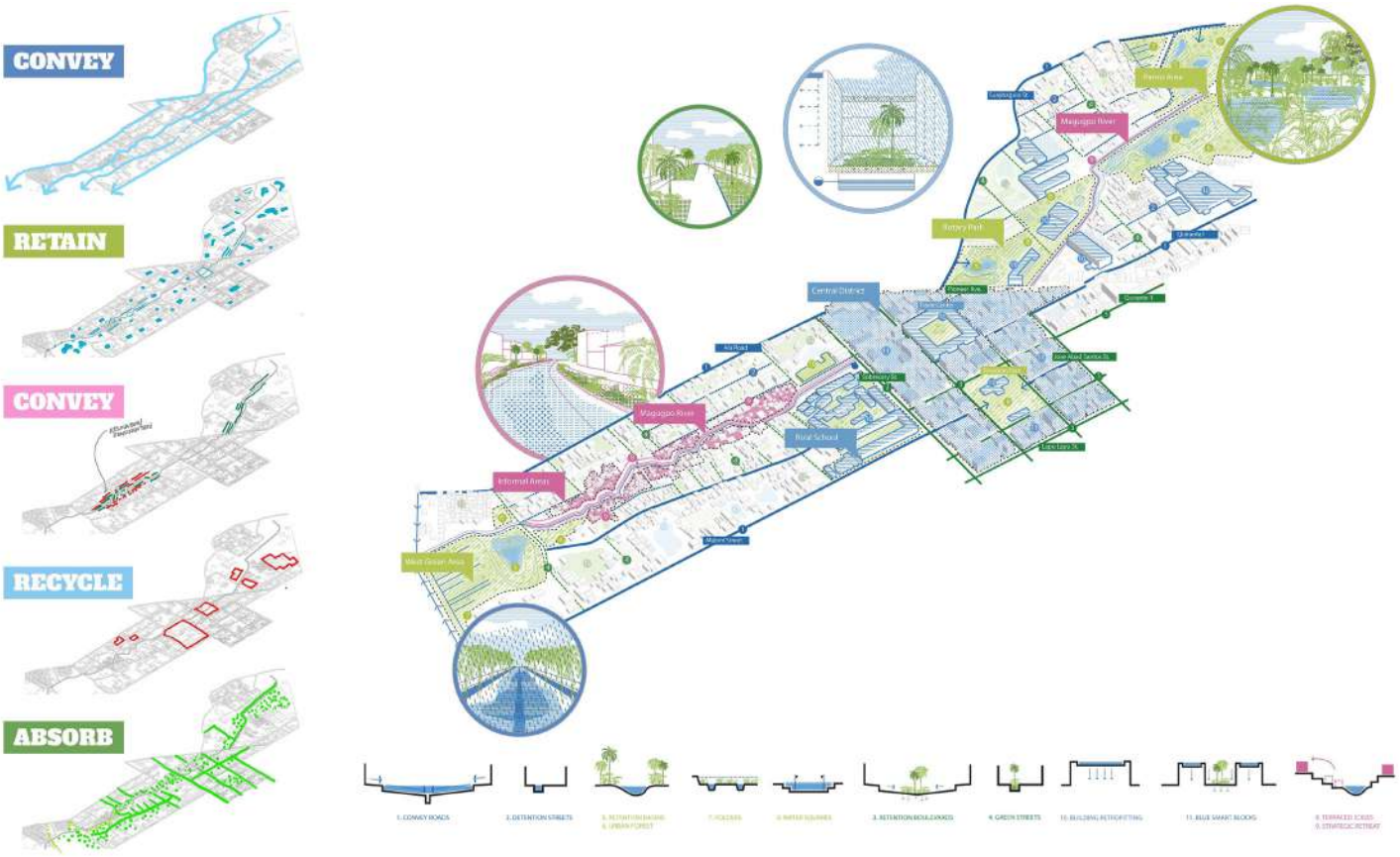
Guided by an urban ecosystems-based approach and strong stakeholder participation, Tagumpay Citywalk integrates several adaptation measures to address the projected impacts of flooding and increasing temperature in the city's built-up area. The main objective of the project is to introduce holistic and integrated urban design solutions to enable the vulnerable communities and businesses to be climate-resilient and sustainable.

The project will include the following interventions:

- Reviving of Garciaville Park as buffer zone, functional open space, access way and temporary critical facility during disasters
- Upgrading of informal settlements to a Magupo Creek Resilient Housing using climate-resilient materials and adding spaces for socioeconomic activities
- Upgrading of the Magugpo Creek as a tree-lined park to help reduce flooding risk and activate natural cooling
- Construction of urban agriculture gardens, a sewerage treatment facility and aquifer recharge wells in the vicinity of Rizal Elementary School
- Re-development of the Central Business District (CBD) and Trade Center with green roof and urban garden, permeable grounds, shading devices, rainwater harvesting facilities, and pedestrianized streets for active mobility and inclusive green economy
- Rehabilitation of the existing Rotary Park into a shaded, vegetated, and cooler socio-civic and recreational park
- Development of the PENRO Area into a natural water retention/aquifer recharge basin and urban forest park
- Opening up sections of the creek diverted to box culverts where possible
- Developing a bikeway by interconnecting both sides of the entire stretch of the waterway with tree-lined linear parks

The design process involved consultations and discussions with concerned stakeholders, especially with informal settlers in the area. The TWG, with inputs from the BCRUPD project, also considered environmental and social safeguards, which helped the city come up with a more inclusive approach in designing projects.

Figure 2: Tagumpay Citywalk Axonometry



Source: City Government of Tagum

THRIVING—AND NOT MERELY SURVIVING—IN THE FACE OF CLIMATE CHANGE

The capacity-building process under the BCRUPD project has resulted in meaningful lessons for the City of Tagum.

Reaching a working understanding of climate science was a turning point for the city. Through the TWG members' increased awareness on climate science, the city government was able to come up with risk-informed and evidence-based inputs needed for their planning and action. The added technical knowledge on climate change projections also informed the city's LCCAP and development strategies that could be translated into climate-sensitive policies and projects. The members of the TWG have become champions of resilience in the city as shown on they have extended beyond the LCCAP. The TWG members have understood the importance of considering climate change scenarios in other local plans such as the Local Shelter Plan and Local Transportation Plan, and other city intitiatives.

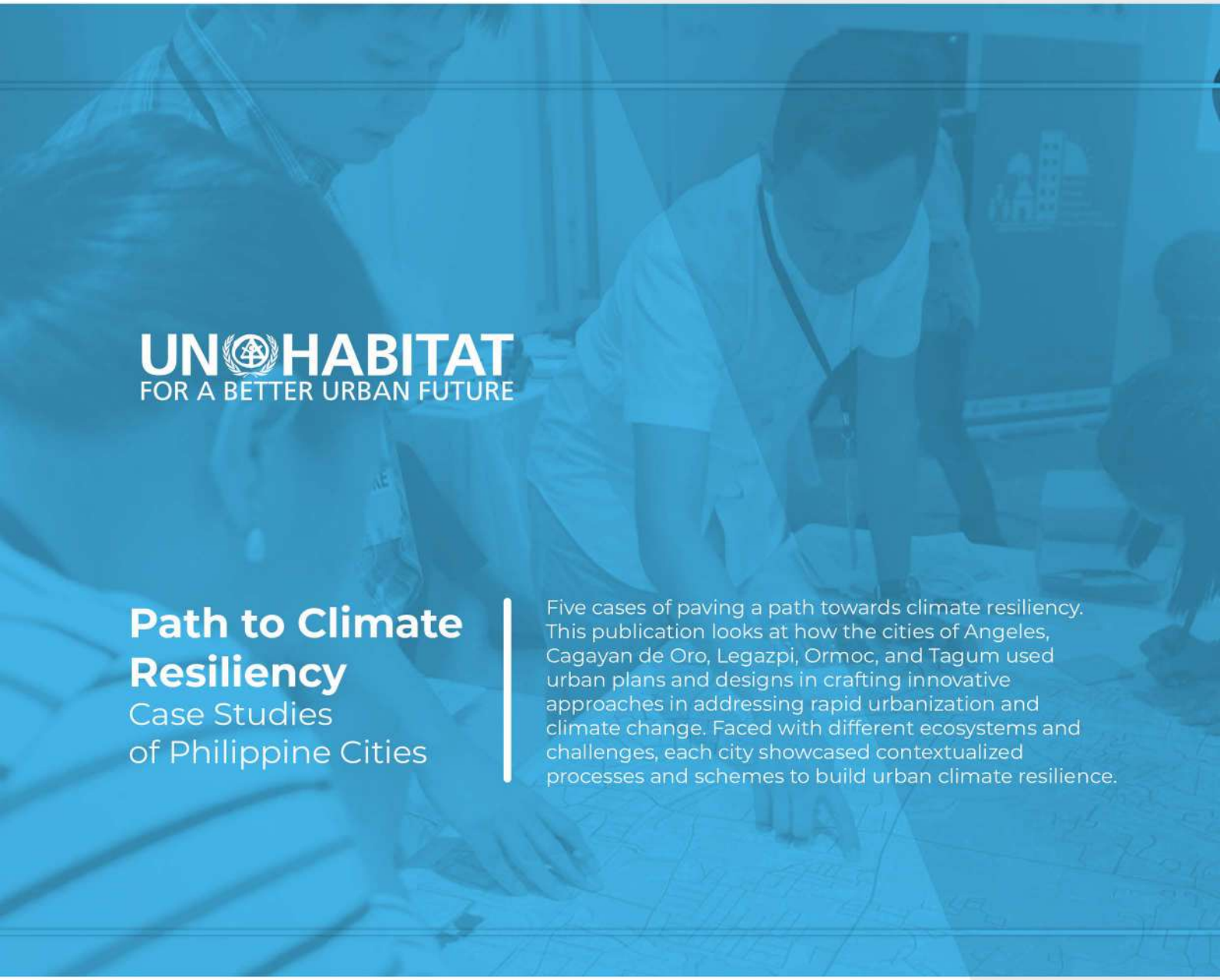
Considering climate change scenarios is important for the LGU to tackle multisectoral development challenges and opportunities and allow communities to prepare for any possible risk. Preparing ahead will help the city lessen potential loss and damages while supporting the city's urbanization and growth. Moreover, treating the city's long-term growth and climate change adaptation as twin considerations in local planning helped ensure resource efficiency and more effective budgeting. This will help the city in saving on post-disaster expenses while ensuring climate resilience through better-informed community designs.

Focusing on communities' needs was indeed central to the shift in the city's perspective. Looking more intently at how climate change impacts people inspired the TWG and stakeholders to come up with better designs, and avoid business-as-usual projects that would have only led to maladaptation. This new paradigm highlighted the crucial role of the natural environment within the urban ecosystem, in ways not previously explored. Revisiting natural resources in the urban setting, including waterways and creeks in the CBD, helped in harnessing potentials for cooling as well as expanding green open spaces. This ultimately addressed urban flooding and heat stress while opening urban spaces as platforms for social and economic activity.

These innovations can be effectively implemented now that the city has its adaptation strategy and design guidelines in place. Not only the LGU but other sectors can rely on these guide posts in all aspects of climate change action—from reinforcing urban infrastructure to designing houses and from developing public

health measures to supporting small and medium enterprises. The guidelines encompass the built and natural environments, helping to improve quality of lives and ensuring the development of a climate-resilient city.

Having tested the process and seeing its own the transformation within the BCRUPD Project, the city can move forward, equipped with knowledge and tools, and with confidence in its capacity for climate-resilient planning and design. This not only validates but enhances the city's role as a regional hub, and a champion for climate change action, environmental protection, and sustainable urban development.



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Path to Climate Resiliency

Case Studies of Philippine Cities

Five cases of paving a path towards climate resiliency. This publication looks at how the cities of Angeles, Cagayan de Oro, Legazpi, Ormoc, and Tagum used urban plans and designs in crafting innovative approaches in addressing rapid urbanization and climate change. Faced with different ecosystems and challenges, each city showcased contextualized processes and schemes to build urban climate resilience.

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