# Economic Impacts of Rainfall and Flooding in Valenzuela and Pasig Cities Using a Multi-week CGE Model Analysis

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## Abstract

This study assesses the impacts of the extreme climate events in a city economy. Using a computable general equilibrium (CGE) model with data calibrated at the city level and at a multi-week period, impacts of extreme climate events are estimated for the Valenzuela and Pasig in metropolitan Manila. Hazard data are exploited to construct simulation scenarios for the CGE model. First, the impact of flooding on the labor constraint faced by the different sectors is econometrically estimated. Second, the CGE model analyzes the impacts of the constraints in the utilization of factors over a one year period Third, a resilience index is constructed analyzing the factors affecting the recovery period of the industries.

The results show that rainfall affects industries differentially and the most resilient sectors are those with the greatest value added. The implications on future modelling are discussed at the end of the report.

**Keywords:** climate change, rainfall, firms, value added, computable general equilibrium

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## Economic Impacts of Rainfall and Flooding in Valenzuela and Pasig Cities Using a Multi-week CGE Model Analysis[1]

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### 1. Introduction

The impacts of climate change events on households and communities is well-studied in the Philippines and abroad. However, little is known on the impacts of hazard measures like windspeed or rainfall exposure on the economy. Less is even known about the economic impacts on the specific cities and municipalities affected by specific climate events. During instances of extreme climate events however, not only are people unable to go to work because of the floods and firms forced to stop their operations, these disruptions in production actually reverberate throughout an entire local economy thereby affecting all sectors in the economy. These disruptions caused by climate events then actually also have impacts on prices, supply, government spending and household welfare, among other things.

In response to the needs to understand city-level impacts of extreme climate events, the current study seeks to assess the impacts of the extreme climate events in the city economy. Using a computable general equilibrium (CGE) model with data calibrated at the city level and at a multi-week period, impacts of extreme climate events are estimated for the cities of Valenzuela and Pasig. Hazard data are also exploited to introduce shocks to labor and capital availability to the CGE model. The current study therefore attempts to extend the standard CGE model by introducing innovations that can allow the model to analyze impacts of extreme climate events for the case of the cities of Pasig and Valenzuela.

#### 1.1. Description of the CCAR 2 Project and its project principles

The Coastal Cities at Risk 2 project aims interrogate the complexity of risk posed by multiple hazards across sectors as well as spatial and time scales using a systems-dynamics lens. It aims to support multi-stakeholder/sector efforts (e.g. government officials and private sector) to jointly design disaster resilience plans that are sensitive to the needs of at-high-risk populations (especially women, children and the elderly) for three cities, namely Metro Manila, Metro Iloilo and Metro Naga, selected because of their rapid socio-demographic growth and expansion while highly exposed to climate and disaster risks. The project will build on the learnings of the five years of operation of the IDRC- IRIACC Coastal Megacities at Risk Project (CCAR) (2011-2015). Among the key lessons of the project is that the scientific research process of identifying and analyzing the drivers and dynamics of risk was actually a shared enterprise requiring transdisciplinary approaches and methods.

The economic sector component aims to support two of the three major objectives of the project which are to advance knowledge of climate change adaptation and disaster risk reduction for resilience, and develop methodologies and tools for climate change adaptation and disaster risk reduction for resilience. The first objective will be undertaken by characterizing and visualizing climate and atmospheric hazards, across space and time, using state of the science approaches in selected coastal cities, and understanding the evolving exposures, and contextual vulnerability and capacities of multiple

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[1] The study is part of the Work Theme 2.1 Coastal Cities at Risk in the Philippines: Investing in Climate and Disaster Resilience, a transdisciplinary (TD) action research project implemented by the Ateneo de Manila University (ADMU) in collaboration with the Manila Observatory and National Resilience Council and supported by International Development Research Centre (IDRC).

stakeholders. The second objective aims to examine the elements and indicators of a resilient city, developed by the National Resilience Council, and its application in developing a City Resilience Suite, and inform and enhance existing tools and approaches, such as the Climate and Disaster Risk Assessment (CDRA) used in disaster and climate risk governance in the Philippines.

The component also builds on the lessons learned in the economic modelling of disaster risks in the first CCAR project which aimed to assess the impacts of typhoons on changes in terms of output, employment, investment and welfare in two Metro Manila cities, Marikina and Pasig over time (Tuaño, Muyrong, and Clarete 2016). While the model was able to track changes in these different economic indicators, the issue of the robustness of results had been raised given that the counterfactuals were built only on the recall in the focus group discussions. At the same time, the database for the study was constructed using national datasets which made it more difficult to assess the spatial impacts of climate change.

The technical report covers the development of a database that relies more on local information that would help in constructing the economic activity and relationships that occur in the target project sites, which include Metro Manila, Metro Naga and Metro Iloilo. At the same time, the study aims to assess the impacts of rapid onset events such as typhoons and flooding, more specifically in two Metro Manila cities, Valenzuela and Pasig, that will allow it to build better counterfactuals and as a result, be able to also strengthen the analysis of the socio-economic impacts of these events and deepen the policy and program insights that can be drawn from such assessments.

The economic model being developed by the economic sector is part of the over-all CCAR project component which focuses on the development and enhancement of methodologies that will be utilized for climate change analysis and disaster-risk response by local government units. As part of the city resilience suite of tools being developed, it is hoped that the initial analysis of the economic impacts of flooding would provide the basis for better understanding the quantitative and qualitative channels on how disasters affect the city and would provide a suitable framework for analysis. It is hoped that after the project, officials in the target cities would be able to be equipped in understanding the effect of disasters in their own respective locales. In addition, it further supports the following points:

- Local stakeholders in cities vulnerable to climate change can improve the resilience of their respective communities. These stakeholders include the officials and staff of the local government units, the business community, the different civil society groups and the general public; providing better information on the impacts of flooding and other natural disasters would help them prepare for the outcomes of these disasters.
- For resilience to improve, local authorities have to have the information about the relative net benefits of inaction and pro-active adaption to climate change. This implies providing the stakeholders with data on how flooding and natural disasters affect economic production and output in the cities, and the possible remedies to avoid such negative impacts.
- Economic impacts of a natural disaster are significant in cities. There are already many studies that show that the synchronous effects of disasters are large. For example, after Tropical storm Ondoy hit Metro Manila and the surrounding provinces, the economic/ financial impacts are recorded in terms of different types of impacts (Muto, Morishita, and Syson 2011; World Bank 2011). The economic value of total "damages" or direct impacts have been estimated to amount to P 68.2 billion, while the value of "losses" or indirect impacts have been estimated at P 137.8 billion. Around half of the damages are in terms of residential property losses; significant amounts also reflect damages (in terms of loss output and property damage) in the commercial and industrial sector, and also devastated infrastructure nationwide. On the other hand, more than half of the losses are economic output loss in terms of the commerce/ service sector and a fifth represented the loss of agricultural output. Thus, it is important to estimate the value of

both direct and indirect losses in order for the general public to be able to assess the specific impacts of disasters in the country.

### 1.2. Description of Work Theme 2.1

This report utilizes a computable general equilibrium (CGE) methodology to analyze the impacts of flooding at a week-by-week basis. CGE analysis is defined as a "multimarket simulation model based on the simultaneous optimizing behavior of individual consumers and firms, subject to economic account balances and resource constraints" (Rose and Liao 2005, 79). CGE models are suitable in terms of analyzing the impacts of natural hazards since these can be disaggregated to enable development of analysis of the vulnerability across different economic sectors.

CGE models could examine the impacts of the changes in the productive system over a longer period, since natural hazards could affect relative prices of goods and inputs, and capital, labor and other mobile factors could move into disaster stricken areas and the pace of the rehabilitation of devastated areas could be speeded up because of the increase in returns to these factors. In these models, because there is an equilibrium of supply and demand, enterprises, which cannot produce due to infrastructure problems, can be replaced by other producers, while consumers, which may be constrained in the purchase of certain goods, may also substituted by other demanders of the same goods. This then is an advantage of this type of modelling as they allow for the substitution of imported goods for regionally produced goods given the presence of the destruction of capital during a disaster.

CGE models also allow for the incorporation of a broad range of behavior across different types of economic sectors, which can be applicable in terms of disaster mitigation and natural resource recovery. Another advantage is that these models allow the analysis of the impacts of the repercussions of disruptions in the provision of goods and services for important types of infrastructure such as transportation, water and electrification.

The innovations introduced in this report include the development of a city-based social accounting matrix which is the basis for the analysis of climate change; very few studies undertake this methodology because of the fact that very little organized data can be found at a disaggregated level. This study aims to provide a framework for assembling such data in the context of the Philippines. Another innovation is that the analysis is undertaken using recursive methods; a week-by-week analysis of the effects of flooding are undertaken to map the recovery period of the cities.

### 1.3. Organization of the technical report

This report is organized as follows. First, a short introduction on the CCAR is discussed in this section, including the objectives and methodology used in the report. Second, a discussion of the different methodologies to assess climate impacts, including systems dynamics, econometric, SAM-based models and computable general equilibrium are analyzed and the limitations of past attempts to assess the impacts of climate change are undertaken.

In the third part, a description of the model is discussed, and the innovations made in the model are also previewed, including the following: a) data is calibrated at the city-level; b) shocks are derived from the hazard estimates of physical sector team; c) multi-period modelling to highlight recovery periods. In the fourth and fifth sections, the city economic profiles, data and SAM construction and the factor recovery matrix and the results of the simulations are presented for Valenzuela and Pasig.

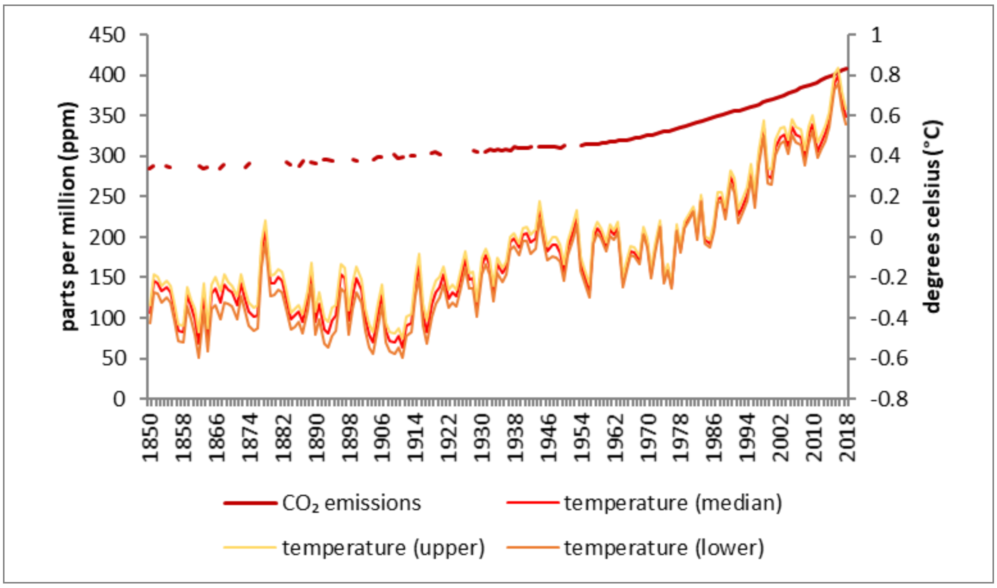
In the sixth part, policy implications are discussed to reduce vulnerability and exposure to climate impacts, including the necessity of economic growth, are assessed. Then lastly, a few recommendations are made on how to improve the analytical framework and methodology are made, and a summary of the results are discussed.

## 2. Review of Literature

Over the recent decades, a consensus among climate scientists has been reached with regards to climate change. The Intergovernmental Panel on Climate Change (IPCC 2018) explains that global warming linked with greenhouse gases (GHG) has resulted in climate change. By now, it has been understood that global warming is linked with the so-called "greenhouse effect" where particular types of gases accumulate in the Earth's atmosphere trapping heat from the sun. The origins of global warming can then be traced back to the emergence of the widespread use of fossil fuels that increased carbon dioxide ($CO_2$) concentration in the atmosphere from about 280 parts per million (ppm) in 1850 to around 400 ppm in today's level. As **Figure 2.1** shows, temperature has been steadily increasing with current temperature at around 0.7 °C compared to 1960-1990 baseline.

Concern for climate change began since around the 1990s after the Brundtland Commission, more formally known as the United Nations World Commission on Environment and Development (UNWCED) reports its findings. In its (1987, 24) publication, *Our Common Future*, it is the first to formally define the concept of sustainable development being the type of development that doesn't sacrifice the needs of future generations. Sustainable development has become synonymous with ensuring that concerns with the global environment be addressed. In response, the United Nations adopted United Nations Framework Convention on Climate Change (UNFCCC) during 1992 Rio Earth Summit and the 197 countries that have ratified the Convention have been called Parties to the Convention. The United Nations also founded the UN Climate Change as the secretariat for the Convention. Since 1995, there has been annual Conference of Parties (COP) that discusses issues revolving around the Convention. These annual conferences had led to the adoption of the Kyoto Protocol in 1997 and then the Paris Agreement in 2015. While the Kyoto Protocol committed industrialized countries to reduce GHG emissions in accordance with agreed individual targets, it is in the Paris Agreement where an agreement has been made among the Parties to the Convention to keep Earth's surface temperatures well below 2 degrees Celsius (°C) above pre-industrial levels and to pursue efforts to limit so that we don't reach a temperature 1.5 °C. above pre-industrial levels.

**Figure 2.1 $CO_2$ emissions versus temperature anomaly**




Source of basic data: Our World in Data, University of Oxford

https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions

As of now, IPCC (2018, 4) reports that "[h]uman activities are estimated to have [already] caused approximately 1.0°C of global warming above pre-industrial levels, with a likely range of 0.8°C to 1.2°C. Therefore, they warn about the impacts of reaching surface temperature levels of 1.5°C above pre-industrial levels as this means that while the tropics will experience more intense rainfall, arid regions will experience even drier droughts as Earth's surface temperature continue to rise. Furthermore, in response to the proceedings of the Paris Agreement, they explain that it is in everyone's best interest to make sure that surface temperature reaching 2.0°C above pre-industrial levels as this scenario posts even greater extremes in climate.

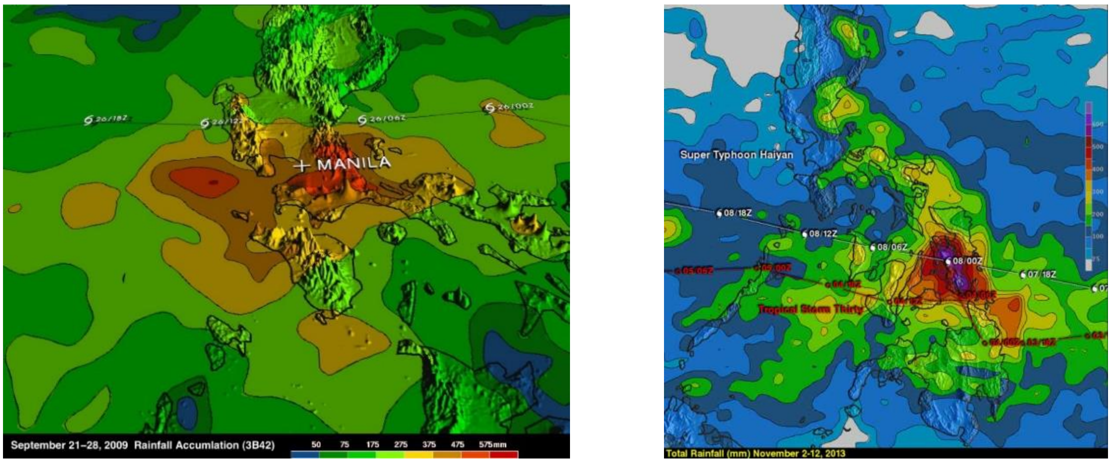
In the Philippines, the increasing concern for climate change has emerged from its experiences with intense typhoons over the recent past decades. Most unforgettable are two of the most infamous typhoons in the recent history of the county (**Figure 2.2**). In September 2009, Tropical Storm Ketsana (known locally as "Ondoy") inundated the country's National Capital Region (NCR) with 454.9 millimeters (17.91 inches) of rain recorded by the weather station at the Science Garden, Quezon City, NCR in just 24 hours with a month's worth of rain 341.122 millimeters (13.43 inches) falling in Manila in 6 hours between 8:00 a.m. and 2:00 p.m. on September 26, 2009.[2] After four years, Super Typhoon Haiyan (known locally as "Yolanda") struck the Eastern Visayas region on November 8, 2013 with windspeed close to 315 kilometers (195 miles) per hour bringing along tsunami-like storm surge to the islands of Leyte and Samar.[3]

While Tropical Storm Ketsana will be infamously remembered for the muddy floods that inundated the cities in the capital region, Super Typhoon Haiyan is infamously remembered for the great destruction it caused for many families, farmers and firms in the Eastern Visayas region. Both will be remembered for the tremendous loss in human lives. While climate scientists cannot readily attribute every instance of storm or hurricane to warming of Earth's surface temperatures, it is accepted that warmer oceans result in stronger and more frequent typhoons in both the Pacific and the Atlantic regions (Grinsted, Moore, and Jevrejeva 2013; Mei and Xie 2016). The increase of surface temperatures according to climate scientists as a result of global warming must therefore also lead to stronger typhoons. This then means that the Philippines, being located right at the Pacific typhoon belt, can expect to experience typhoons similar to Ketsana and Haiyan.

**Figure 2.2 Tropical Storm Ketsana (2009) and Super Typhoon Haiyan (2013)**

[2] See NASA Report on October 1, 2009 at https://www.nasa.gov/mission_pages/hurricanes/archives/2009/h2009_Ketsana.html

[3] See NASA Report on November 14, 2013 at https://www.nasa.gov/content/goddard/haiyan-northwestern-pacific-ocean/

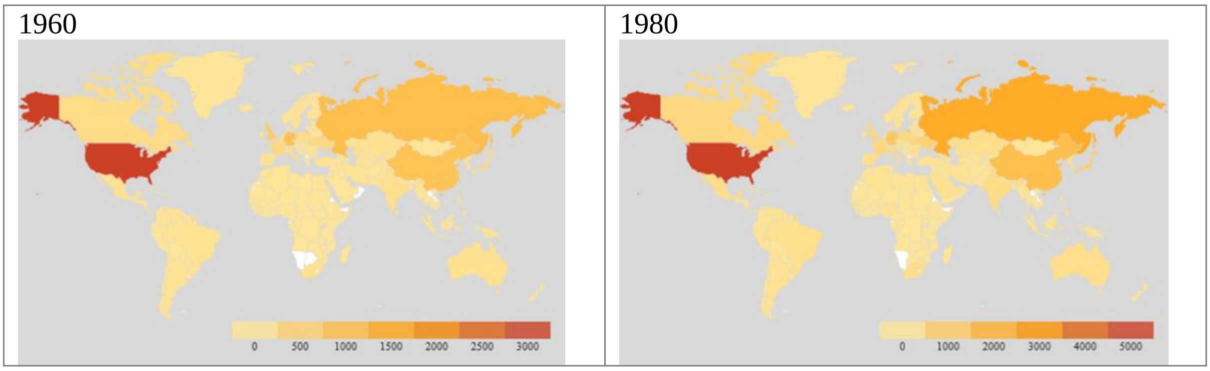



Credit: Hal Pierce, SSAI/NASA GSFC

Indeed, the most common concern from climate change for tropical countries like the Philippines is the increasing intensity of typhoons alongside the expected sea level rise as polar ice caps continue to melt. It is in this context that coastal cities find themselves in peril. While IPCC (2018) highlights the extreme impacts on biodiversity in lands and oceans due to higher temperatures, the panel does not fail to explain that endangerment and extinction of various animal species will have great impacts on human lives too as we start to lose free environmental services. These ecosystem impacts, in turn, not only affect not only the welfare of the most vulnerable of the populations—those dependent on agricultural and coastal livelihoods—but also constrain economic growth for all. In the end, even when climate change is a global issue, it is also a local issue with cities and municipalities bearing the responsibilities of adaptation and mitigation measures.

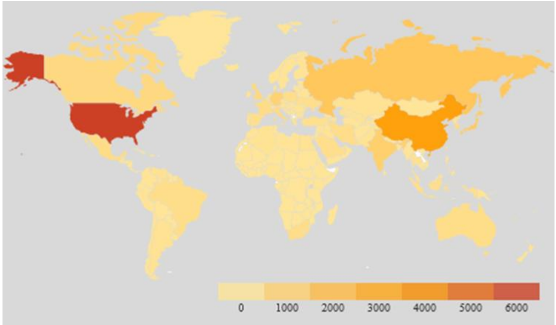
What is unfortunate, however, for the Philippines is that our contribution to global GHG emissions seems too small compared damages experienced due to typhoon exposure. While the Philippine $CO_2$ emissions in 2018 was at 135.07 metric tons (MT), China contributes the most at 10,064.69 MT, which is around 30 percent of all emissions.[4] As it turns out, different nations have different levels of carbon footprint as shown by **Figure 2.3**. What does this imply for the global environmental concerns? If certain countries emit much volumes of GHG emissions while other countries suffer climate disasters even when they are not large carbon emitters, how should climate change discourse be framed? What actions must be taken from these developing nations receiving the brunt of ecological backlash? Is there a role for local action in developing nations like the Philippines?

**Figure 2.3 $CO_2$ territorial emissions (metric tons)**

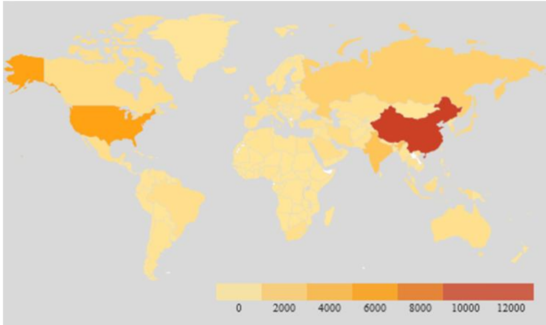



[4]Data from Gilfillan et al. (2019), UNFCCC (2019), BP (2019)

2000




2018




Source of basic data: Gilfillan et al. (2019), UNFCCC (2019), BP (2019)

Cities therefore take a central role in economic growth and development being the hub for various economic production and innovation signaling the need for cities to adapt to climate change to maintain these activities. High temperature inside cities (i.e. heat island effect, the potential of flooding due to cemented surfaces, among other things, therefore not only require planning to mitigate their effects in the short run, but also require adaptation measures. In addition to this, it is found that vulnerability of urban areas is going to be a confluence of the location, he economy and the size of the urban settlement (Wilbanks et al. 2007, 361).

According to the literature (Benson and Clay 2004; Pelling, Özerdem, and Barakat 2002; Stephane Hallegatte and Przyluski 2010), economic impacts of natural hazards include:

a. ***Direct impacts:*** These are the immediate consequences of disaster phenomenon, especially on physical assets (including raw materials, goods in process and final goods), property, valued at agreed upon replacement prices; the values of these shocks can be observed directly from market goods or their replacement costs.
b. ***Indirect impacts:*** These are losses are not provoked by the disaster itself but by its consequences, including effects on firm productivity and household incomes and expenditures over time until assets are fully recovered; there are also additional costs in terms of provision of goods, losses of personal income and partial/ total loss in terms of production, businesses and livelihoods. They also include medical costs of treating victims of the disaster and costs of lower productivity or lost output.
c. ***Macroeconomic 'secondary' impacts:*** These include changes in the over-all state of economy-wide indicators, such as the changes in over-all or sectoral GDP, balance of trade and balance of payments, level of indebtedness, employment, money supply, public finance and capital investments.

Pelling, Özerdem, and Barakat (2002), in particular, noted that direct losses have been the focus of most studies on disaster effects because these have been utilized for disaster mitigation and preparedness, and also the provision of insurance and other similar types of financial instruments. Some of the immediate effects of a disaster would be the loss of housing, business and industrial production and crops, and damages to infrastructure, marketing systems, transport and communication. On the other hand, Indirect impacts are measured mainly in terms of the degree in which the impacts of disasters can spread through economic networks. The loss of critical infrastructure, such as road networks, bridges, electricity, telecommunications and water systems, can impact on the agriculture, industrial and service sectors, even if there is no physical damage of the assets of some (or even most of) the firms in these sectors. The short-term decline in commodity exports may also be affected given a loss of productive capacity and the disruptions in domestic and international transportation infrastructure.

And lastly, the economic effects of disasters have impacts last for a longer duration on the economy and may impact on the production, distribution and consumption of goods and services; these are called the 'secondary' effects of a natural shock. Damage to infrastructure causes production to fall, fewer commodities will circulate, and prices for basic commodities will increase. Employment may be displaced as production may be disruption, but urban based industries will recover much faster given that these have better access to insurance and credit. The balance of payments may be adversely affected given the disruptions in export capacity and the need for short-term imports that would cover interruptions in production. Public expenditures would have to shift towards short-term relief and rehabilitation, and this may have consequence on the government debt stock.

Various methods have been used to analyze the impacts of climate events in the Philippines. Most common are single event analyses that investigate direct impacts of a particular climate event on various factors. Partial equilibrium analysis including econometric and IO-based multiplier analyses, on the other hand, focus on linking climate and weather variables with economic variables. Finally, there exist system-wide or economy-wide approaches that investigate not only direct and indirect costs. They also attempt to relate these variable to the rest of the economy as for case of computable general equilibrium (CGE) analysis or to the rest of the entire ecological system such as in the case of systems dynamic (SD) approaches.

### 2.1. Single event analysis: Accounting of damages and losses

The 2018 World Disaster Report, using the data from the Emergency Events Database (EM-DAT) of the Centre for the Research on the Epidemiology of Disasters (CRED), reports that 186 out of 3,751 (5.0%) natural hazards happened in the Philippines over the last 10 years (IFRC 2018, 179). It also reports that these hazards affected 105 billion people out of 1 billion (5.3%) worldwide. The Philippines therefore ranks third in both the country most affected by natural hazards and the country with the greatest number of people affected. However, the report does not include the Philippines among the top ten countries affected when it comes to recorded costs of damages suggesting that accounting of disaster damages must be undervalued in the country.

The damages caused by typhoons usually reported by the National Disaster Risk Reduction and Management Council (NDRRMC) include damages on public infrastructure, damages to the social service delivery sector, and losses to selected industries. For instance, damages and losses caused by Tropical Storm Ketsana was estimated at PHP 11 billion with infrastructure damage of PHP 4.3 billion to infrastructure and PHP 6.7 billion to the social service delivery and agricultural sectors (NDCC 2009, 4). This translates to 993,227 families (4,901,234 persons) affected in a total of 2,018 barangays. Then, 1,382 school buildings and 185,004 houses were damaged. Furthermore, a total of 203,477 hectares (has) were affected affecting an equivalent of 329 metric tons (mt) of various crops.

For the case of Super Typhoon Haiyan, the estimated costs of damages and losses amounted to PHP 93 billion (NDRRMC 2014, 2). Total damages to infrastructure was estimated at PHP 9.6 billion, PHP 43 billion to the social service delivery sector, PHP 24.4 billion to the productive sectors including not only agriculture and fisheries but also mining and quarrying, trade and tourism. NDRMCC also estimated ‘secondary’ damages and losses relating to governance and disaster response as well as assessments of changes in the macroeconomy, impact on communities and on the environment for the case of Haiyan. This last estimate amounted to PHP 3 billion. All these massive damages translated to 3.4 million families (16 million persons) affected in a total of 12,139 barangays. Indeed, NDRRCM (2014, 2) reports that out of the over 700 tropical cyclones that entered the Philippine Area of Responsibility (PAR) since 1970, Haiyan is the worst ever to hit the country ranking first in terms of total damage and losses.

Various other authors provided an extension of these single event analyses from NDRRMC. For example, after Ketsana alongside Typhoon Parma (known locally as “Pepeng”) hit Metro Manila and the surrounding provinces, the socio-economic impacts are estimated in terms of different types of factors (Muto, Morishita, and Syson 2011; World Bank 2011). The economic value of total damages or direct impacts have been estimated to amount to PHP 68.2 billion, while the value of losses or indirect impacts have been estimated at PHP 137.8 billion. For the case of Haiyan, authors focused on mapping of impacts of the storm surge against the loss of human lives (Yi et al. 2015; Lagmay et al. 2015). Other authors would then provide an analysis comparing various on-site analyses (Acosta et al. 2016) or a nation-wide survey of costs and damages (Israel and Briones 2012).

These reports therefore measure only the so-called direct and indirect impacts of these typhoons. They estimate the immediate consequences of the natural hazard and they focus on damages incurred on physical assets including inventory of raw materials, intermediate goods and final goods valued at agreed upon replacement prices. Indirect impacts may then refer to costs that are incurred not directly due to the natural hazard but by its consequences. These include changes in firm's labor and capital availability which affects their production operations and changes in household incomes and expenditures which affect their savings and consumption patterns including necessary medical bills and insurance.

However, once the question of damages involve looking at impacts on the rest of the economy as a result of the destruction caused by winds and flooding, Tuaño, Muyrong, and Clarete (2016) explains that economic impacts of natural hazards must also include macroeconomic 'secondary' impacts. Macroeconomic impacts, on the other hand, include changes in the over-all state of economy-wide indicators, such as the changes in GDP and sectoral outputs, prices of goods and factors of production as well as capital investments and government spending among many others. Therefore, there remains many gaps in these approaches as they are unable to measure indirect and secondary impacts of climate events.

### 2.2. Partial equilibrium analysis

Econometric techniques in climate change studies are utilized to evaluate the impacts of climate change variables on socio-economic variables. In the Philippines, household-level analyses are common using the Family Income and Expenditure Survey (FIES). On the other hand, the input-output (IO)-based multiplier analysis attempt to provide an economy-wide analysis given interdependence across sectors. However, the approach remains a partial analysis or 'static' since it is unable to include feedback effects across the economy.

#### 2.2.1 Econometrics

Empirical methodologies looking at the impacts of climate change focus on regression analysis on incomes and expenditures. These studies take advantage of household or individual-level data that they can match with exposure to climate shocks. Wishing to estimate the post-disaster impacts of climate events on Filipino households, Antilla-Hughes and Hsiang (2013) implemented a difference-in-difference (DID) methodology on a province and regional-level dataset using the Family Income and Expenditure Survey (FIES) and National Demographic and Health Survey (NDHS) with province-level windspeed as the treatment variable. Taking advantage of wind field data for every West Pacific typhoons from the International Best Track Archive for Climate Stewardship (IBTrACS) database using a model called Limited Information Cyclone Reconstruction and Integration for Climate and Economics (LICRICE), Antilla-Hughes and Hsiang were able to construct a province-level maximum windspeed exposure in meters per second (m/s). In this case, windspeed incidence may either be some positive value for provinces affected by the typhoon or zero for provinces not affected by the typhoons, allowing for DID. They found that, given the average typhoon exposure in the Philippine (16.9 m/s), typhoon exposure decreases average household income by 6.6 percent and expenditures by 7.1 percent. Even more interesting is that their analysis found that female infant mortality is significantly affected the year after typhoon exposure with as much as 15-to-1 ratio compared to the infants who died during the typhoon. Their results suggest that Filipino households discount the future through reduction in human capital investment. As it turns out, these human capital disinvestments affect female infants more than male infants thereby suggesting intra-household gender bias.

Focusing instead on the rainfall shocks-poverty nexus, Bayudan-Dacuycuy and Baje (2019; 2017) turned their analysis on the impacts of rainfall shocks and other weather-related variables not just on chronic and transient poverty rates as well as on wages. Using data from FIES and the Annual Poverty Indicators Survey (APIS), Bayudan-Dacuycuy and Baje (2017) first implemented a generalized linear model (GLM) since poverty estimates are between 0 and 1 making them bounded dependent variables. These poverty estimates were ran on weather data from PAGASA: temperature, heat index and rainfall. They found that rainfall deviation from normal level (i.e. rainfall shocks) has the most impact on total and food chronic poverty incidences. An extension of the original study, Bayudan-Dacuycuy and Baje (2019) then implemented a simultaneous equations model on more deeply investigate how rainfall shocks impact poverty incidence by first estimating impact of rainfall shock on income and wages, $z_i$, before using the latter variables as regressors for poverty alongside control variables, $z_i$:

$$Y_i = \varphi + \gamma \cdot rainfall\ shock_i + e_i$$

$$poverty_i = \alpha + \delta \cdot \hat{Y}_i + \phi \cdot z_i + \varepsilon_i$$

Rainfall shocks are computed as standard deviations (SD) from the mean allowing for binary variables depending on whether rainfall measure is within a positive 1 SD from normal rainfall, -1 SD or -2 SD. They highlight that weather shocks are likely to reduce income through forgone earnings especially in the case of rural households wherein negative rainfall shocks that can affect crop yield that lead to reduction in rural agricultural wages by an average of 1.169 percent for provinces whose rainfall shock is negative 2 SD away from normal. However, the impact of either positive or negative rainfall shocks vary across types of wages.

A similar study was implemented using individual-level data for people residing in the US Gulf Coast when Hurricanes Katrina and Rita struck in the third quarter of 2005 (Groen, Kutzbach, and Polivka 2019). Using a dummy variable that tracks whether the individual was affected by the typhoon and whether the data point was recorded at certain quarters before or after the typhoon, they implement a quasi-experimental technique that divides the population into those affected by the storms and those who were not. They find that long-term differences between individuals' earnings can be explained by differences in wage growth between areas affected and not affected by the storms.

### 2.2.2 IO-based multiplier analysis

Galbusera and Giannopolous (2018) provide a survey of the various extensions to the Leontief IO model for disaster assessment given its capacity to provide estimates of impacts to all sectors given an assumption that only one or a few of the sectors were affected by the climate event. Extensions include introducing shocks or imbalances due to the disaster, analyzing changes in stocks and flows, and analysis of forward and backward linkages to understand 'causal paths and cascades' across the economy. Hallegatte (2008) then proposes an IO model that would take into account the production capacities of each economic sector, the backward and forward linkages, and the integration of adaptive behavior for the estimation of the economic costs of Hurricane Katrina. The study finds out that the indirect losses exceed the direct losses and therefore the former needs to be taken into account.

In the Philippines, what has been implemented by Yu, Tan and Santos (2013) is the Inoperability Input-Output Model (IIM) developed by Haimes and Jiang (2001). Specifically, they analyze the impact of a climate events by constraining the availability or 'operability' of production assets in key sectors and then analyzing its effect in the whole economy in terms of loss in output to the rest of the sectors. The model of Haimes and Jiang makes use of the basic IO framework where output vector $\boldsymbol{x}$ is the product between the Leontief inverse $(I - A)^{-1}$ and final demand vector $\boldsymbol{c}$.

$$\boldsymbol{x} = (I - A)^{-1}\, \boldsymbol{c}$$

In this basic model, the Leontief inverse is a matrix of output multipliers. In other words, changes in the final demand vector leads to economy-wide changes in the economy. Then, they introduce a vector of inoperability $\boldsymbol{q}$ contains values from 0 (which denotes an industry that is not affected at all) to 1 (which denotes an industry is totally affected):

$$\boldsymbol{q} = (I - A^{*})^{-1}\boldsymbol{c}^{*}$$

For their case study, they analyze the impacts of inoperability of the transportation sector in Luzon when Ketsana and Parma hit the region. Their model explains that since most of economic activity is in Luzon, constraints faced by the transportation sector in Luzon, even when it only accounts for 15 percent inoperability to the entire country's transportation sector, will have significant impacts to the rest of the economy. They find that the most affected remain to be transportation sector itself given linkages of land transportation to other modes. Ranked second in terms of economic losses is the manufacturing sector followed by the agricultural sector.

## 2.3. System-wide approaches

Studies that seek to provide system-wide analysis may either include natural systems through the SD approach or may be focused on economic impacts alone through the CGE analysis. While the former would usually be implemented by environmental scientists, the latter is implemented by economists. Despite this, both methodologies attempt to provide linkages across various factors and both seek to trace the impacts of climate change events across these variables.

### 2.3.1 Systems dynamic approach

SD approach looks at the movements of stocks and flows of various variables across the natural systems. On the other hand, CGE analysis assesses economy-wide impacts through a system of linear equations that link various economic variables. However, SD approach is able to include economic systems inside its model, while CGE analysis would usually establish simulation scenarios from the natural systems outside its model. In this way, the SD approach may also be extended to establish a resiliency measure for a community where the approach has been applied.

For instance, the SD approach implemented Gotangco, et al. (2015) on measuring the loss of system performance due to adverse impacts alongside how the system can recover has the ultimate goal of providing a resiliency index for their case community. Their analysis can then show whether the level of resilience among households is increasing or decreasing as changes in the system occurs over time. Focusing on the low-income households in Pasig City, they find that the resilience of these households given flooding events is also related to pre-existing conditions in the community which makes it difficult for the households to recover.

### 2.3.2 Computable general equilibrium analysis

In response to this need for localized studies that can be designed to inform local policymakers, Tuaño, Muyrong, and Clarete (2016) implemented a CGE analysis of the impacts of Typhoon Ondoy in the cities of Pasig and Marikina by. The study's methodology began with the construction of a city-level social accounting matrix (SAM) that provides a snapshot of the city's economy at a given year. The equilibrium scenario is then calibrated and changes in this equilibrium scenarios are designed to simulate who various types of macroeconomic variables (e.g. output, supply, prices, government spending) change across sectors as a result of changes brought by the climate change event. For the case of this study, the impact of Typhoon Ondoy (or the storms caused by Habagat that happened October 2009) enter the model through its impacts on the availability of labor, capital and raw materials over time with recovery estimated at a weekly basis.

The study highlights that both cities may have lost a total of PHP 22.54 billion, 90 percent of which represent the loss of Pasig City. Taking advantage of the so-called equivalent variation (EV) of income embedded in the microeconomic model of the CGE, they also estimate how much people may be willing to pay in order to not suffer from the consequences of extreme flooding. For the case of Pasig, it is estimate that the residents must be willing to pay PHP 12 billion, the cumulative value of their welfare change from baseline over 28 weeks. The case of Marikina City however showed increase in overall welfare by a cumulative sum over 16 weeks before returning to normal which may be explained due to the reduction in prices that resulted in the city's CGE model as a result of changes in labor and capital availability.

The study, however, shows that more improvements to the CGE modelling at the city level is necessary to improve estimates of economic impacts. For instance, the CGE analysis for Marikina and Pasig involve estimating the SAM using secondary data rather than data from the city. Furthermore, simulation scenarios on the impacts of flooding to capital and labor availability come from recall of interviewees rather than from a survey of firms.

## 3. Research Methodology

CGE model analysis is usually used in studies to analyze the impacts of international trade and taxation. In these usual CGE studies, the analysis is also implemented at the national level using a macroeconomic database calibrated at annual time period. The current study, in order to understand the impacts of climate change on the economy, had to innovate. Specifically, the current study attempts to estimate economic impacts at the city level in order to bring the results of the study to the pertinent policymakers. In response to the need for local-level study, Tuaño, Muyrong, and Clarete (2016) previously implemented a CGE analysis of the impacts of Typhoon Ondoy in the cities of Pasig and Marikina. To improve the multi-week CGE model analysis, the current study implemented innovations on the CGE model to analyze the impacts of climate-related hazards to the cities of Valenzuela and Pasig.

### 3.1. Standard CGE model

Economic input-output (IO) and computable general equilibrium (CGE) techniques are the best models to assess the impact of disaster on the whole economic system, focusing on the effects on the local production system. In input-output models, industrial (and probably household) output is constrained by the loss of infrastructure, machinery and other production assets in key sectors that were affected by the natural hazard, and these have ripple effect in the whole economy as the loss of output means the loss of inputs for other productive sectors. Only imports or foreign capital inflows can improve production in the short-term, while local capacities are being built. Hallegate (2008) proposed an input-output model that would take into account the production capacities of each economic sector, backward and forward linkages and the integration of adaptive behavior; the study finds out that the indirect losses exceed the direct losses and therefore the former needs to be taken into account.

On the other hand, CGE models examine the impacts of the changes in the productive system over a longer period, since natural hazards could affect relative prices of goods and inputs, and capital, labor and other mobile factors could move into disaster stricken areas and the pace of the rehabilitation of devastated areas could be speeded up because of the increase in returns to these factors. In these models, because there is an equilibrium of supply and demand, enterprises, which cannot produce due to infrastructure problems, can be replaced by other producers, while consumers, which may be constrained in the purchase of certain goods, may also substituted by other demanders of the same goods.

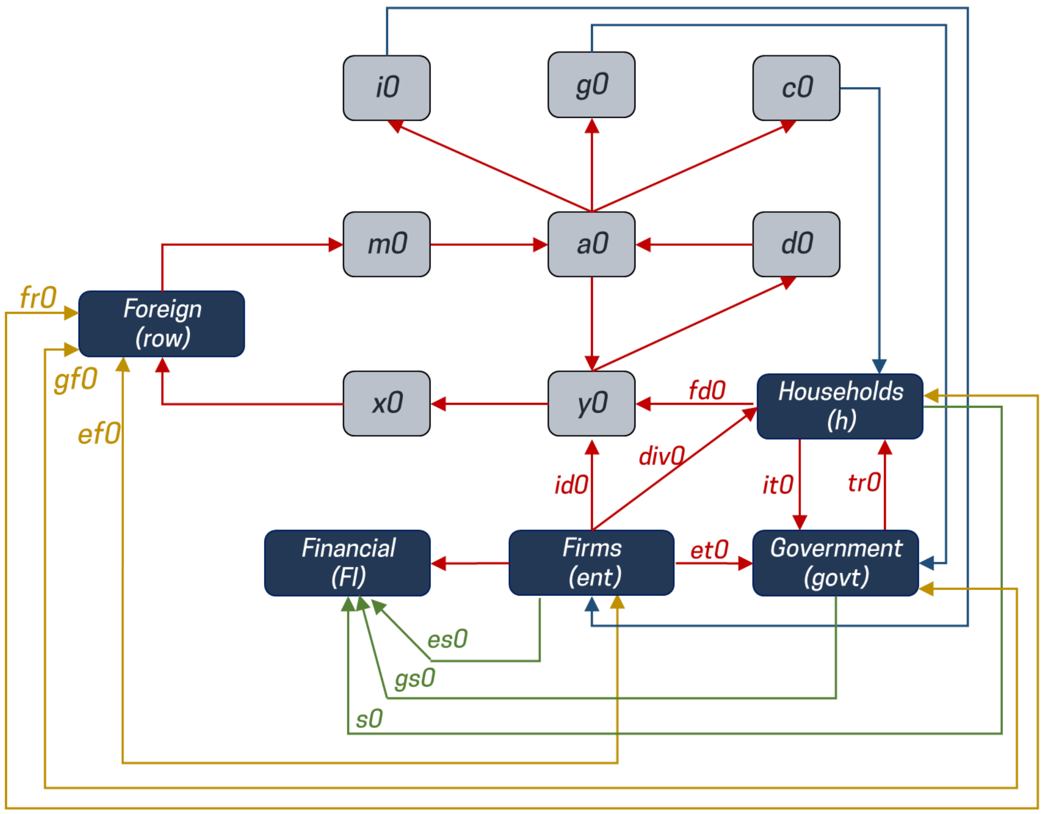
### 3.1.1 An overview of the analytical framework

This part of the paper describes the recursive multi-week CGE model applied to the cities used in this study. The model tracks the different payment flows and exchanges that institutions of the economy undertake. Figure 1 illustrates the range of transactions in the economy involving the services of productive resources, intermediate inputs, and final outputs. Payment flows between institutions cover the transfer of ownership of intermediate inputs, products, and primary factor services in the economy.

***Agents, incomes, and spending.*** There are five institutions or agents in the model: households, firms, government, financial intermediaries, and the foreign sector. Except for households, these institutions are represented by one entity: the government. Agents generate incomes and spend the same on the products produced in the economy, or provide exogenous net income transfers to other institutions. Households and businesses pay taxes to the government. Agents save part of their incomes. These institutions and the corresponding flows across them is shown in **Figure 3.1.**

Income levels differentiate types of households. Households generate their incomes from selling the services of the primary factors they own (*fr0*) to firms, which will then be used in production. These include wages of high- and low-skilled labor, as well as returns to capital and agricultural lands. Other income components include exogenous transfers from other institutions (*tr0*), particularly from the government. Households pay income taxes (*it0*), purchase goods and services for final consumption (*c0*), including public goods spent by the government (*g0*).

**Figure 3.1 Economic flows in a computable general equilibrium model**



Source: Modified from Markusen and Rutherford (2004, 141, 147)

Firms provide intermediate inputs (*id0*) from other firms, and factors from households (*fd0*) and firms to produce goods, which are either sold domestically (*d0*) or are exported abroad (*x0*). Locally produced goods to be sold in the home market and imported products and services (*m0*) make up the intermediate inputs, as well as products used in final consumption by households and other agents. A hypothetical composite product of both types of goods—called the "Armington good" (*a0*) (Armington 1969)—conveniently represents the transactions involving local and imported products.

Net income transfers between the economy and the foreign sector are exogenous. These transfers include net remittances of incomes of the labor force working abroad, profits of the capital that is invested overseas, and net purchases of financial assets. The exchange rate is endogenous; its level is changing depending on the net flows of merchandise and services trade between the country and the rest of the world.

On the other hand, government receives taxes from households (*it0*) and from enterprises (*et0*), and spends these on transfers to households. The representative financial intermediary receives savings from different institutions including households (*hs0*), business enterprises (*es0*), government (*gs0*), and the foreign sector (*fs0*). It uses the aggregate savings to invest in new capital assets in the economy (*i0*), thereby increasing the stock of capital available for use in the following time period. In the short-run model used in this paper—the time period being a week—there is no saving and investment in new capital.

The interdependencies of the agents in the economy depicted in Figure 1 confirm that any disruption in one part of the economy will affect the rest of the economy. For example, a loss of productive factors due to a disruption in the flow of capital, for example, will reduce output in the economy and, therefore, will reduce the total amount of goods available for household consumption, firm investment, and government spending. This will lower household incomes and total investment in the economy.

***Equilibrium conditions.*** The basic CGE model used in this paper is described in Rutherford (1999) and Rutherford and Paltsev (1999). The model is a standard Walrasian model with neoclassical closures (i.e., total spending of all agents equals exactly their aggregate incomes). While other agents save, the act of saving represents a purchase of financial asset from the financial intermediary. It models a typical "economy" where firms maximize their profits subject to technology and input constraints. Endowed with primary factors, households maximize their respective utilities consistent with their budget constraints. Both households and firms are presumed to be price takers, and markets are perfectly competitive. The optimization behaviors of economic agents in the model produce market demands and supplies of goods, services, and factors of production. The corresponding markets settle to equilibrium with appropriate adjustments to commodity and factor prices.

The production model in the CGE model assumes that there are so-called "zero-profit conditions"[5] in the production and goods market, and that the commodity markets in the model are assumed to be perfectly competitive. The condition for each type of factor is assumed to be fully mobile across sectors. The zero profit functions for domestic output, *Y(s)*, and the Armington, *A(s)*, are as follows:

5 Utilizing the framework from Mathiesen (1985), Markusen (2002) suggested the solution to solving a series of production functions, factor supply, and consumer income equations would be to convert the problem into a series of equations, and solve the system. This would be undertaken by solving the underlying cost minimization problem for consumers and producers (i.e., solving for cost and expenditure functions, so that the optimizing behavior is embedded in the solution system). These equilibrium conditions can then be formulated as a complementarity problem, in which each inequality is associated with a particular variable; the complimentary variable can be noted as what is not produced if strict inequality in the equation holds. As with "strict inequalities", there would be three inequalities in the general equilibrium system: (1) zero-profit conditions, (2) market clearing conditions, and (3) income balance.

$$PD(s)*d0(s)+PE(s)*(px0(s)*x0(s))-\sum_{\forall g}PQ(g)*id0(g,s)$$

$$\sum_{\forall f}PF(f)*fd0(f,s) \leq 0 \perp Y(s) \geq 0 \text{ [1]},$$

which the zero profit function for domestic production determining *Y(s)*; and,

$$PQ(s)a0(s)\left(tauz(s)/(1+tauz(s)\right)-PM(s)pm0(s)m0(s) \; -PD(s)d0(s) \; \leq 0$$

$$\perp A(s) \geq 0 \text{ [2]},$$

which is the zero profit function for Armington supply determining *A(s)*, and where *tauz(s)* is the indirect (sales) tax for the sector *s* (also characterized by the italicized letter *g*). *d0, x0, m0, id0,* and *fd0* are benchmark domestic supply, exports, imports, intermediate demands, and factor demands, respectively, while *pm0* and *px0* are the respective benchmark price levels for imports and exports. *PD, PE, PQ,* and *PF* are the domestic, export, Armington, and factor price levels, respectively, calculated from the model.

Each of the cities in this analysis is assumed to trade with the "rest of the world". In order to simplify the analysis, the "rest of the world" assumes all regions outside the subject city (i.e., Valenzuela and Pasig). The amount of exports of a given locally produced good to the rest of the world is a constant elasticity of transformation function based on the volume of the local good produced. Locally produced goods are imperfectly substitutable with imported goods. Thus, domestic products are assumed to be differentiated from imported products, and exported merchandise is assumed to be qualitatively different from those sold in domestic markets. In the case of imports, the model assumes cities are "small open economies" and, thus, are assumed to be a price taker in these markets. Zero-profit conditions are also assumed for consumption of different institutions, including households (personal consumption), firms (investment), and government (public consumption). Household consumption assumes Cobb-Douglas aggregation of the different goods purchased.

Another requirement for equilibrium to hold is the condition for "market balance". Market clearance is characterized by the equilibrium between the demand and supply of all commodities in each of the sectors. Therefore, market clearance conditions can be characterized by the following:

$$Y(s)*d0(s)-d0(s)*A(s) \leq 0 \; \perp \; PD(s) \geq 0 \text{ [3]},$$

for domestic goods determining the price of domestic goods, *pd(s)*;

$$\sum_{\forall h}RA(h)*fe0(f,h)+ENTR*ek0(f)+ROW*xk0(f)-\sum_{\forall s}fd0(f,s)*Y(s) \leq 0$$

$$\perp \; PF(f) \geq 0 \text{ [4]},$$

for primary factors (i.e., labor and capital) determining price of primary factors *PF(f)*; where the italicized letter *f* stands for the factor; where *RA*, *ENTR*, and *ROW* represent activity levels for household *h*, enterprises, and the rest of the world, respectively; and *fe0, ek0, xk0,* and *fd0* represent factor endowment, enterprise capital, rest of the world capital, and factor demand, respectively;

$$A(s)*a0(s)-\sum_{\forall g}id0(\text{g,s})*Y(\text{s})-\sum_{\forall h}C(h)*c0(s,h)-GOV*g0(s)-INVEST*i0(s) \leq 0$$

$$\perp \; PQ(s) \geq 0 \text{ [5]},$$

where *PQ(s)* is the price of the Armington good.

In the same vein, there is equal demand and supply of exported and imported commodities, while the demands for household, investment, government, and enterprise consumption goods are equal to their supplies.

The last condition for equilibrium to hold is to note that the income and expenditures of the various institutions are equal to their expenditures.

Briefly, the illustration provides the information that, initially, the impacts of a hazard event would be the damage that it would result in terms of infrastructure or physical assets. Around two-thirds of all losses in flood-related events in Asia are infrastructure losses, including housing, road networks, agricultural systems, and firm physical structures. Natural disasters severely impact households in terms of the partial or full damage of their residential areas, and on assets that are utilized for generating incomes.

### 3.1.2 Analytical framework involving climate change impacts

This study is undertaken by identifying key economic parameters, in which flooding affects changes in income and productivity of several sectors in the economy, and then identifying the dynamic nature of these changes in the economy. The geographical unit utilized in the analysis is the level of metropolitan regions and key cities in Metro Manila affected by the flooding. These parameters included the flows of: (1) productive factors, including labor and capital in firms affected by flooding; (2) intermediate inputs in firms affected by the flooding; and (3) goods and services that flow into a local economy.

The effects on households would lead to the decline in consumption and investment in favor of activities that would help individuals and families cope with the after-effects of natural damage. Private consumption significantly declines after the onset of a catastrophic event, while public consumption also falls but to a smaller degree (Auffret 2003). At the same time, private investments are diverted to reconstruction and rehabilitation of firm physical capital and infrastructure. The resulting effect would be a short-term decline in economic output. Because of the decline in output, there would be a decrease in the demand for labor services, leading to a decline in employment and cuts in formal sector wages and informal sector income (Skoufias 2003). In some cases, because of disruptions in agricultural output and in the distribution of goods, there would be a slight increase in prices until the marketing channels are restored.

At the same time, the literature (Benson and Clay 2004; Pelling, Özerdem, and Barakat 2002; Stephane Hallegatte and Przyluski 2010) also suggests that there are several factors that would affect secondary impacts of hazard (in terms of economic values): (1) changes in prices due to disaster shock; (2) length of reconstruction; (3) output effects due to negative "network effects", such as vulnerabilities in transportation infrastructure and utilities (e.g., water, electricity, gas, and transportation) whose effects can be felt throughout the economic system; and (4) the stimulus effect of disasters, which may be positive or negative depending on whether the resources are mobilized or diverted (as the case may be) because of reconstruction activities that need to take place.

Because of disruptions in supply, prices could possibly rise, reflecting the loss or damage to goods, and transport and marketing infrastructure. The increase in prices could also be due to an increase in demand for certain goods that are needed in disaster relief and rehabilitation, such as canned foodstuff, clothing, and housing materials. In some disaster episodes, there may also be a decline in demand for luxury goods, which may temper the general increase in prices, but these comprise only a small percentage of the expenditure baskets of ordinary households. In the Philippines, for example, the combined effects of the 1990 Central Luzon earthquake and the 1991 Mount Pinatubo disaster increased prices of fruits and vegetables by 46 percent at the peak of supply disruptions.

In order to better identify the temporal impacts of flooding, key informant interviews were undertaken with business associations in Valenzuela and Pasig; the informants were primarily key leaders of the local chambers of cities in their respective areas. The qualitative extent of the impacts of the three parameters discussed above were assessed by these leaders using their experiences during the onslaught of Typhoon Ondoy in their areas. These qualitative impacts were then translated using estimated quantitative impacts to be utilized in the CGE model.

This approach was also partly undertaken in response to the lack of quantitative impacts of flooding among agricultural, industrial, and services establishments in the country. The national and local government provided quantitative assessments of agricultural damages only, which in the urban/city context may not be useful in terms of developing a complete picture of the extent of economic effects of flooding.

A major limitation on the use of a CGE model is the inadequacy of practical data at the city level that can be used to construct a SAM. Economic data on households, firms, local governments, and the flow of resources among these institutions and with the economy outside the city, including the profile of these institutions, are very scarce. This information is also absent among local government units. Many assumptions were made to construct the dataset based on available national-level data.

### 3.2. Innovations in the current CGE model

First innovation is a response to the need to allow for the downloading of both the results and methodology to the agencies that can directly address the economic impacts. Hence, the data used in the CGE model had to be calibrated at the city level that would allow the study to be directly communicated with the local government units (LGUs) of the two cities in the analysis. The so-called social accounting matrix (SAM) is therefore constructed for the cities of Valenzuela and Pasig using data from both primary and secondary sources.

Secondly, the simulation scenarios involve exploiting hazard data to construct simulation scenarios for the CGE model. This therefore involves a set of estimations to construct simulations that would be used to assess the impacts of climate change on the economy are derived from actual hazard measures rather than simple assumptions.

Final innovation is related to implementing a multi-week CGE analysis to highlight impacts of climate event to a local economy on a weekly basis. As extreme climate events happen only at a specific time within a year, the city-level data has also been brought down to weekly levels. In the same manner, the CGE model was programmed to be ran for 52 weeks (i.e. a year) against a weekly ‘factor recovery matrix’ that highlights how much of labor and capital becomes available or ‘operable’ for the various economic sectors as the economy recovers over time.

#### 3.2.1 City-level SAM construction

Before a CGE model becomes useable, it has to be calibrated first. Calibration of a CGE model means estimating and fixing the values of coefficients of all its equations based on empirical data (Hosoe, Gasawa, and Hashimoto 2010). Thus, calibration links the equations representing the behavior of agents in the CGE model to their behavior in the real world. A social accounting matrix (SAM) is used to calibrate a CGE model.

***Overview of SAM.*** A SAM is a database that summarizes the flow of resources and economic transactions across producers, households, government, firms, financial institutions, and the rest of the world. In actuality, the SAM takes the form of a square matrix where rows and columns are labeled according to the accounts they represent: economic activities, commodities, households, firms, government, savings-investment and rest of the world (**Figure 3.2**). Each cell in the SAM corresponds to payments made by the column entity to the row entity. For instance, the cell corresponding to (Household, Service) refers to payments made by household for services. Similarly, the cell (Agriculture, Manufacturing) is the amount paid by agricultural producers for intermediate inputs such as agricultural equipment produced by manufacturers. The sum of cells along a column is the total expenditure made by the corresponding entity. Meanwhile, the sum of cells in a row is the total income of an economic agent.

**Figure 3.2 A social accounting matrix**

| | Activity | Commodity | Labor | Capital | Household | Firm | Government | Savings-Investment | Rest of the World | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity | | $c^1$ | | | | | | | $r^1$ | $A$ |
| Commodity | $a^1$ | | | | $h^1$ | | $g^1$ | $s^1$ | | $C$ |
| Labor | $a^2$ | | | | | | | | | $L$ |
| Capital | $a^3$ | | | | | | | | | $K$ |
| Household | | | $l$ | $k^1$ | | | | | $r^2$ | $H$ |
| Firm | | | | $k^2$ | | | | | | $F$ |
| Government | $a^4$ | | | | $h^2$ | $f^1$ | | | | $G$ |
| Savings-Investment | | | | | $h^3$ | $f^2$ | $g^2$ | | $r^3$ | $S$ |
| Rest of the World | | $c^2$ | | | $h^4$ | | | $s^2$ | | $R$ |
| Total | $A$ | $C$ | $L$ | $K$ | $H$ | $F$ | $G$ | $S$ | $R$ | |

Source: Adapted from Cororaton (2003, 1)

The SAM shows the total value created in the economy from both expenditure and production sides. On the expenditure side, the gross value added (GDP) is the sum of all spending of institutional accounts (households, firms, government, saving-investment and rest of the world):

$$GDP = consumption + investment + gov\ spending + net\ exports$$

On the production side, value added can be expressed as the sum of payments made by production sectors to factors of production:

$$GDP = labor\ compensation + returns\ to\ capital$$

The SAM also presents a snapshot of the production technologies existing across different sectors. Production technology is the combination of intermediate inputs and factors of production necessary to produce a unit of output. However, the figures in a SAM are expressed not in terms of number of units but in terms of total values consumed by a production sector so one has to compute the ratios of each input consumed by a sector to total inputs consumed.

SAMs are snapshots of an economy in a given base year. The values in the SAM are baseline scenarios from which counterfactual solutions produced by CGE model will be compared. In this paper, city-level SAMs are used instead of an economy-wide SAM because this paper focuses on how equilibria in city-level economies change in the presence of shocks.

***Construction and data sources.*** The SAM is composed of several accounts: activities, commodities, factors of production, and institutional accounts. The columns of the SAM correspond to these accounts. The row labels of a SAM mirror the column labels. This section discusses the description of each of these accounts and how they are constructed.

**Table 3.1. Sectors in Valenzuela and Pasig SAM**

| Pasig | | Valenzuela | |
|---|---|---|---|
| Code | Sector name | Code | Sector name |
| food | Food manufacturing | food | Food manufacturing |
| | | text | Textile, garments and leather |
| | | wood | Wood, bamboo, cane and rattan articles |
| | | papr | Paper and paper products |
| chem | Chemicals | chem | Chemicals |
| rupl | Rubber and plastic | rupl | Rubber and plastic (and non-metallic) products |
| otmn | Miscellaneous manufactures, nec | | |
| | | metl | Metals |
| | | mach | Computer, machinery and equipment |
| | | otmn | Miscellaneous manufactures, nec |
| util | Utilities | util | Electricity, gas and water |
| cons | Construction | cons | Construction |
| trad | Wholesale and retail trade and Maintenance and repair of motor vehicles | trad | Wholesale and retail trade and Maintenance and repair of motor vehicles |
| comm | Transportation service and Communication | tran | Transportation, storage and communication |
| finr | Financial activities and real estate | fina | Financial intermediation |
| | | real | Real estate |
| prst | Business activities | busa | Business activities |
| ppsr | Public Administration and Defense; Compulsory social security | ppsr | Public Administration and Defense; Compulsory social security |
| eduh | Education, health and social work | educ | Education |
| | | heal | Human Health and Social Work Activities |
| otsr | Other service activities, nec | otsr | Other Service Activities, nec |

Source: Authors' calculations.

The activities account refers to sectoral production activities. This account is subdivided into sectors presented in **Table 3.1**. The entries under the activities account are constructed using city-level database of firms (prepared by local government units), the Annual Survey of Business and Industries (ASPBI from PSA), and the national input output table (IO table). The column sums of activities account are total value of output produced by sectors. These values are obtained from the datasets mentioned above. The values of output are distributed across cells in each sector using technical coefficients obtained from an IO table. By using a national IO table, city-level production activities are assumed to utilize the same technology used by firms in a particular sector at the national level.

The commodities account represents values of goods produced by domestic sectors that are traded in domestic markets as well as the imports. The commodities account has a diagonal submatrix $c_1$ where the diagonal entries are the values of goods produced in the domestic economy net of exports to the rest of the world. The diagonal values are obtained as residual between total output produced by sectors (from the activities accounts) and "exports" to the rest of the world which are obtained from Flow of Commodities accounts (prepared by PSA). The bottom row vector $c_2$ are imports from the rest of the world. Imports at the city-level are goods and services "imported" from areas outside the city of interest. The values of imports are obtained from Flow of Commodities accounts. Commodities account contains the same sectors as in the activities account.

Factor account contains the factor earnings of labor and capital. Labor and capital earnings come from activities accounts and are distributed to households. Labor earnings are classified into skilled and unskilled labor. In this paper, earnings of skilled labor refer to wages and salaries received by workers with tertiary education. The rest of labor earnings fall under unskilled labor. There are ten representative households corresponding to each income decile in the Pasig and Valenzuela SAMs so the factors earnings need to be distributed across these representative households. Ratios computed from Family Income and Expenditure Survey – Labor Force Survey (FIES-LFS) are used to distribute both wage income and capital earnings across households.

Institutional account is composed of household expenditures, firm consumption, government consumption, savings-investment accounts and rest of the world account. Household consumption is derived from FIES. In the SAMs, firms pay taxes to government and saves the rest of its earnings. Firm's tax payments are obtained from BLGF and savings are obtained residually. Government consumption is obtained from the Bureau of Local Government Finance (BLGF) dataset from Department of Finance. Values in the savings-investment account can be obtained from either the local government database of firms or the ASPBI. Lastly, the values for the rest of the world account are obtained from the Flow of Commodities accounts.

The Pasig and Valenzuela SAMs sets 2015 as the base year. Except for the IO table, all the datasets used in constructing the SAMs are dated 2015. Since the 2012 IO table is used to construct the SAM in the absence of a more recent dataset, it is assumed that there is no significant difference between the production technologies in 2012 and 2015.

Row sums must equal column sums of SAMs. However, because various datasets are used, the process of filling in the values resulted in an unbalanced Pasig and Valenzuela SAMs. An unbalanced SAM is not useable in CGE modeling so excess values (or deficits) in each account were redistributed across cells in the column where column sum is not equal to corresponding row sum. The principle behind this approach is based on Walras Law which implies that excess demand in one sector must be matched with excess supply. In the actual balancing of the Pasig and Valenzuela SAMs, the redistribution of values across cells in a column still resulted in imbalances in some accounts. This was addressed by using the RAS method.[6]

[6] The RAS algorithm is a common method used in balancing a SAM.

### 3.2.2 Deriving shocks from hazard measures

To understand the impacts of shocks to the macroeconomy, the study's simulation scenarios are derived from estimates of relationship between rainfall and value added. A fixed effects panel regression is implemented to establish a measure of changes in value added from labor and capital due to rainfall exposure. Then, similar to the 'inoperability' of the economic sectors in an IO framework from Haimes and Jiang (2001) and Yu, Tan and Santos (2013), the current study constructs a multi-week 'factor recovery matrix' to feature the availability of labor and capital for over a year after a flooding event.

For both innovations, data provided from teams of the Manila Observatory are important sources of hazard measures to improve the measure of shocks to be introduced through the factor recovery matrix. This therefore involves a set of estimations to construct shocks derived from actual hazard measures rather than simple assumptions.

***Rainfall impacts on value added.*** The output of any firm, sector, or economy can be expressed as a functional relationship $Y = f(L, K)$ between output and its factors of production—labor and capital. At the firm level, firms produce by transforming their raw materials to goods and services. Work done by labor and capital bring about value added. Labor and capital are therefore called primary inputs and is differentiated from various intermediate inputs that we commonly refer to as raw materials.

When access to the primary factors of production is constrained by any reason such as extreme flooding, then production is constrained as well. In the case of extreme climate events, value added to labor and capital are constrained as labor and capital become unavailable. Disruptions in business continuity is therefore demonstrated by the inability of a firm to operate fully because of constraints to its inputs. Municipal-level rainfall data from the satellite-based rainfall exposure from the Tropical Rainfall Measuring Mission (TRMM) prepared by the Manila Observatory[7] is used in fixed effects regression analysis to determine their impacts firm's value added from labor and capital. The econometric results are then used as initial shock to the returns to labor and capital.

**Table 3.2** below shows the results of the regression analysis which shows that for every 1 mm of rainfall measured, value added decreases by 0.093% according to model, capital returns decrease by 0.105%, and compensation decrease by 0.016% according to model. This must mean that the impact of rainfall exposure is more significant on returns to capital compared to impact on labor compensation. As it can be expected, the impacts of rainfall exposure on value added comes mostly from its impacts on value added from physical assets. The results suggest that value-adding activities of firms are affected by rainfall exposure when labor efforts of employees are funneled towards cleaning and repair of capital. As employees are still compensated despite their non-productive work after rainfall exposure, value-adding capacities of a firm's physical assets are affected due to rainfall exposure.

**Table 3.2 Fixed effects regression results**

| VARIABLES | (1)<br>ln_va | (2)<br>ln_return | (3)<br>ln_comp |
|---|---|---|---|
| ln_employed | 0.774*** | 0.729*** | 0.957*** |
| | (0.016) | (0.018) | (0.009) |
| ln_assets | 0.241*** | 0.260*** | 0.142*** |
| | (0.009) | (0.010) | (0.005) |
| ln_infra | 0.079*** | 0.060*** | 0.054*** |
| | (0.010) | (0.011) | (0.006) |

[7] The fixed effects regression analysis has been implemented using rainfall data by the team from the Regional Climate Systems of the Manila Observatory led by Dr. Faye Abigail Cruz.

| | | | |
|---|---|---|---|
| mean_rain | -0.093*** | -0.105*** | -0.016*** |
| | (0.009) | (0.010) | (0.006) |
| age | | | |
| | | | |
| fil | -0.487*** | -0.516*** | -0.350*** |
| | (0.078) | (0.105) | (0.036) |
| i1 | | | |
| | | | |
| i2 | -0.255*** | -0.265** | -0.045 |
| | (0.096) | (0.105) | (0.067) |
| Constant | 9.047*** | 9.426*** | 8.594*** |
| | (0.258) | (0.285) | (0.146) |
| | | | |
| Observations | 24,104 | 21,523 | 33,142 |
| Number of TIN_id | 17,864 | 16,368 | 21,803 |
| Adjusted R-squared | 0.581 | 0.575 | 0.696 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Source: Authors' calculations.

***Multi-week factor recovery matrix.*** In order to finally introduce shocks to labor and capital availability due to a climate event, information from the regression analysis and business sector representatives alongside barangay-level flooding data and establishment data for the cities of Valenzuela and Pasig are used to construct a "factor recovery matrix". This matrix contains 'scenarios' that will be considered as shocks to the economic system being modeled. The steps used by the team to construct these factor recovery matrices for the cities of Valenzuela and Pasig therefore include:

1. Estimate initial shock (i.e. within first week after climate event) to all the economic sectors using information from regression analysis and from business sector representatives;
2. Obtain sectoral level estimates of recovery over the next 51 weeks using information from the business sector representatives;
3. Translate spatial (i.e. barangay-level) flooding data into sectoral flooding data using the distribution of economic sectors across barangay to derive an estimate how much of each sector's production is affected by flooding; and
4. Use the sectoral-level estimates of affected operations to revise sectoral level estimates of recovery from Step 2.

Such matrices trace labor and capital availability over weekly time periods across all the economic sectors included in the SAM. The recovery matrix contains values between 0 and 1. Unlike Yu, Tan and Santos (2013) however, a value of 0 means that no amount of capital or labor is available for production. On the other hand, a value of 1 means that all of the capital and labor are available for production. It therefore has a dimension of 52 weeks times the number of sectors in the SAM. It can then trace how labor and capital become more available for production over time across the various economic sectors.

Data on barangay-level flood maps constructed from historical rainfall data from Project Noah prepared by the Manila Observatory[8] are also combined with data on barangay-level distribution of business establishments across the various sectors from the List of Establishments provided by the LGUs Business Permits and Licensing Office (BPLO) to estimate the percentage of affected area per barangay.

[8] The construction of the factor recovery matrix use flood maps data prepared by the team from the Geomatics for Environment and Development of the Manila Observatory led by Dr. May Celine Thelma M. Vicente.

This therefore allows for an estimate of how much of each sector is affected by potential flooding by assuming that the percentage of flooding per barangay is the same percentage of production is affected by flooding. These floods maps are available for three types of flooding with various intensities. The flooding scenario in '100-year flood' refers to rainfall scenarios that occur once every 100 years, '25-year flood' refers to rainfall scenarios that occur every 25 years, and '5-year flood' referring to the rainfall scenarios that are most common.

Since not all firms are affected by flooding, information on flooding may be necessary in order to improve the recovery estimates. In Valenzuela, it is found that the flooding problem is varied across the barangays as shown in **Table 3.3a** below. This information on flooding intensity at different levels of probability of happening is then interacted with the various types of industry. We therefore must estimate the average flooding experienced by the various sectors whose firms scattered around the entire city as shown in **Table 3.3b**. Finally, the estimates from Table 5 is then fed into the original recovery periods the following formula using weighted average:

$$average\ input\ availabity = (\%\ flooded \bullet \%\ input\ availability) + (1 - \%\ not\ flooded)$$

**Table 3.3a Percentage of total area estimated to be flooded in Valenzuela City**

| *Barangay* | *Total area* | *5-year flood* | *25-year flood* | *100-year flood* |
|---|---|---|---|---|
| *Arkong Bato* | 377,287.67 | 45.09 | 69.22 | 49.20 |
| *Bagbaguin* | 1,055,770.21 | 20.23 | 26.30 | 19.89 |
| *Balangkas* | 1,228,414.36 | 40.19 | 57.87 | 44.08 |
| *Bignay* | 3,327,036.21 | 33.29 | 43.42 | 47.33 |
| *Bisig* | 147,335.37 | 46.23 | 67.58 | 66.51 |
| *Canumay East (Canumay)* | 1,332,232.14 | 23.92 | 31.88 | 22.10 |
| *Canumay West (Canumay)* | 1,841,591.59 | 26.13 | 33.31 | 28.55 |
| *Coloong* | 1,965,761.51 | 76.34 | 89.53 | 90.54 |
| *Dalandanan* | 1,198,417.85 | 35.36 | 55.76 | 28.82 |
| *Gen. T. De Leon* | 3,395,295.12 | 15.41 | 21.64 | 17.30 |
| *Isla* | 469,350.01 | 60.72 | 79.37 | 70.42 |
| *Karuhatan* | 1,901,286.23 | 17.95 | 25.46 | 16.37 |
| *Lawang Bato* | 2,730,208.43 | 29.51 | 37.67 | 39.62 |
| *Lingunan* | 1,997,075.00 | 48.33 | 55.34 | 56.03 |
| *Mabolo* | 93,117.42 | 28.04 | 66.52 | 40.33 |
| *Malanday* | 2,198,044.77 | 70.11 | 85.98 | 81.26 |
| *Malinta* | 2,063,708.73 | 35.06 | 42.07 | 34.96 |
| *Mapulang Lupa* | 1,428,232.78 | 20.39 | 27.03 | 19.21 |
| *Marulas* | 2,501,365.15 | 34.67 | 40.50 | 43.45 |
| *Maysan* | 2,137,088.10 | 43.34 | 54.84 | 46.97 |
| *Palasan* | 310,479.55 | 44.07 | 69.60 | 88.44 |
| *Parada* | 1,457,188.08 | 30.11 | 39.82 | 24.17 |
| *Pariancillo Villa* | 106,580.25 | 36.86 | 53.84 | 33.63 |
| *Paso De Blas* | 1,415,403.25 | 33.81 | 42.81 | 34.96 |
| *Pasolo* | 486,948.25 | 50.85 | 82.07 | 65.79 |
| *Poblacion* | 35,510.91 | 23.19 | 45.25 | 27.91 |
| *Pulo* | 50,465.29 | 43.72 | 77.79 | 54.81 |
| *Punturin* | 1,813,096.16 | 23.89 | 30.29 | 33.63 |
| *Rincon* | 403,907.33 | 51.32 | 69.97 | 45.98 |

| | | | | |
|---|---|---|---|---|
| *Tagalag* | 1,347,228.81 | 78.76 | 90.87 | 91.75 |
| *Ugong* | 3,344,933.35 | 17.78 | 26.49 | 27.28 |
| *Viente Reales* | 1,945,389.97 | 51.45 | 62.54 | 60.98 |
| *Wawang Pulo* | 443,114.21 | 57.56 | 68.24 | |

*Source: Manila Observatory*

**Table 3.3b Estimated extent of flooding per sector in Valenzuela City**

| *Sector* | *5-year flood* | *25-year flood* | *100-year flood* |
|---|---|---|---|
| *Food manufacturing* | 37.13 | 51.04 | 43.87 |
| *Textile, garments and leather* | 34.47 | 45.03 | 38.53 |
| *Wood, bamboo, cane and rattan articles* | 36.82 | 47.73 | 44.39 |
| *Paper and paper products* | 33.98 | 45.66 | 38.96 |
| *Chemicals* | 34.70 | 46.19 | 38.61 |
| *Rubber and plastic products* | 35.08 | 47.04 | 39.26 |
| *Non-metallic mineral products* | 34.70 | 46.19 | 38.61 |
| *Metals* | 34.05 | 43.84 | 40.29 |
| *Computer, machinery and equipment* | 29.40 | 37.66 | 33.16 |
| *Transport equipment* | 29.40 | 37.66 | 33.16 |
| *Miscellaneous manufactures, nec* | 37.30 | 49.13 | 41.48 |
| *Electricity, gas and water* | 39.19 | 51.97 | 45.09 |
| *Wholesale and retail trade and Maintenance and repair of motor vehicles* | 39.20 | 53.66 | 45.89 |
| *Transportation, storage and communication* | 39.70 | 53.92 | 46.45 |
| *Financial intermediation* | 33.78 | 46.95 | 39.98 |
| *Real estate* | 38.63 | 53.21 | 45.38 |
| *Business activities* | 38.52 | 52.37 | 45.46 |
| *Accommodation and Food Service Activities* | 37.04 | 51.47 | 43.13 |
| *Education* | 36.45 | 50.03 | 42.07 |
| *Human Health and Social Work Activities* | 35.32 | 49.16 | 41.51 |
| *Other Service Activities, nec* | 36.78 | 49.96 | 42.64 |

*Source: Authors' calculations.*

Unfortunately for the case of Pasig City, distribution of the various economic sectors across the barangays cannot be computed from their BPLO database. The percentage of business operations affected is therefore assumed the same across the sectors using the total flooded area in the Pasig flood maps. **Tables 3.4 and 3.5** show the factor recovery matrices for Valenzuela and Pasig respectively for the case of a 100-year flood.

**Table 3.4a Capital recovery matrix for Valenzuela City in a 100-year flood scenario**

| Sectors | Weeks | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| food | 0.56 | 0.56 | 0.56 | 0.56 | 0.57 | 0.58 | 0.62 | 0.66 | 0.70 | 0.74 | 0.78 | 0.79 | 0.86 | 0.87 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.95 | 0.96 | 0.97 | 0.98 | 0.99 | 1.00 |
| text | 0.61 | 0.61 | 0.61 | 0.61 | 0.62 | 0.63 | 0.67 | 0.70 | 0.74 | 0.77 | 0.81 | 0.81 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.91 | 0.92 | 0.93 | 0.94 | 0.94 | 0.95 | 0.96 | 0.97 | 0.97 | 0.98 | 0.99 | 1.00 |
| wood | 0.56 | 0.56 | 0.56 | 0.56 | 0.57 | 0.57 | 0.61 | 0.66 | 0.70 | 0.74 | 0.78 | 0.79 | 0.86 | 0.86 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 0.94 | 0.94 | 0.95 | 0.96 | 0.97 | 0.98 | 0.99 | 1.00 |
| papr | 0.81 | 0.80 | 0.80 | 0.80 | 0.81 | 0.81 | 0.83 | 0.86 | 0.89 | 0.92 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| chem | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.83 | 0.86 | 0.89 | 0.92 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| rupl | 0.81 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.83 | 0.86 | 0.89 | 0.92 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| nmet | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.81 | 0.83 | 0.86 | 0.89 | 0.92 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| metl | 0.60 | 0.60 | 0.60 | 0.60 | 0.61 | 0.61 | 0.65 | 0.69 | 0.72 | 0.76 | 0.80 | 0.81 | 0.87 | 0.88 | 0.89 | 0.89 | 0.90 | 0.91 | 0.92 | 0.93 | 0.93 | 0.94 | 0.95 | 0.96 | 0.97 | 0.97 | 0.98 | 0.99 | 1.00 |
| mach | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.68 | 0.71 | 0.74 | 0.77 | 0.80 | 0.83 | 0.84 | 0.89 | 0.90 | 0.91 | 0.91 | 0.92 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.96 | 0.97 | 0.97 | 0.98 | 0.99 | 0.99 | 1.00 |
| treq | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.68 | 0.71 | 0.74 | 0.77 | 0.80 | 0.83 | 0.84 | 0.89 | 0.90 | 0.91 | 0.91 | 0.92 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 | 0.96 | 0.97 | 0.97 | 0.98 | 0.99 | 0.99 | 1.00 |
| otmn | 0.59 | 0.59 | 0.59 | 0.59 | 0.59 | 0.60 | 0.64 | 0.68 | 0.72 | 0.75 | 0.79 | 0.80 | 0.87 | 0.87 | 0.88 | 0.89 | 0.90 | 0.91 | 0.91 | 0.92 | 0.93 | 0.94 | 0.95 | 0.96 | 0.96 | 0.97 | 0.98 | 0.99 | 1.00 |
| util | 0.57 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| trad | 0.54 | 0.54 | 0.54 | 0.54 | 0.77 | 0.77 | 0.80 | 0.84 | 0.87 | 0.90 | 0.93 | 0.93 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| tran | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| fina | 0.60 | 0.60 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| real | 0.55 | 0.55 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| busa | 0.55 | 0.55 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| htrt | 0.57 | 0.57 | 0.57 | 0.57 | 0.78 | 0.78 | 0.82 | 0.85 | 0.88 | 0.91 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| educ | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| heal | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| otsr | 0.57 | 0.57 | 0.57 | 0.57 | 0.79 | 0.79 | 0.82 | 0.85 | 0.88 | 0.91 | 0.94 | 0.94 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Source: Author’s calculations

### Table 3.4b Labor recovery matrix for Valenzuela City in a 100-year flood scenario

| Sectors | Weeks | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| **food** | 0.67 | 0.71 | 0.78 | 0.87 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **text** | 0.71 | 0.75 | 0.80 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **wood** | 0.66 | 0.71 | 0.78 | 0.87 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **papr** | 0.70 | 0.74 | 0.80 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **chem** | 0.71 | 0.75 | 0.80 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **rupl** | 0.70 | 0.74 | 0.80 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **nmet** | 0.71 | 0.75 | 0.80 | 0.89 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **metl** | 0.69 | 0.74 | 0.80 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **mach** | 0.75 | 0.78 | 0.83 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **treq** | 0.75 | 0.78 | 0.83 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **otmn** | 0.69 | 0.73 | 0.79 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **util** | 0.69 | 0.70 | 0.72 | 0.74 | 0.76 | 0.79 | 0.81 | 0.84 | 0.87 | 0.91 | 0.95 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **trad** | 0.65 | 0.70 | 0.77 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **tran** | 0.69 | 0.70 | 0.70 | 0.71 | 0.72 | 0.73 | 0.74 | 0.75 | 0.77 | 0.78 | 0.79 | 0.80 | 0.82 | 0.83 | 0.85 | 0.86 | 0.88 | 0.90 | 0.92 | 0.94 | 0.96 | 0.98 | 1.00 |
| **fina** | 0.67 | 0.67 | 0.74 | 0.88 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **real** | 0.62 | 0.62 | 0.70 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **busa** | 0.62 | 0.62 | 0.70 | 0.86 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **htrt** | 0.67 | 0.72 | 0.78 | 0.87 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **educ** | 0.72 | 0.77 | 0.82 | 0.89 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **heal** | 0.73 | 0.77 | 0.82 | 0.89 | 0.98 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **otsr** | 0.68 | 0.72 | 0.78 | 0.87 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Source: Author’s calculations

## Table 3.5a Capital recovery matrix for Pasig City in a 100-year flood scenario

| Sectors | Weeks | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 29 |
| **food** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **beve** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **text** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **wood** | 0.66 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **chem** | 0.66 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **rupl** | 0.66 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **nmet** | 0.66 | 0.64 | 0.64 | 0.64 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **metl** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **mach** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **treq** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 0.99 |
| **otmn** | 0.29 | 0.29 | 0.29 | 0.29 | 0.30 | 0.32 | 0.38 | 0.45 | 0.51 | 0.58 | 0.64 | 0.66 | 0.77 | 0.78 | 0.80 | 0.81 | 0.83 | 0.84 | 0.85 | 0.87 | 0.88 | 0.90 | 0.91 | 0.93 | 0.94 | 0.95 | 0.97 | 0.98 | 1.00 |
| **util** | 0.33 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **trad** | 0.29 | 0.29 | 0.29 | 0.29 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **tran** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **finr** | 0.29 | 0.29 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **prst** | 0.29 | 0.29 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **ppsr** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **eduh** | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **otsr** | 0.29 | 0.29 | 0.29 | 0.29 | 0.64 | 0.64 | 0.70 | 0.75 | 0.80 | 0.85 | 0.90 | 0.90 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Source: Author's calculations

**Table 3.5b Labor recovery matrix for Pasig City in a 100-year flood scenario**

| Sectors | Weeks | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 |
| **food** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **beve** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **text** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **wood** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **chem** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **rupl** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **nmet** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **metl** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **mach** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **treq** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **otmn** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **util** | 0.51 | 0.54 | 0.56 | 0.59 | 0.63 | 0.66 | 0.71 | 0.75 | 0.80 | 0.86 | 0.92 | 0.99 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **trad** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **tran** | 0.52 | 0.54 | 0.55 | 0.56 | 0.58 | 0.59 | 0.61 | 0.62 | 0.64 | 0.66 | 0.68 | 0.70 | 0.72 | 0.74 | 0.77 | 0.79 | 0.82 | 0.85 | 0.88 | 0.91 | 0.94 | 0.97 | 1.00 |
| **finr** | 0.41 | 0.41 | 0.54 | 0.78 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **prst** | 0.41 | 0.41 | 0.54 | 0.78 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **ppsr** | 0.54 | 0.61 | 0.70 | 0.81 | 0.96 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **eduh** | 0.54 | 0.61 | 0.70 | 0.81 | 0.96 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| **otsr** | 0.46 | 0.54 | 0.64 | 0.79 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |

Source: Author's calculations

## 4. Results in Valenzuela City Model

The discussion in this section shows the results of the simulation made for Valenzuela. An overview of the socio-economic profile of the city is first discussed, including the businesses that are present in the urban area. Then a discussion of the simulation results is provided, showing an initial introduction of the labor constraint in the model and the results of the simulations. Then a resilience index is computed to analyze the impact of changes in the industry value added on the recovery period of the different sectors in the city.

### 4.1. Socio-economic profile of Valenzuela City

As a highly urbanized city, the City of Valenzuela has been emerging as one of the country's top manufacturing hubs given its numerous rising infrastructures and highly innovative environment. Being known as the "Gateway of the North", Valenzuela City is part of National Capital Region (NCR) as its third district, together with Caloocan City, Malabon City and Navotas City (collectively known as CAMANAVA). CAMANAVA is the third district of NCR and is known for being one of the country's most disaster-prone area not only during heavy rains but also high tides and river overflows. Flooding occurs not only during the rainy season of May to September but through the year due the high tides. This became one of the city's biggest challenges.

With a total of 33 barangays, the city of Valenzuela is divided into two political districts to equally represent the entire city to the congress. Specifically, District 1 is comprised of barangays Arkong Bato, Balangkas, Bignay, Bisig, Canumay East, Canumay West, Coloong, Dalandanan, Isla, Lawang Bato, Lingunan, Mabolo, Malanday, Malinta, Palasan, Pariancillo Villa, Pasolo, Poblacion, Pulo, Punturin, Roncon, Tagalag, Viente Reales, and Wawang Pulo; and District 2 has barangays Bagbaguin, Karuhatan, Gen. T. De Leon, Mapulang Lupa, M:arulas, Maysan, Parada, Paso de Blas, and Ugong. Through its infrastructure development and innovation, the city was able to sustain its productivity through effective government system and economic factors such as financial, natural, human and physical capital. Aside from the city's effective regulations as reflected by its numerous awards and recognitions, the accelerating development of industries had provided job opportunities to the growing labor force, improving the city's economic status.

***Land use distribution*.** Geographically, it is bordered by four major interconnecting rivers, namely, Meycauayan River, Polo River, Calooing River and Tullahan River. With only an average elevation of 2.0m above sea level, the city is within an area that has a 16% frequency of tropical cyclones which makes it vulnerable to flooding during high tides and flash floods on rainy seasons (Department of Transportation, 2017). Despite its geographical setbacks, industrial development transformed the city into a hub of emerging businesses and flourishing industries – head starting its economic boom. Overall, the city has a total land area of 4,459.48 hectares which is distributed into different land uses such as commercial use, institutional use, industrial use, residential use, agricultural use, roads, parks, etc. Majority of its land area are allocated for residential use with 1666.29 hectares, occupying 37% of the city's land area. Specifically, Barangay Gen. T. de Leon has the largest residential land area with 284.47 hectares followed by Malanday and Ugong with 136.03 and 106.04 hectares, respectively. Moreover, industries and commercial buildings hold 741.74 and 160.61 hectares, respectively, together occupying 20% of Valenzuela. It is also worth noting that aside from businesses, the city is still holding agricultural areas, fishponds and rivers which diversifies its sources of livelihood. Unfortunately, only Brgy. Punturin remains to have an agricultural land which has an area of 22.81 has. Specifically, swamps, rivers and fishponds have an area of 71.89 has., 103.48 has., and 345 has., respectively, totally occupying 11.68% of the city's total area.

***Business environment.*** In terms of ease of doing business, Valenzuela City is at the top amongst the ease of registering property in the Philippines. Moreover, it ranks fourth on ease of doing business and sixth in the easiest to deal with construction permits. These qualities were seen to reflect the prominent role of local governments in the city's business start-ups and construction requirements. To better understand the economic landscape of the City of Valenzuela, the database of the Business and Permits Licensing Office (BPLO) for their business permit applications is used to estimate the distribution of the number of establishments and the productive activities across the sectors.

As it is already well-known, Valenzuela City is a popular location for manufacturing firms in the National Capital Region. In fact, different forms of manufacturing firms comprise almost 15% of all establishments for year 2015 in the city based on the database of BPLO. Revenue data from the same database, however, reveals that manufacturing firms comprise of around 65% of revenues in Valenzuela for the year 2015. With regards to the manufacturing activities inside the city, rubber and plastic industries produce the most with their sales comprising around 15% of the revenues. The second and third largest manufacturing sectors are the food & beverages and the metals sectors, respectively. The other big sector is the wholesale and retail trade & maintenance and repair, which comprises more than a third of the total number of establishments. Albeit, their revenues only make up a quarter of the total revenues. Such can be expected that cities like Valenzuela with large manufacturing sectors also involve a lot of scrap recycling on top of the usual wholesale and retail trade. Other establishments that contributed to the city's revenues includes transport, storage & communication (2%) and real estate (1%).

Based on the self-reported data on capital spending for newly-applied business permits, it shows that the biggest capital investment in 2015 came from the metal sector at 6.5%. This is followed at around 4% by the other manufacturing which include the following activities: (1) agro-industrial processing, (2) assembly & processing, (3) metalcraft, machine works, and fabricators, and (4) all other manufacturing activities with or without machineries. Interestingly, data shows that self-reported investment is biggest for firms involved with trade at 41% of all capital spending. As it can be expected, investments made by apartment rental activities are also high. For the case of employment, the transport, storage & communication is surprisingly the biggest employer at 46% of all employees. The next biggest employer is trade at around 12%.

***Population structure.*** Based on the 2015 Population data from Philippine Statistics Authority (PSA), the city of Valenzuela is recorded to have a population count of 620,422, 7th highest in the NCR Region. Using a Geometric Growth Model estimated by the city's Planning and Development Office, Valenzuela is projected to have 675,979 residents by 2021. In terms of population per se (i.e. based on the actual numbers of population living in an area), Brgy. Gen T. de Leon is recognized to have the highest population with 89,441 residents (14% of the city's total population) while the heaviest populated barangay is Ugong. In addition, Brgy. Palasan was recorded to have the densest population in the city.

In terms of its gender composition, the city has 50.51% male (313,419) and 49.48% female (307,003), with a sex ratio of 102 i.e. 102 males for every 100 females. The city's sex structure with regards to age is aligned with the flow of the global pattern where males predominate at birth and gradually declines with age since males have higher age-specific mortality rates. Furthermore, it is observed that most of the city's population are aged between 20 to 24 while the least are aged between 85 onwards. This reflects the higher concentration of its population distribution on labor force where 69% of the population are between 15 to 64 years old. Owing it to the city's effective policies on social protection, the ration of young dependents is high wherein there is only 5 elderly people who are dependent to every working individual.

***Social statistics.*** Given its consistently growing economy, the city of Valenzuela is also determined to ensuring inclusive and sustainable growth through government programs and projects to eliminate its poverty issues in terms of income and livelihood, health, housing, water and sanitation, education, and peace and order. With rising businesses and booming industries, employment opportunities were expanded and more residents were able to find jobs, resulting to an unemployment rate of 8.5 percent – substantially lower than the 12.8 percent unemployment rate of 2012. From 2005 to 2012, the City Public Employment Service Office (PESO) was able to provide jobs to 146,184 city residences.

Poverty incidence in the city was still high at 28.2 percent i.e. 28 out of 100 households were living below the poverty threshold. Furthermore, the city has a subsistence incidence of 18% wherein 18 out of 100 households have income below the food (subsistence) threshold. In terms of water access and sanitation, there is only 1.4 percent of households who do not have access to safe water and 0.4 percent that do not have access to sanitary toilet facilities. With regards to its crime and protection, Valenzuela is recognized as the safest city in the Philippines. It has been focusing on providing its residents with effective local social services programs to eradicate crime. This resulted to low crime rate where only 0.1 percent of the city population has been victims of crime, standing up to its reputation as the Best Police Station in NCR.

Based on its Community-Based Monitoring System (CBMS), health statistics also showed that the city has an average of 0.1 percent of households that has a member under 5-year-old who died. Moreover, the proportion of women who died during pregrancy-related causes was average at 0.0 since it was only barangays Palasan, Pariancillo Villa, Bagbaguin, and Gen. T. De Leon with 0.6 percent, 0.4 percent, 0.2 percent, and 0.2 percent, respectively, that had one while the rest had none. Lastly, the proportion of household with malnourished children were 1.9 percent. However, it should be noted that the government has been taking steps to enhance the quality of its residence from various health programs to facility development such as improving hospital facilities, doctor-patient ratio and numerous health programs.

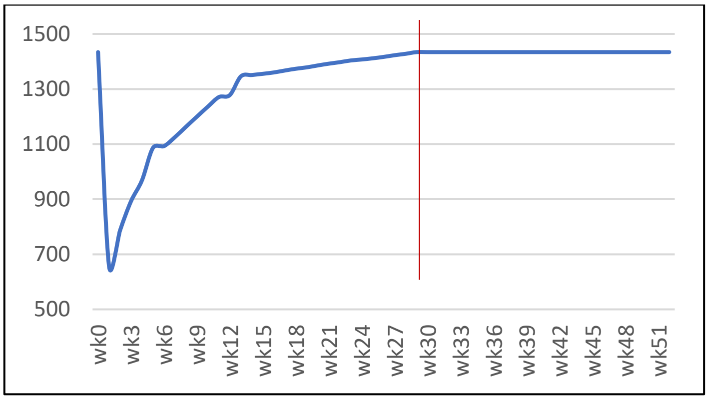
Improving education has also been one of the city's accomplishments. From 2004 to 2012, the city of Valenzuela was able to build more classroom and now has a total of 731 classrooms in its vicinity. Based on CBMS' education indicators, the city's proportion of children aged 6-15 years who are not attending school is at 5.8 percent. To point it out, the proportion of children aged between 6-11 years old who are not attending elementary school is only 2.4 percent.

### 4.2. Impacts on economic variables

In the following, the economic impacts of extreme weather resulting in the flooding of areas within the City of Valenzuela are explored. A series of computations of weekly economic equilibria was computed with the weekly discount factors describing the availability of weekly labor and capital endowments of the city used as the shocks. The factors are those obtained from the factor recovery matrices.

**Figure 4.1** shows the trajectory of the city's GDP from week 0 to week 52. In week 0, the weekly GDP of the city was 1.434 billion pesos. Following the extreme flooding of a type that may occur once in a hundred years, the GDP dropped to 656.6 million, or economic activity slowed down by 54%. Recovery started to gradually pick up starting in the second week. The process continued until in week 29, the weekly GDP before the extreme weather shock occurred. Recovery started to gradually pick up starting in the second week. The process continued until in week 29, the weekly GDP before the extreme weather shock occurred.

**Figure 4.1 Effects of extreme flooding on the weekly GDP (in mln. pesos) of Valenzuela City**




Source: Authors' calculations.

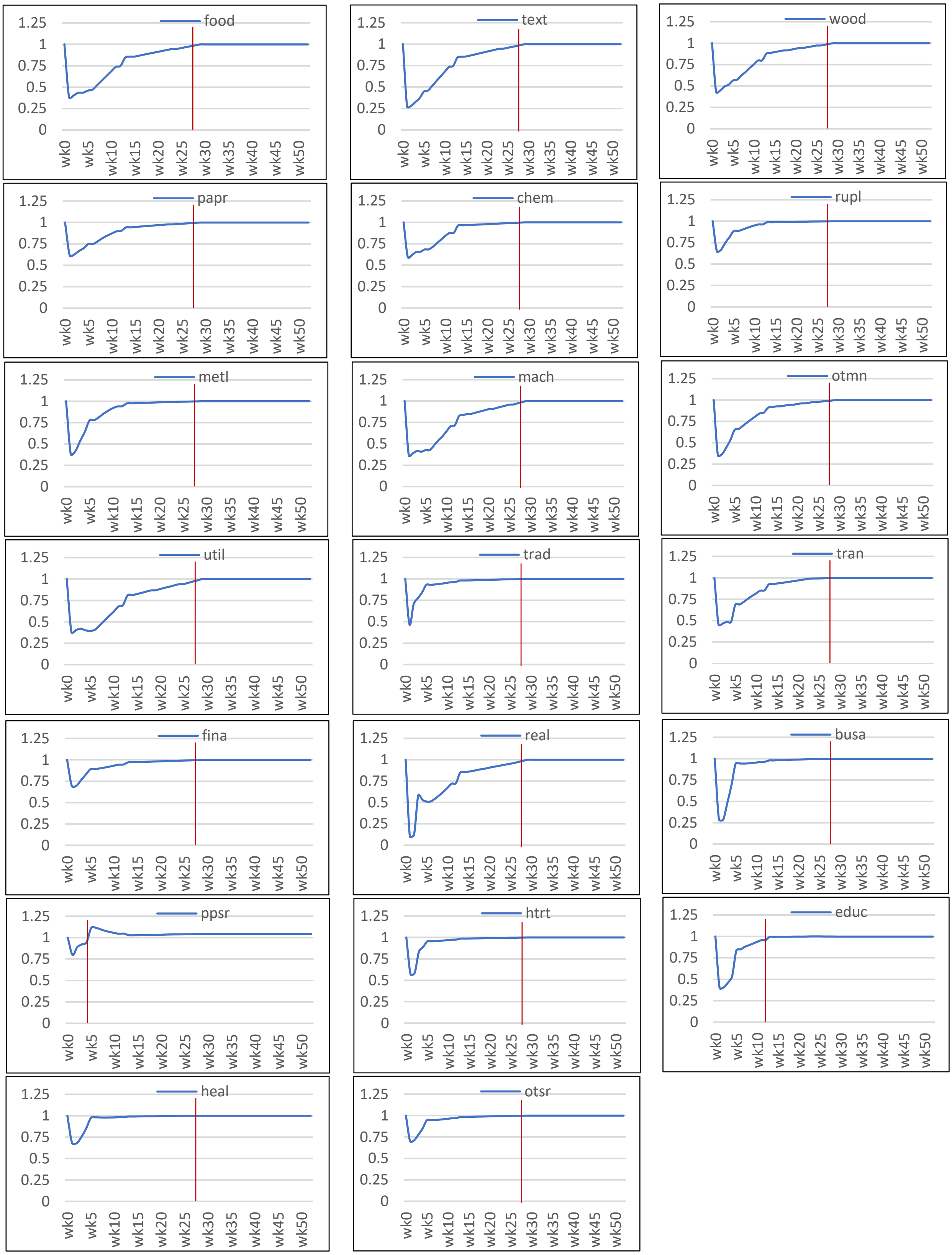
The shocks in the first week were obtained from the labor and capital recovery matrices. The average non-availability rates of capital and labor were 71% and 72%, respectively. The GDP went down by only 54% in the first week. This may be explained by some able to make use of the resources which other industries are not able to do so because they might have been hit harder by the shock.

In **Figure 4.2**, we show the adjustments of each industry of the local economy to extreme flooding. Typically, the first few weeks witness the reduction of economic activities. The lowest observed drop was by about 90%, and this was for the real property sector. All industries adjust to the shocks, but the least to adjust was public administration and services, which is expected. It only slowed down its activity in the first week by 20%.

Gradually these industries recover at varying rates. Public administration and services recovered fully by the fourth week, and even expanded more its activity presumably to provide assistance to the private sector industries and the constituents of the local government affected by the calamity.

But most of the other industries took 29 weeks or a period of about 7 and a half months. Educational services recovered fully in 22 weeks. Usually the activities of the public schools get disrupted as their buildings are used to shelter residents affected by the flood.

**Figure 4.2 Weekly output changes to extreme flooding by industry**




Source: Authors' calculations.

As these industries approach full recovery, the activities are very close to recovering fully what they used to produce before these get inundated by the floods.

To describe how the calamity affected each industry, the following parameters are noted: the initial drop of economic activity, the length in weeks of the recovery, and based on the two the weekly recovery rate. **Table 4.1** shows these parameters by industry.

The first parameter captures the vulnerability of the industry to the extreme weather situation. Industries like the real estate, textiles, business activities, other manufacturing, computers, machineries and equipment, metals, utilities, food manufacturing, education, wood and bamboo, transportation storage and trade services have output reductions in the first week by above average, which is 52%. Less vulnerable industries are the services sector, as well as chemical industry, paper and paper products, and rubber and plastic for merchandise products.

There is hardly any variation in the duration each industry goes through to fully recover from the flooding. Except for a few industries, namely public administration and services, education and health and social work, it took 29 weeks for the local industries to be back to where they were before the calamity. The average recovery rate is 2.57% each week.

**Table 4.1 Adjustment of industries to extreme flooding**

| Industry | Largest drop in output by % | Length of recovery in weeks | Recovery rate in weekly output increase (%) |
|---|---|---|---|
| Food manufacturing | 61.9 | 29 | 1.31 |
| Textile | 73 | 29 | 0.93 |
| Wood and bamboo | 57.2 | 29 | 1.48 |
| Paper and paper products | 38.6 | 29 | 2.12 |
| Chemicals | 40.7 | 29 | 2.04 |
| Rubber and plastic | 35 | 28 | 2.32 |
| Metals | 62 | 29 | 1.31 |
| Computer machine and equipment | 63.8 | 29 | 1.25 |
| Other manufacturing | 64.8 | 29 | 1.21 |
| Electricity gas and water | 62 | 29 | 1.31 |
| Wholesale and retail trade | 53.1 | 29 | 1.62 |
| Transportation storage and communication | 54.7 | 29 | 1.56 |
| Finance | 30.5 | 29 | 2.40 |
| Real estate | 89.7 | 29 | 0.36 |
| Business activities | 71 | 29 | 1.00 |
| Public administration and services | 20.2 | 4 | 19.95 |
| Hotel and restaurant | 42.8 | 29 | 1.97 |
| Education | 60.1 | 22 | 1.81 |
| Health and social work | 31.7 | 22 | 3.10 |
| Other services | 29.9 | 29 | 2.42 |

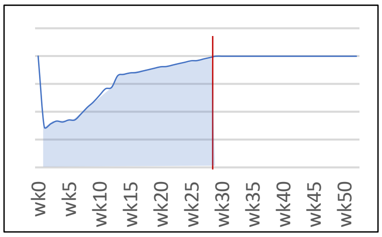
Source: Authors' calculations.

An industry resilience index is computed for each of the industries of the city. Box describes the concept and the computation of the measure. The more resilient industries of the city include rubber and plastic; and most of the services industries. Aside from rubber and plastic, the other above average resilient goods industries are the metals, paper and per products, metals, and chemicals.

The industry resilience index is associated with the respective value added contributions of the industries concerned to the local industry. Figure 3 plots the variables and the generated relationship is mixed. A downward sloping trend line would have suggested the city con do more to protect the industries with relatively large value added. Wholesale and retail trade appear to be a model, highly resilient and significant contribution to the local economy. It is an outlier because of its relatively large value added. If the observation is limited to industries except domestic trade, the pattern remains unclear.

The correlation coefficient is low at 14.6%. Of the industries which have above average industry resilience indices only three of the industries with above average IIE belonged to the group of industries with above-average contributions to the city's GDP, namely rubber and plastic; finance and wholesale and retail trade services. This suggests that local authorities can still improve their protection of local industries which are vulnerable to extreme weather situations in order to minimize the economic cost of natural calamities.

**Box. Industry Resilience Index (IRI)**




An industry hit by extreme flooding loses temporarily resources to produce its output. This may be due to its impaired access to materials; inability of workers to report for work because of the flood; or the capital equipment is damaged. It takes the adjustment period before its firms regain their respective original productive capacities.

The industry resilience index (IRI) is defined as the industry's output generated over the adjustment period in proportion to its pre-calamity level divided by the number of periods it went through till full recovery. It is the shaded area in the Chart. An industry with hardly any loss in output would be more resilient compared to otherwise. The shaded area portrays the output generated over the adjustment period delineated by the period when its productive capacity is fully restored. Computationally, $IRI = \frac{\left\{\frac{\sum_{t=1}^{n} VA_t}{VA_0}\right\}}{n}$. If the industry did not lose its productive capacity following a calamity, then $IRI = 1$, or it is perfectly resilient. However, if in the limit, all the value added, $VA_t$, during the adjustment period with length n periods sums up to zero, then $IRI = 0$, i.e. a situation where the industry completely lacks any resilience.

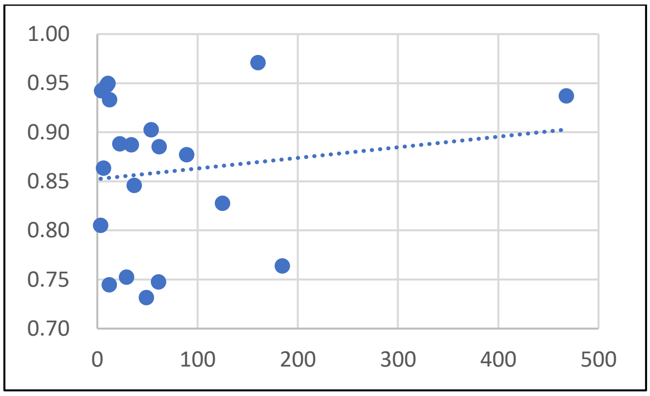
**Table 4.2 Resilience levels and value added of industries in Valenzuela City**

| Industry | Industry Resilience Index (1, perfectly resilient to 0, not resilient) | Weekly Value added (mln. Pesos) |
|---|---|---|
| Food manufacturing | 0.76 | 184.64 |
| Textile | 0.75 | 61.19 |

| | | |
|---|---|---|
| Wood and bamboo | 0.81 | 3.3 |
| Paper and paper products | 0.89 | 33.94 |
| Chemicals | 0.88 | 89.35 |
| Rubber and plastic | 0.97 | 160.27 |
| Metals | 0.89 | 61.96 |
| Computer machine and equipment | 0.74 | 11.92 |
| Other manufacturing | 0.83 | 124.92 |
| Electricity gas and water | 0.73 | 48.97 |
| Wholesale and retail trade | 0.94 | 468 |
| Transportation storage and communication | 0.85 | 36.91 |
| Finance | 0.93 | 12.21 |
| Real estate | 0.75 | 29.21 |
| Business activities | 0.90 | 53.9 |
| Public administration and services | 0.89 | 22.49 |
| Hotel and restaurant | 0.95 | 9.4 |
| Education | 0.86 | 6.24 |
| Health and social work | 0.94 | 4.27 |
| Oth[illegible] | [illegible] | [illegible] |

Source:  Authors for index (see Box)

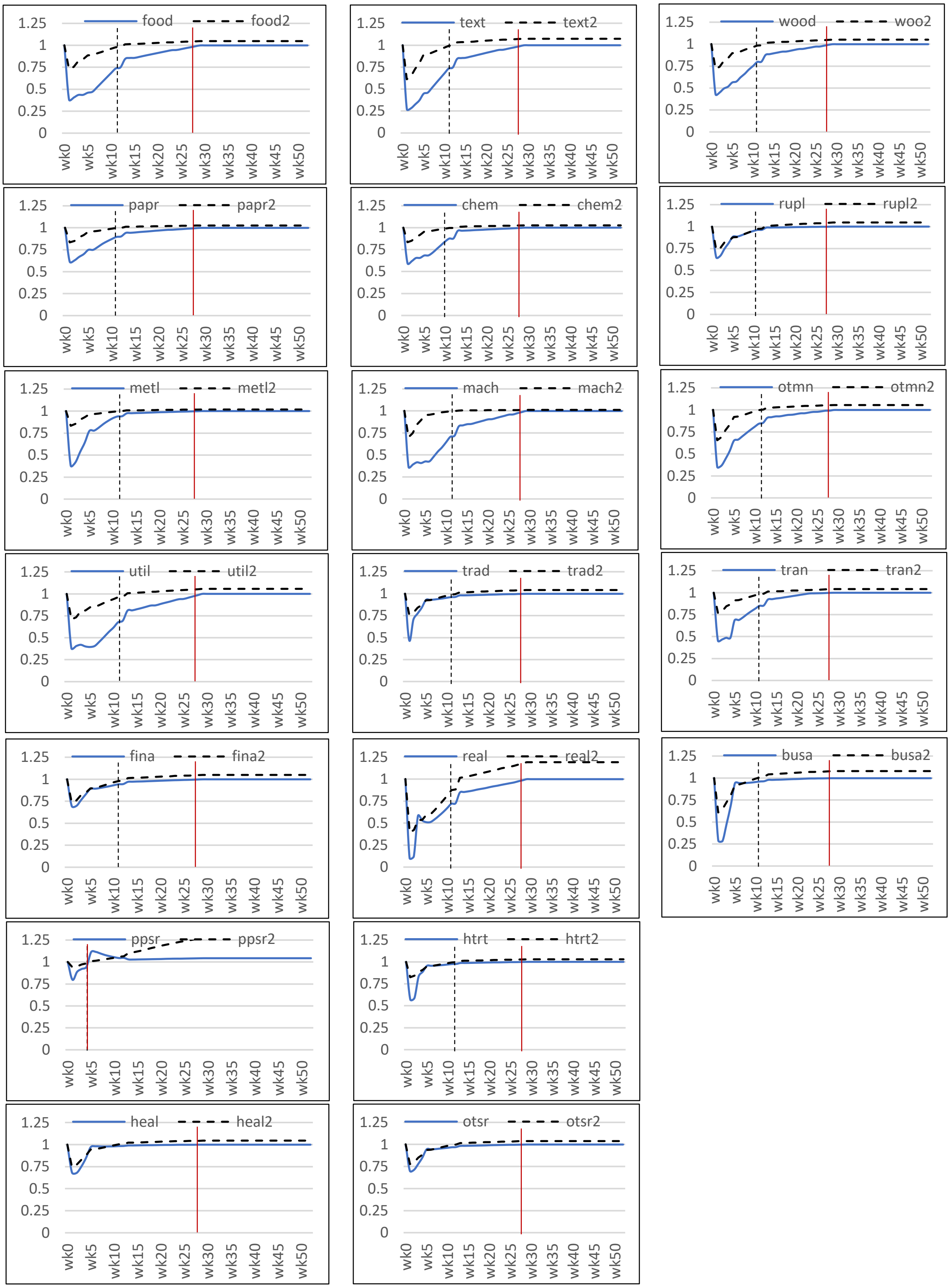
**Figure 4.3 Industry resilience index and value added in Valenzuela City**




Source: Authors' calculations.

Improving the resilience of industries saves the local economy the productivity and income it stands to lose due to the extreme flooding.  The loss amounts to PhP 6.236 billion over the adjustment period. This involves reducing the vulnerability of industries to the shock, i.e. reducing the initial drop of productivity, as well as shortening the adjustment period.

**Figure 4.3 Weekly output changes due to extreme flooding with higher TFP of the industries**




Note: Charts containing only red vertical lines mean that the numbers of weeks before recovery is the same for both cases.
Source: Authors' calculations.

These gains are simulated in the CGE model by analyzing the impact of the calamity but this time with a higher total factor productivity. The TFP of the local economy is raised by 5 %.

In **Figure 4.4**, the adjustment of each industry to the calamity is depicted with higher TFP. It is contrasted with the adjustment with a lower TFP as shown in Figure 2. In it, the adjustment period is significantly reduced from 29 weeks to only 12 weeks, and the initial drop in output is smaller.

**Table 4.3** shows the industry resilience indices given a higher TFP. On average, it is 3 percentage points higher than the indices shown in Table 2 or with a lower TFP.

**Table 4.3 Industry resilience indices with two levels of total factor productivity**

| Industry | Industry Resilience Index with higher TFP (1, perfectly resilient to 0, not resilient) | Industry Resilience Index with a lower TFP | Weekly Value added (mln. Pesos) |
|---|---|---|---|
| Food manufacturing | 0.88 | 0.76 | 184.64 |
| Textile | 0.86 | 0.75 | 61.19 |
| Wood and bamboo | 0.89 | 0.81 | 3.3 |
| Paper and paper products | 0.94 | 0.89 | 33.94 |
| Chemicals | 0.88 | 0.88 | 89.35 |
| Rubber and plastic | 0.95 | 0.97 | 160.27 |
| Metals | 0.92 | 0.89 | 61.96 |
| Computer machine and equipment | 0.86 | 0.74 | 11.92 |
| Other manufacturing | 0.89 | 0.83 | 124.92 |
| Electricity gas and water | 0.86 | 0.73 | 48.97 |
| Wholesale and retail trade | 0.91 | 0.94 | 468 |
| Transportation storage and communication | 0.91 | 0.85 | 36.91 |
| Finance | 0.89 | 0.93 | 12.21 |
| Real estate | 0.65 | 0.75 | 29.21 |
| Business activities | 0.88 | 0.90 | 53.9 |
| Public administration and services | 0.96 | 0.89 | 22.49 |
| Hotel and restaurant | 0.94 | 0.95 | 9.4 |
| Education | 0.88 | 0.86 | 6.24 |
| Health and social work | 0.90 | 0.99 | 4.27 |
| Other services | 0.92 | 0.95 | 10.89 |
| Average | 0.89 | 0.86 | |

Source: Authors for index (see Box)

Another way of interpreting a higher TFP is a stronger growth of the local economy. Stronger growth makes the industries absorb the adverse shock of natural calamities and mitigating productivity losses. Economic growth makes the industries more resilient.

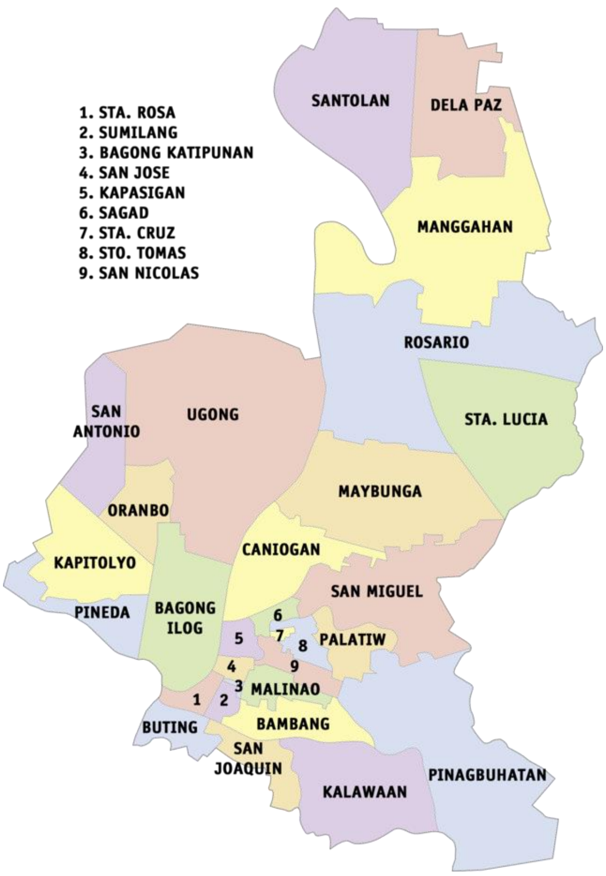
## 5. Results in Pasig City Model

In this section, we analyze the results of the model for Pasig City. Essentially the structure of this section is similar to the previous section; a short discussion of the urban area is undertaken, and then the labor constraint is introduced into the model. Simulation results are then shown, including the calculation of a resilience index for the different economic sectors in the city.

### 5.1. Socio-economic profile of Pasig City

Pasig City is among the cities and municipalities of National Capital Region's 2nd District (i.e. Eastern Manila District) with Mandaluyong, Marikina, Quezon City and San Juan. The city is divided into two districts: District 1 and District 2. District 1 has twenty-two (22) barangays namely Bagong Ilog, Bagong Katipunan, Bambang, Buting, Caniogan, Kalawaan, Kapasigan, Kapitolyo, Malinao, Oranbo, Palatiw, Pineda, Sagad, San Antonio, San Joaquin, San Jose, San Nicolas, Sta. Cruz, Sta. Rosa, Sto. Tomas, Sumilang, and Ugong. On the other hand, District 2 has only eight (8) barangays i.e. Dela Paz, Manggahan, Maybunga, Pinagbuhatan, Rosario, San Miguel, Santolan, and Sta. Lucia. Amongst all cities in Metro Manila, Pasig City is the smallest city with only 13 km$^2$.

**Figure 5.1: Map of Pasig City**




Source: https://www.wikiwand.com/en/Pasig

***Geographical Profile***. Pasig City has been well-known for its river i.e. The Pasig River. Historically, this river has been known for its transportation, recreation and tourism advantages, specifically as transport route and water source. However, it has been declared as biologically dead due to industrial development, overpopulation and negligence. This includes the informal settlers and dumping around the river area. The government agency who was tasked to rehabilitate the river to its pristine form has also been abolished.

***Land use distribution***. Regarding the distribution of its land, the city is dominated by residential spaces. Formal residential spaces occupied 47.74 percent of total land area while industrial area and the commercial spaces have 9.83 and 4.6 percent of the city's land area, respectively. **Table 5.1** shows the detailed land use distribution of Pasig City.

**Table 5.1: Land Use Distribution of Pasig City**

| Land Use Type | Existing Land Uses 2012 | | Proposed Land Uses 2015-2023 | |
|---|---|---|---|---|
| | Land Area (in hectares) | % Share to Total Land Area | Land Area (in hectares) | % Share to Total Land Area |
| Built-Up Area | | | | |
| Residential (Formal) | 1,638.87 | 47.75 | 1,608.22 | 46.86 |
| Residential (Socialized Housing) | 42.19 | 1.23 | 8.93 | 0.26 |
| Residential (Informal Settlement) | 274.85 | 8.01 | | 0.00 |
| Commercial (including Bulk Warehousing and Storage) | 157.85 | 4.60 | 356.13 | 10.38 |
| Mixed Use | 40.26 | 1.17 | 633.34 | 18.45 |
| Industrial | 336.92 | 9.82 | 58.27 | 1.70 |
| Institutional | 97.81 | 2.85 | 91.54 | 2.67 |
| Tourism Site | 6.96 | 0.20 | 6.14 | 0.18 |
| Utility | 18.93 | 0.55 | 14.16 | 0.41 |
| Sub-total | 2,614.64 | 76.18 | 2,776.73 | 80.91 |
| Open Spaces | | | | |
| Roads | 384.61 | 11.21 | 393.60 | 11.47 |
| Waterway | 133.36 | 3.89 | 133.20 | 3.88 |
| Legal Easement of Waterway | 2.32 | 0.07 | 28.15 | 0.82 |
| Open Spaces (City Parks, Linear Parks, Playgrounds, Sports Facilities) | 23.87 | 0.70 | 54.47 | 1.59 |
| Cemetery | 14.03 | 0.41 | 14.01 | 0.41 |
| Idle Land | 255.02 | 7.43 | - | 0.00 |
| Other Open Spaces | 4.15 | 0.12 | | |
| Buffer Areas and Ancillary Open Spaces | | 0.00 | 28.97 | 0.84 |

Source: Pasig City Government.

Specifically, residential spaces are mostly at the western and northern Pasig, with average to middle income class. The largest subdivision in the city is the Valle Verde, which occupies 80 hectares and is recognized as the only low-density subdivision in Pasig City. Moreover, the developments in the residential areas are concentrated on single-type dwellings and some medium rise types of housings. For the commercial land areas, majority of its land use is occupied by the city's central business district – the Ortigas Center – which has more than 80 condominium buildings that accommodate most of the city's largest businesses and other establishments.

***Business Environment.*** Pasig City's business environment is flourishing with numerous businesses and establishments, primarily within its central business district. Table 2 below ranks these businesses based on its declared gross receipts and business tax paid.

**Table 5.2: Top 50 Business Taxpayer According to Business Permit & License Office, in pesos, 2018**

| Rank | Business Trade Name | Declared Gross Receipts | Business Tax Paid |
|---|---|---|---|
| 1 | SOUTH PREMIERE POWER CORP. | 33,745,665,825.02 | 199,093,825.48 |

| | | | |
|---|---|---|---|
| 2 | JOLLIBEE FOODS CORPORATION - MAIN OFFICE | 32,201,529,672.07 | 163,748,417.96 |
| 3 | SAN MIGUEL ENERGY CORPORATION (SMEC) | 11,991,278,391.05 | 89,937,297.92 |
| 4 | VOUNO TRADE & MARKETING SERVICES CORPORATION | 12,403,914,967.48 | 88,378,654.16 |
| 5 | TOYOTA PASIG | 8,984,210,626.48 | 65,446,155.24 |
| 6 | LG ELECTRONICS PHILIPPINES, INC. (FR. LG COLLINS ELEC. MLA., INC.) | 8,670,958,120.63 | 65,035,295.92 |
| 7 | DMCI PROJECT DEVELOPERS, INC. | 1,728,270,927.72 | 64,988,098.04 |
| 8 | VSTECS PHILS. INC. | 7,150,830,785.00 | 53,634,521.12 |
| 9 | METRO RAIL TRANSIT CORP. | 5,851,001,932.17 | 50,743,175.04 |
| 10 | FIRST GAS POWER CORPORATION | 9,327,128,937.87 | 50,393,793.52 |
| 11 | DAVIES PAINTS PHILIPPINES, INC. | 5,677,695,601.51 | 45,481,761.43 |
| 12 | PROFESSIONAL SERVICES, INC. (THE MEDICAL CITY) | 4,625,745,303.00 | 43,205,621.10 |
| 13 | EPSON PHILIPPINES CORPORATION | 5,698,459,028.29 | 42,738,842.72 |
| 14 | ROCKWELL LAND CORPORATION | 1,404,498,544.00 | 42,134,956.32 |
| 15 | PAG-ASA STEEL WORKS INC. | 7,455,979,336.59 | 42,014,685.12 |
| 16 | PMFTC INC. | 7,046,600,461.41 | 39,638,102.60 |
| 17 | ORTIGAS & COMPANY LIMITED PARTNERSHIP | 1,254,693,553.47 | 37,640,806.60 |
| 18 | ENERGY DEVELOPMENT CORPORATION | 7,040,181,285.31 | 37,622,911.40 |
| 19 | PORTICO LAND CORP. | 1,206,424,472.55 | 36,192,734.20 |
| 20 | GNPOWER MARIVELES COAL PLANT LTD. CO. | 6,501,885,549.46 | 34,745,377.16 |
| 21 | J.S. UNITRADE MERCHANDISE, INC. | 4,389,847,227.05 | 32,967,076.36 |
| 22 | VIVO MOBILE TECH., INC. | 4,317,599,116.82 | 32,382,393.40 |
| 23 | PHILIPPINE OPPO MOBILE TECHNOLOGY, INC. | - | 30,404,086.40 |
| 24 | FGP CORP. | 5,005,961,257.66 | 27,436,282.52 |
| 25 | ORTIGAS & COMPANY LIMITED PARTNERSHIP | 901,995,768.75 | 27,059,873.08 |
| 26 | ISUZU AUTOMOTIVE DEALERSHIP, INC. | 3,783,249,029.11 | 26,983,666.80 |
| 27 | ABENSON VENTURES, INC. | 2,862,311,343.00 | 26,840,568.88 |
| 28 | DMCI PROJECT DEVELOPERS, INC. | 846,927,110.54 | 25,407,813.32 |
| 29 | FINDEN TECHNOLOGIES INC. | 2,938,597,754.29 | 24,720,358.16 |
| 30 | LUNAR STEEL CORP. | 4,324,085,009.46 | 24,323,953.20 |
| 31 | PHILUSA CORPORATION | 3,672,997,745.02 | 23,373,954.56 |
| 32 | BULACAN HOLDING INC. | 900,000.00 | 22,438,230.88 |
| 33 | READYCON TRADING CONST. CORP. | 1,794,535,316.87 | 22,077,117.88 |
| 34 | CENTURY PACIFIC FOOD, INC. | 5,626,981,760.48 | 21,586,496.68 |
| 35 | THE ROCKWELL BUSINESS CENTER | 698,435,080.00 | 20,953,052.40 |
| 36 | MERALCO ENERGY, INC. | 2,650,612,849.03 | 20,717,662.24 |
| 37 | ALLIANCE IN MOTION GLOBAL INC. | 1,404,625,467.00 | 20,688,894.14 |
| 38 | L`OREAL PHILIPPINES, INC. | 2,742,172,165.31 | 20,566,691.24 |
| 39 | AMBERLAND CORPORATION | 676,320,256.84 | 20,289,607.72 |
| 40 | MAGNOLIA INC. | 5,591,606,479.64 | 20,219,589.64 |
| 41 | I3 TECHNOLOGIES CORPORATION | 98,053,032.60 | 18,796,372.58 |
| 42 | SM HYPERMARKET | 1,756,089,376.61 | 17,917,698.90 |
| 43 | MEDICAL CENTER TRADING CORPORATION | 1,903,912,060.76 | 17,467,685.28 |
| 44 | EPLDT, INC. | 2,446,040,870.87 | 17,430,615.68 |
| 45 | PANASIA ENERGY, INC. | 2,317,586,676.00 | 17,384,610.08 |

| | | | |
|---|---|---|---|
| 46 | UNIVERSAL ROBINA CORP | 586,401,334.00 | 15,773,560.90 |
| 47 | STRATEGIC POWER DEVT. CORP. | 1,996,094,933.39 | 15,490,218.20 |
| 48 | GREEN CORE GEOTHERMAL INC. | 2,873,222,352.58 | 15,355,724.60 |
| 49 | THE PUREFOODS-HORMEL COMPANY, INC. | 5,525,565,271.19 | 14,968,105.80 |
| 50 | INDRA PHILIPPINES, INC. | 1,991,053,446.03 | 14,935,610.84 |

Source: Pasig City Profile 2018.

Based in the Business Permit and License Office, South Premier Power Corporation is recognized to be the largest business in Pasig city followed by Jollibee Foods Corporation and San Miguel Energy Corporation (SMEC) with 199 million, 163 million and 89 million taxes paid, respectively. South Premier and SMEC are subsidiaries of SMC Global Power under electric power generation industry. With just the top 50 businesses alone, the government of Pasig City has accumulated 1.9 billion revenue from their taxes paid.

According to the Finance and Budget Department, Pasig City has a total income of P10,090,816,480,83, with an Internal Revenue Allotment (IRA) share (i.e. share of the local government unit from the revenue of the national government) is P1,094,054,125. Not to mention, its total expenditure reached P8,073,968,877.25, as per stated in the city's website. One of the factors that contributed to the local government's high revenue is the increasing number of establishments in the city, as shown in **Table 5.3**.

**Table 5.3: Number of Establishment Applied**

| Year | New | Renewal | Total | Less Retirement | Net Total |
|---|---|---|---|---|---|
| 2013 | 4,146 | 25,665 | 29,811 | 1,084 | 28,727 |
| 2014 | 4,173 | 26,979 | 31,152 | 1,255 | 29,897 |
| 2015 | 3,618 | 22,976 | 26,594 | 1,143 | 25,451 |
| 2016 | 3,759 | 22,498 | 26,257 | 1,375 | 24,882 |
| 2017 | 4,084 | 23,758 | 27,842 | 1,447 | 26,395 |
| 2018 | 4,173 | 24,787 | 28,960 | 1,188 | 27,772 |

Source: Pasig City Business Licensing Office 2018

In 2018, a total of 28,960 establishments have applied which is significantly higher than the past three years. Although in terms of new applications, this year has been the highest since 2013, similar with 2014.

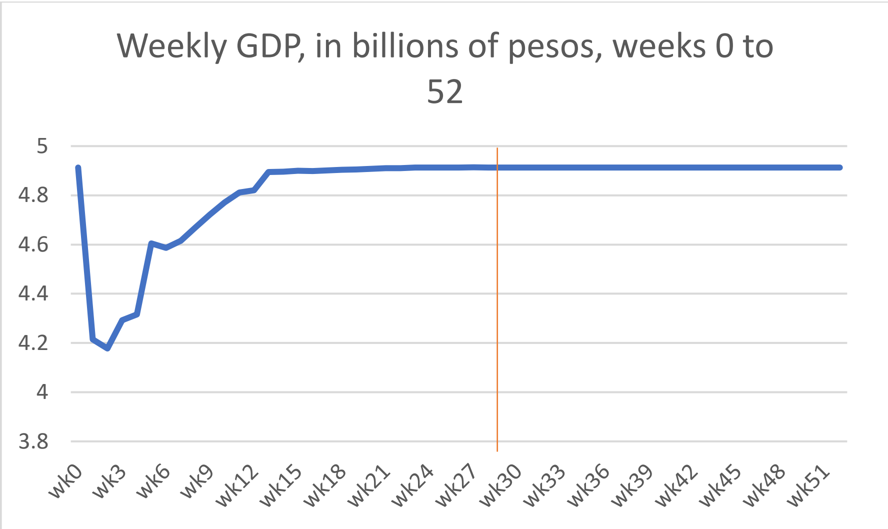
In terms of economic geography, the western portion of the City, more specifically, barangays Ugong, San Antonio, Obando and Kapitolyo, are relatively more prosperous and many of the establishments in these areas are composed of commercial and service firms. The eastern portion of the Ortigas Center is in Barangay San Antonio, here most of Pasig's financial resources are primarily concentrated. In fact, San Antonio, which contains the buildings of major Philippine conglomerates such as the Benpres Building (of the Lopez Group of Companies) and One San Miguel Avenue (the headquarters of the San Miguel Corporation), is one of the more prosperous financial and commercial districts in the country; the area also contains buildings which houses business process outsourcing companies including the One Corporate Centre, Orient Square, and Wynsum Corporate Plaza, and also the Tektite Towers, which previously contains the trading floor of the Philippine Stock Exchange. Government agencies such as the Department of Education are also headquartered there.

On the other hand, the northern part of the city, including Barangays Santolan, Dela Paz, Manggahan and Rosario, used to contain the textile and garment factories in the county; many of these factories have been converted into storage warehouses or small and medium sized manufacturing facilities. The southern part of the city, including Barangays Palatiw and Pinagbuhatan, is mainly residential, where previously lower income workers reside, although as more upper-income subdivision and condominiums are being constructed in the area, is also becoming more commercial.

### 5.2. Impacts on economic variables

**Figure 5.1** shows the trajectory of the city's GDP from week 0 to week 52. In week 0, the weekly GDP of the city was 4.91 billion pesos. Following the extreme flooding of a type that may occur once in a hundred years, the GDP dropped to 4.21 billion pesos in the first week after the flooding and then to 4.18 billion in the second week, or economic activity slowed down by 15%. Recovery started to gradually pick up starting in the third week and the city economy only fully recovered in week 29, similar to that of Valenzuela.

**Figure 5.1 Effects of extreme flooding on the weekly GDP (in bln. pesos) of Pasig City**

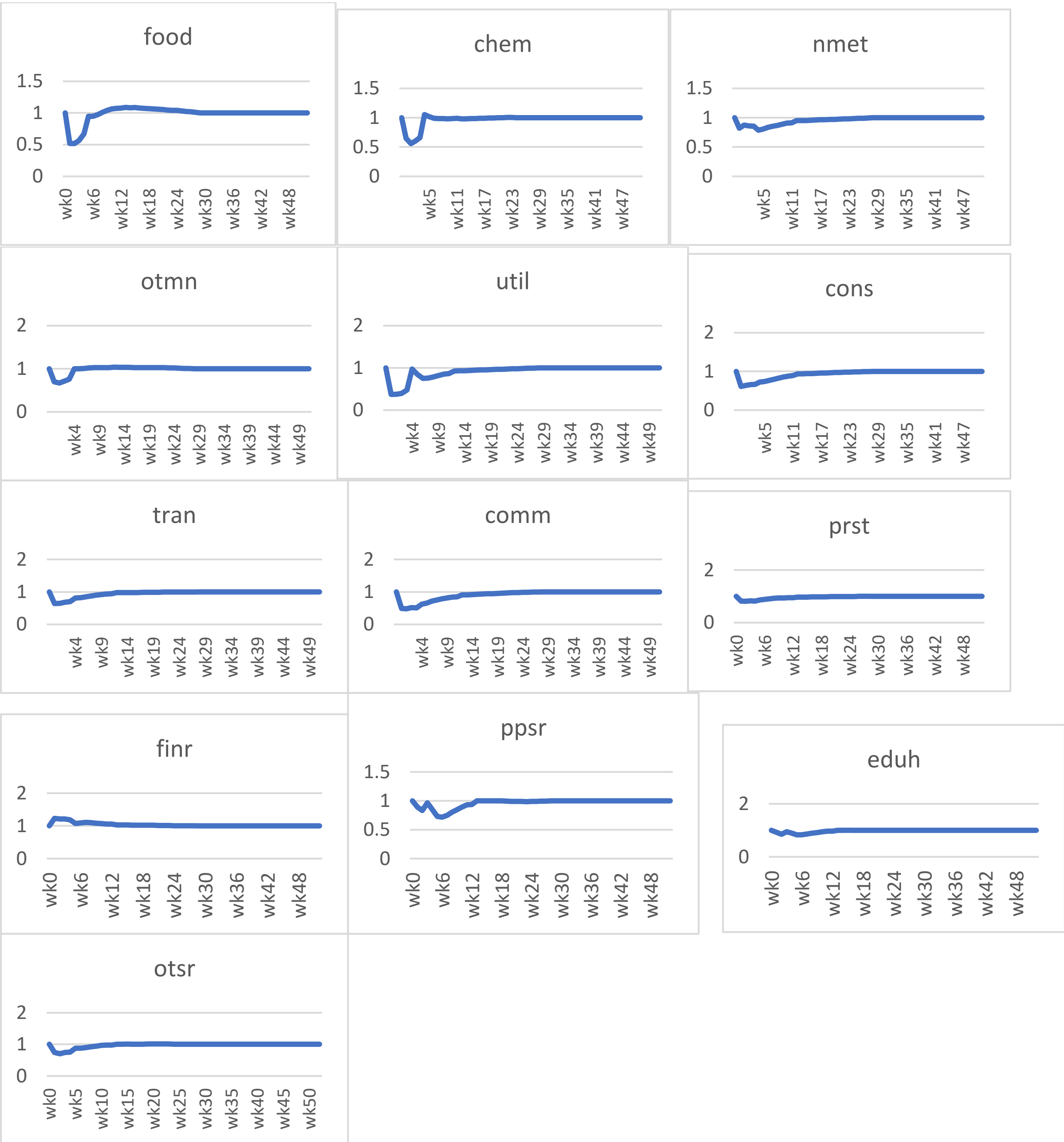



Source: Authors' calculations.

The shocks in the first week were obtained from the labor and capital recovery matrices. The average non-availability rates of capital and labor were 71% and 72%, respectively. The GDP went down by only 15% in the first week. Compared to Valenzuela, the drop in the GDP is not as large and thus Pasig was able to recover slightly more quickly compared to the former;

In **Figure 5.2**, we show the adjustments of each industry of the local economy to extreme flooding. Typically, the first few weeks witness the reduction of economic activities. The lowest observed drop was by more than 60 percent for the metal manufacturing and the utilities sector. However, the financial services sector did not experience a fall in their output; in fact, it experienced a slight jump in its output, which most likely was a means to ensure that capital from the banking industry was able to compensate for the fall in other outputs. All of the other industries adjust to the shocks, but the least to adjust was public administration and services, which is expected. It only slowed down its activity in the first week by 20%.

**Figure 5.2 Weekly output changes to extreme flooding by industry**




Source: Authors' calculations.

Gradually these industries recover at varying rates. Public administration and services recovered fully by the thirteenth week, to assist the private sector industries and the constituents of the local government affected by the calamity. On the other hand, it is the chemical manufacturing and professional services and science and technology sectors that are quickest to recover.

The quickest industries to recover are the food manufacturing and the chemistry manufacturing industries which were able to return back to their pre-disaster output levels by the sixth week, which is much faster than the 29th week that many of the other industries. As these industries approach full recovery, the activities are very close to recovering fully what they used to produce before these get inundated by the floods.

Similar to the Valenzuela case, to describe how the calamity affected each industry, the following parameters are noted: the initial drop of economic activity, the length in weeks of the recovery, and based on the two the weekly recovery rate. **Table 5.3** shows these parameters by industry.

Also as with the Valenzuela case, the first parameter captures the vulnerability of the industry to the extreme weather situation. Industries with large output reductions, i.e. more than 50 percent, include metallic products, utilities and communications. Less vulnerable industries, whose output declines are less than 30 percent, are non-metallic products, finance, real estate and business activities, public administration and other services..

**Table 5.3 Adjustment of industries to extreme flooding**

| Industry | Largest drop in output by % | Length of recovery in weeks | Recovery rate in weekly output increase (%) |
|---|---|---|---|
| Food manufacturing | 48.1% | 8 | 6.5% |
| Chemical and chemical products | 44.1% | 6 | 9.3% |
| Non-metallic products | 21.3% | 29 | 2.7% |
| Metallic products | 62.1% | 29 | 1.3% |
| Other manufacturing | 33.0% | 6 | 11.2% |
| Utilities | 62.7% | 29 | 1.3% |
| Electricity, gas and water | 38.7% | 29 | 2.1% |
| Wholesale and retail trade | 31.6% | 26 | 2.6% |
| Transportation | 35.7% | 29 | 2.2% |
| Communication | 52.0% | 29 | 1.7% |
| Finance | 0.0% | 0 | NA |
| Real estate and busines s activities | 18.8% | 29 | 2.8% |
| Public administration and services | 28.3% | 13 | 5.5% |
| Education Health and social work | 16.8% | 13 | 6.4% |
| Other services | 29.8% | 13 | 5.4% |

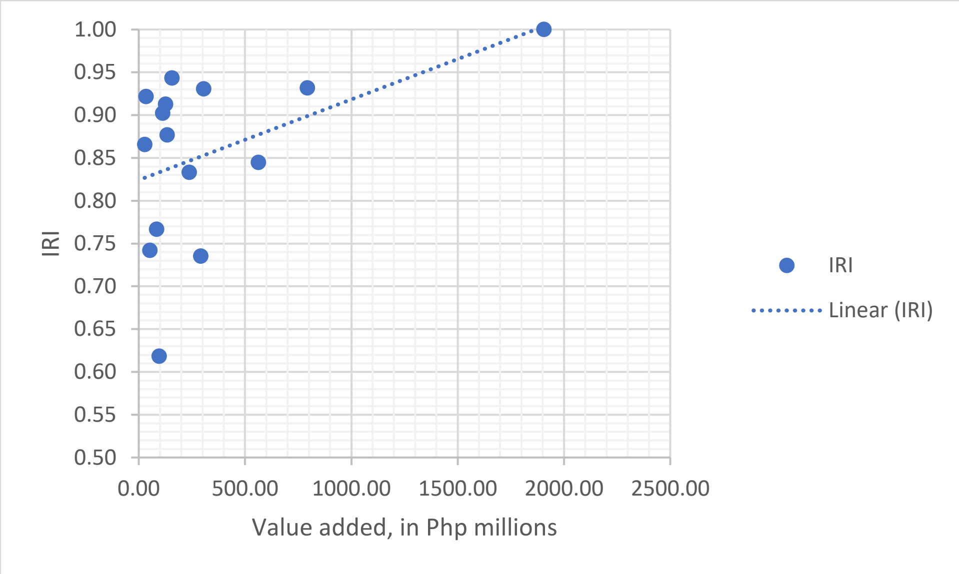
Source: Authors' calculations.

The financial services industry seems to be impervious to the decline in output; in fact, output in the industry increased during the imposition of the shock. In the first week, financial services output increased by 22.9 percent, indicating that resources were utilized by the other industries in the face of reductions of labor and capital, and only in week 29 did output normalize to one.

An industry resilience index (IRI) is computed for each of the industries of the city. Given that the financial services industry has been the most resilient among the different industries, then its IRI is the highest. On the other hand, it is the chemical manufacturing industry whose index is the lowest at 0.63. The index in most other industries are around 0.8 and 0.9

The industry resilience index is associated with the respective value-added contributions of the industries concerned to the local industry. Figure 5.3 plots the variables and the generated relationship is mixed. The upward sloping line shows that the higher value added, the higher the resilience of the industry. Besides financial services, the industries in Pasig that have a high level of resilience are private and busines services, public administration and non-metallic industries.

**Figure 5.4 Industry resilience index and the value added of each of the industries**




Source: Authors' calculations.

The correlation coefficient is low at 22.9%. This suggests that local authorities can still improve their protection of local industries which are vulnerable to extreme weather situations in order to minimize the economic cost of natural calamities, especially lower industries with lower value added.

## 6. Policy Implications for Resilience

This study showed that the impacts of flooding, and possibly other types of disasters, have significant effects on the business establishments at the municipal level. The impacts are also dependent on the intensity and duration of the disaster, the vulnerability of the different types of establishments found in the city and the ability of the local government and businesses to respond to the post-disaster situation.

According to several studies on economic vulnerability, there are several policy implications that can come out of the different studies that have been made. We also include some implications from the Valenzuela and Pasig study.

First, business recovery processes and outcomes are affected not only by the direct physical impacts that businesses experience at the time of the disaster, but also by the ways in which disasters create short-term and longer-term problems for business owners. Those problems can include extended periods of business interruption, difficulties with transporting raw materials and accessing important production factors, declines in revenue due to loss of customers, and other operational and administrative issues. Clearly, in this study, what determines the change in firm output and production is not only the depth of the impact of flooding but also the period of recovery of firms to return to normal. In this study, we constructed an

Second, even the indirect impacts of flooding can often be substantial, especially for small and medium scale enterprises. Impacts like travel difficulties for customers, increased costs, and decreased sales have affected many SMEs in many areas irrespective of whether they were flooded or not. These firms are also affected by the loss of output in the upstream and downstream industries and the recovery of other firms will also determine the speed of the return of these firms back to normal.

Third, some proportion of inherent business resilience stems simply from being less vulnerable in the first place—that is, businesses can be said to be more inherently resilient if they possess fewer of the vulnerability factors. In the literature, these factors include: larger business size; being in better financial condition when the disaster strikes; doing business during periods of economic expansion and in more robust economic niches, rather than fragile ones; having a diversified market base, as opposed to an exclusively local one; and taking steps to mitigate damage and disruption and ensure business continuity, rather than simply engaging in workplace preparedness. The ability of the enterprise to keep a significant amount of savings may also be an advantage.

In this study, we note that the smaller enterprises have a more difficult time in their recovery period. In the consultations that the study authors have made in Pasig for example, we note that: a) micro- and small-sized enterprises (0-100 employees) near the river and floodway, were washed away by the floodwaters; most of these businesses were never able to recover; b) medium-sized firms (101-500 employees) took 1.5 months to 6 months before they were able to return to normalcy, after significant clean-up of muddied factories and machineries; and, c)large-sized firms (> 500 employees) were able to recover quickly and went back into operations a week at most after the typhoon, albeit producing at a lower capacity compared to the situation before the typhoon. At the same time, service companies, which were mainly impacted by the lack of availability of personnel, were less like to be affected by a lack of machinery and inventory.

Not unexpectedly, according to Tierney (2007), disaster recovery was positively associated with business owners' situational awareness and leadership in knowing the recovery priorities and mobilizing staff, family and friends supports. This vulnerability assessment should identify businesses that are located in hazard-prone areas, assess their structural vulnerability, and evaluate their needs for emergency response and disaster recovery after different types (hurricanes, earthquakes, floods) and intensities of environmental disasters.  Businesses that had prior disaster experience and prior cash flow problems were also less likely to meet demise after the disaster, suggesting that prior experiences with some type of adversity may provide knowledge and insight that aid small business owners during subsequent experiences during disaster preparation, response, and recovery periods.

Fourth, There is a significant linkage between household and business return sheds light on community disaster management and community resilience building; households and business are closely related with each other in a complex system. Just as businesses benefit from community adoption of pre-disaster mitigation and preparedness measures and from community-level response effectiveness, they also benefit when their communities employ knowledge and foresight during the post-event recovery process. Disseminating information about the effectiveness of hazard mitigation to businesses may raise their awareness of pre-disaster risk reduction. But beyond investing in hazard mitigation related to business itself—for example, structural mitigation against potential damage and purchase of insurance to recover potential losses—businesses should also invest in improving the resilience of their host communities because their survival depends on the returning of community residents.

Procedures that have been incorporated into a community's preimpact recovery plan, such as monitoring contractors and retail prices (Wu and Lindell, 2004) can also be extended to facilitate local business recovery. For example, local construction companies can be given a head start by allowing them to register for post-disaster reconstruction before a disaster strike. Moreover, government contracts for infrastructure restoration can give bonus points to those contractors that utilize local firms.

Fifth, business recovery processes and outcomes are influenced by a range of factors, coming from the community key among which especially include  public participation in recovery decision making; the presence of strong networks that exist among various community organizations and institutions with business and enterprises; and vertical integration, or the extent to which strong ties exist among local communities, higher levels of government, and other stakeholders outside of the community, including the suppliers, vendors and marketing companies

There is a strong link between relief of enterprises and the relief of households. In many of the studies, loans to affected enterprises were found to be inefficient for business recovery because they only cover part of the company loss and increase debt for these enterprises which they may not be able to eventually pay. Moreover, changes in the population and the incomes which may impact on incomes may shift after the disaster may leave businesses enterprises with few or no customers (Alesch, Holly, Mittler and Nagy, 2001; Tierney, 2007). Hence, businesses and households need to recover together. Speedy household return helps businesses to retain customers. On the other hand, more favorable policies and programs for business disaster relief, such as simplifying the business loan application process, reducing waiting time, providing more favorable interest rates and imposing less rigid locational requirements can help businesses return to the community and eventually, through the spatial spillover effects, help households.

In this study, wages actually recover at the same time, the output and productivity over time. Household welfare the improves as firm revenues increase. Therefore, the feedbacks between different sectors are as important as stated earlier.

Local governments can also organize assistance from other businesses to ameliorate the impacts of a disaster by shortening the time that victimized firms take to return to normal operations. Support from the business community can include emergency labor support, including the provision of additional full- and part-time employees for their, extended credit and assistance from suppliers, accelerated payments for products and services, and above normal levels of purchases made by regular customers, including procurement by cities and provinces of services from those who are affected by disasters.

The findings of the different studies show that flood-affected enterprises are likely to experience increases in their insurance premiums because of the impact of disasters; at the same time, they would also see an increase in the amount that are exempted from disasters. As these two impacts were found to be largely interconnected, this means that enterprises, especially micro, small and medium firms, will not receive a similar level of protection from their insurers in the future, even at a higher cost. One of the ways it seeks to manage the risk of flooding is by increasing awareness of risks and vulnerabilities in the community and develop 'increasing public awareness of the risk that remains and engaging with people at risk to encourage them to take action to manage the risks that they face and to make their property more resilient'.

## 7. Ways Forward

In this section, we briefly review the progress in the work that this project had undertaken in the past year or so, especially in terms of the construction of the Pasig and Valenzuela city models and also the

This study has shown that there are impacts of flooding across different industries; some of the industries are more resilient than others and one of the key factors that affect this resiliency is the amount of value added, in terms of capital and labor. The results of the analysis show that improving total factor productivity could also be a significant factor in the improvement of sectoral output across time.

There were several areas of improvement that were made in this study, including the refinement in the construction of the city-level SAM, especially in terms of estimating the intermediate and factor input values, and the use of rain-fall data to estimate the labor constraint in the economy.

In the methodology used for this study, we note that the SAMs are integral component of CGE models. While construction of national level SAMs is straight forward due to availability of datasets, CGE modeling at the subnational level is challenging mainly because most of these datasets required to build a subnational SAM are absent. Because of this, modelers are forced to produce SAMs by estimating the values each cell must have while keeping accuracy of estimates in mind. Additional information on the city would have enhanced this paper as it had been generating may datasets, which unfortunately, were not made available for this study, except for local government revenues and expenditures; these included income and expenditure surveys and estimates of the level of investments and capital expenditures of firms in the area. A survey of firms and households was explored in Valenzuela but due to data limitations, this was not pursued anymore.

This paper proposed a procedure that can be used to build a SAM for a city-wide economy. This paper also presented various datasets as well as data sources that can be used to estimate the values in a city-level SAM. Just as in building a national SAM, a subnational SAM may result in imbalance. To address this, this paper presented two ways by which an unbalanced SAM is corrected. Non-survey methods to construct subnational SAMs still can still be improved. This paper intends to encourage more work on this area to fill in the gaps in estimation of SAMs and raise the level of accuracy of these estimations.

The study exploits municipality-level rainfall data to understand rainfall exposure impact on value added of firms. Using fixed-effects panel data econometric analysis, estimates show that rainfall exposure affects production activities of firms through its impacts on returns to capital. For every 1 mm of rainfall measured, value added decreases by 0.093% according to model, albeit the impact of rainfall exposure is more significant on returns to capital compared to impact on labor compensation. Using an econometric methodology, the study was able to assess the impact of rainfall on the labor and capital constraints being faced by firms.

The paper assessed the changes in output and prices at the sectoral level of rainfall. One of the areas that could be undertaken in the future is to develop a more geographic-based analysis of the impacts of the rainfall. This requires a more precise location of the industries in the different cities and to simulate the effect of the flooding in the different areas of the city could also be undertaken.

## 8. Bibliography


Acosta, Lilibeth A, Elena A Eugenio, Paula Beatrice M Macandog, and Damasa B Magcale-macandog. 2016. “Loss and Damage from Typhoon-Induced Floods and Landslides in the Philippines : Community Perceptions on Climate Impacts and Adaptation Options Elaine Kuan-Hui Lin Edwin R . Abucay and Alfi Lorenz Cura Mary Grace Primavera.” *International Journal of Global Warming* 9 (1).

Anttila-Hughes, Jesse Keith, and Solomon M. Hsiang. 2013. “Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster.” *SSRN Electronic Journal*, no. 415. https://doi.org/10.2139/ssrn.2220501.

Armington, Paul S. 1969. “A Theory of Demand for Products Distinguished by Place of Production.” *IMF Staff Papers* 16 (1): 159–78. https://doi.org/10.2307/3866403.

Asgry, Ali Muhammad Anjum and Nooreddin Azimi (2012). “Disaster recovery and business continuity after the 2010 flood in Pakistan: Case of small businesses,” International Journal of Disaster Risk Reduction 2 (1), pp. 46- 56.

Auffret, Philippe. 2003. “High Consumption Volatility: The Impact of Natural Disasters?” 2962. World Bank Policy Research Working Paper. Washington DC. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=636324.

Ballesteros, Marife and Sonny Domingo (2015). “Building Philippine SMEs Resilience to Natural Disasters,” Discussion Paper Series No. 2015- 20, Philippine Institute for Development Studies.

Bayudan-Dacuycuy, Connie, and Lora Kryz Baje. 2017. “Chronic and Transient Poverty and Weather Variability in the Philippines: Evidence Using Components Approach.” 2017–24. PIDS Discussion Paper Series. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1724.pdf.

———. 2019. “When It Rains, It Pours? Analyzing the Rainfall Shocks-Poverty Nexus in the Philippines.” *Social Indicators Research* 145 (1): 67–93. https://doi.org/10.1007/s11205-019-02111-1.

Benson, Charlotte, and Edward J Clay. 2004. “Understanding the Economic and Financial Impacts of Natural Disasters.” 4. Disaster Risk Management Series. Washington DC.

Brundtland Commission. 1987. “Our Common Future.”

Business Continuity Institute (2015). Expecting the Unexpected: Business Continuity in an Uncertain World. London: BCI.

Cororaton, Caesar B. 2003. “Construction of Philippine SAM for the Use of CGE-Microsimulation Analysis.”

Galbusera, Luca, and Georgios Giannopoulos. 2018. “On Input-Output Economic Models in Disaster Impact Assessment.” *International Journal of Disaster Risk Reduction* 30 (November 2017): 186–98. https://doi.org/10.1016/j.ijdrr.2018.04.030.

Gotangco, C. K., J. See, J. P. Dalupang, M. Ortiz, E. Porio, G. Narisma, A. Yulo-Loyzaga, and J. Dator-Bercilla. 2015. “Quantifying Resilience to Flooding among Households and Local Government Units Using System Dynamics: A Case Study in Metro Manila.” *Journal of Flood Risk Management* 9 (3): 196–207. https://doi.org/10.1111/jfr3.12222.

Grinsted, Aslak, John C. Moore, and Svetlana Jevrejeva. 2013. “Projected Atlantic Hurricane Surge Threat from Rising Temperatures.” *Proceedings of the National Academy of Sciences of the United States of America* 110 (14): 5369–73. https://doi.org/10.1073/pnas.1209980110.

Groen, Jeffrey, Mark Kutzbach, and Anne Polivka. 2019. "Storms and Jobs: The Effect of Hurricanes on Individuals' Employment and Earnings over the Long Term." *Journal of Labor Economics*, no. March. https://doi.org/10.1086/706055.

Haimes, Yacov Y., and Pu Jiang. 2001. "Leontief-Based Model of Risk in Complex Interconnected Infrastructures." *Journal of Infrastructure Systems* 7 (1): 1–12.

Hallegatte, Stéphane. 2008. "An Adaptive Regional Input-Output Model and Its Application to the Assessment of the Economic Cost of Katrina." *Risk Analysis* 28 (3): 779–99. https://doi.org/10.1111/j.1539-6924.2008.01046.x.

Hallegatte, Stephane, and Valentin Przyluski. 2010. "The Economics of Natural Disasters: Concepts and Methods." 5507. Vol. 11. Policy Research Working Paper WPS5507. Washington DC. https://doi.org/10.1146/annurev-resource-073009-104211.

Hosoe, Nobuhiro, Kenji Gasawa, and Hideo Hashimoto. 2010. *Textbook of Computable General Equilibrium Modelling: Programming and Simulations*. Hampshire: Palgrave Macmillan. https://doi.org/10.1017/CBO9781107415324.004.

IFRC, International Federation of Red Cross and Red Crescent Societies. 2018. *World Disasters Report 2018: Leaving No One Behind*. Geneva: International Federation of Red Cross and Red Crescent Societies. www.ifrc.org.

IPCC. 2018. "Summary for Policymakers SPM." In Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al., 32. Intergovernmental Panel on Climate Change (IPCC). https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

Israel, Danilo C, and Roehlano M Briones. 2012. "Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines." 2012–36. PIDS Discussion Paper Series.

Kiss, Marita and Katalin Racz (209). "Factors and Policy Measures Influencing Local Economic Develpoment: An Overview of the Conceptual Framework," in P. Futo (ed.) Contemporary Drivers of Local Development. London: Lex Localis.

Lagmay, Alfredo Mahar Francisco, Rojelee P. Agaton, Mark Allen C. Bahala, Jo Brianne Louise T. Briones, Krichi May C. Cabacaba, Carl Vincent C. Caro, Lea L. Dasallas, et al. 2015. "Devastating Storm Surges of Typhoon Haiyan." *International Journal of Disaster Risk Reduction* 11: 1–12. https://doi.org/10.1016/j.ijdrr.2014.10.006.

Markusen, James R. 2002. Multinational Firms and the Theory of International Trade. Cambridge: The MIT Press.

Markusen, James, and Thomas Rutherford. 2004. "MPSGE: A User's Guide." Boulder: Department of Economics, University of Colorado.

Marshall, Maria and Linda Niehm, Alexandra Sydnor and Holly Schrank (2015). "Predicting Small Business Demise After A Natural Disaster: An Analysis of Pre-Existing Condition," Naturdal Hazards 79, pp. 331-354.

Mathiesen, Lars. 1985. "Computation of Economic Equilibria by a Sequence of Linear Complementarity Problems." In *Economic Equilibrium: Model Formulation and Solution*, edited by A. S. Manne, 144–62. North-Holland: The Mathematical Programming Society.

Mei, Wei, and Shang Ping Xie. 2016. "Intensification of Landfalling Typhoons over the Northwest Pacific since the Late 1970s." *Nature Geoscience* 9 (10): 753–57. https://doi.org/10.1038/ngeo2792.

Muto, M., K. Morishita, and L. Syson. 2011. "Impacts of Climate Change upon Asian Coastal Areas: The Case of Metro Manila." Japan International Cooperation Agency. https://doi.org/10.4324/9781849775267.

NDCC, National Disaster Coordination Council. 2009. "FINAL Report on Tropical Storm 'ONDOY' {Ketsana}."

NDRRMC, National Disaster Risk Reduction and Management Council. 2014. "FINAL REPORT Re EFFECTS of Typhoon 'YOLANDA' (HAIYAN)."

Pelling, Mark, Alpaslan Özerdem, and Sultan Barakat. 2002. "The Macro-Economic Impact of Disasters." *Progress in Development Studies* 2 (4): 283–305. https://doi.org/10.1191/1464993402ps042ra.

Rose, Adam, and Shu Yi Liao. 2005. "Modeling Regional Economic Resilience to Disasters: A Computable General Equilibrium Analysis of Water Service Disruptions." *Journal of Regional Science* 45 (1): 75–112. https://doi.org/10.1111/j.0022-4146.2005.00365.x.

Rutherford, T, and S Paltsev. 1999. "From an Input-Output Table to a General Equilibrium Model: Assessing the Excess Burden of Indirect Taxes in Russia." Boulder: Department of Economics, University of Colorado. http://mpsge.org/papers/exburden.pdf.

Rutherford, Thomas F. 1999. "Applied General Equilibrium Modeling with MPSGE as a GAMS Subsystem: An Overview of the Modeling Framework and Syntax." *Computational Economics* 14 (1–2): 1–46. https://doi.org/10.1023/A:1008655831209.

Skoufias, Emmanuel. 2003. "Economic Crises and Natural Disasters: Coping Strategies and Policy Implications." *World Development* 31 (7): 1087–1102. https://doi.org/10.1016/S0305-750X(03)00069-X.

Tierney, Kathleen (2007). "Businesses and Disasters: Vulnerability, Impacts, and Recovery, " in Havidán Rodríguez, Enrico L. Quarantelli and Russell R. Dynes (eds) Handbook of Disaster Research. New York: Springer.

Tuaño, Philip, Marjorie Muyrong, and Ramon Clarete. 2016. "Economic Impact of Typhoon Ondoy in Pasig and Marikina Cities Using a Multiweek CGE Model Analysis." *Philippine Journal of Development* 43 (2).

Wedewatta, Gayan, Binganuth Ingirige and David Proverbs (2012). "Small Business and Flood impacts: The Case of the 2009 Flood Event in Cockermouth," Journal of Flood Risk Management 7 (1), pp. 42- 53.

Wilbanks, Tom, Patricia Romero Lankao, Manzhu Bao, Frans Berkhout, Sandy Cairncross, Jean-Paul Ceron, Manmohan Kapshe, Robert Muir-Wood, and Ricardo Zapata-Marti. 2007. "Industry , Settlement and Society." In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution OfWorking Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linder, and C.E. Hanson, 357–90. Cambridge: Cambridge University Press.

World Bank. 2011. "TYPHOONS ONDOY AND PEPENG : Post-Disaster Needs Assessment." Washington DC: World Bank.

Xiao, Yu and Shannon Van Zandt (202). "Building Community Resiliency: Spatial Links Between Household and Business Post-disaster Return," Urban Studies 49 (11),pp. 2523- 2542.

Yi, Carine J., Anawat Suppasri, Shuichi Kure, Jeremy D. Bricker, Erick Mas, Maritess Quimpo, and Mari Yasuda. 2015. "Storm Surge Mapping of Typhoon Haiyan and Its Impact in Tanauan, Leyte, Philippines." *International Journal of Disaster Risk Reduction* 13: 207–14. https://doi.org/10.1016/j.ijdrr.2015.05.007.

Yu, Krista Danielle S., Raymond R. Tan, and Joost R. Santos. 2013. "Impact Estimation of Flooding in Manila: An Inoperability Input-Output Approach." In *2013 IEEE Systems and Information Engineering Design Symposium, SIEDS 2013*, 47–51. https://doi.org/10.1109/SIEDS.2013.6549492.

Zhang, Yang, Michael Lindell and Carla Prater (2009). "Vulnerability of Community Businesses to Environmental Disasters," Disasters 33 (1), pp. 38- 57.

## Appendix A. Socio-economic Profile of Valenzuela City

As a highly urbanized city, the City of Valenzuela has been emerging as one of the country's top manufacturing hubs given its numerous rising infrastructures and highly innovative environment. Being known as the "Gateway of the North", Valenzuela City is part of National Capital Region (NCR) as its third district, together with Caloocan City, Malabon City and Navotas City (collectively known as CAMANAVA). CAMANAVA is the third district of NCR and is known for being one of the country's most disaster-prone area not only during heavy rains but also high tides and river overflows. Flooding occurs not only during the rainy season of May to September but through the year due the high tides. This became one of the city's biggest challenges.

**Figure A.1. Location of City of Valenzuela in the National Capital Region**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Since its independence from Bulacan in 1975, Valenzuela has been impressively developing its economy specifically its infrastructures which eventually led it to be one of the country's highly urbanized cities, as reinstated by the Republic Act No. 8526. It has also been recognized by the National Competitiveness Council Philippines as 11th highly urbanized city, given its ability to sustain its productivity through effective government system and economic factors such as financial, natural, human and physical capital. With its innovativeness, result-driven and stakeholder-centered initiatives, the city has also been awarded with Government Best Practice Recognition by the Development Academy of the Philippines. It has been awarded "Seal of Good Local Governance" by the Department of the Interior and Local Government (DILG) as recognition for its distinctive governance in the aspects of financial administration, disaster preparedness, social protection, business competitiveness, peace and order, and environmental management. Aside from the city's effective regulations as reflected by its numerous awards and recognitions, the accelerating development of industries had provided job opportunities to the growing labor force, improving the city's economic status.

## LAND USE DISTRIBUTION

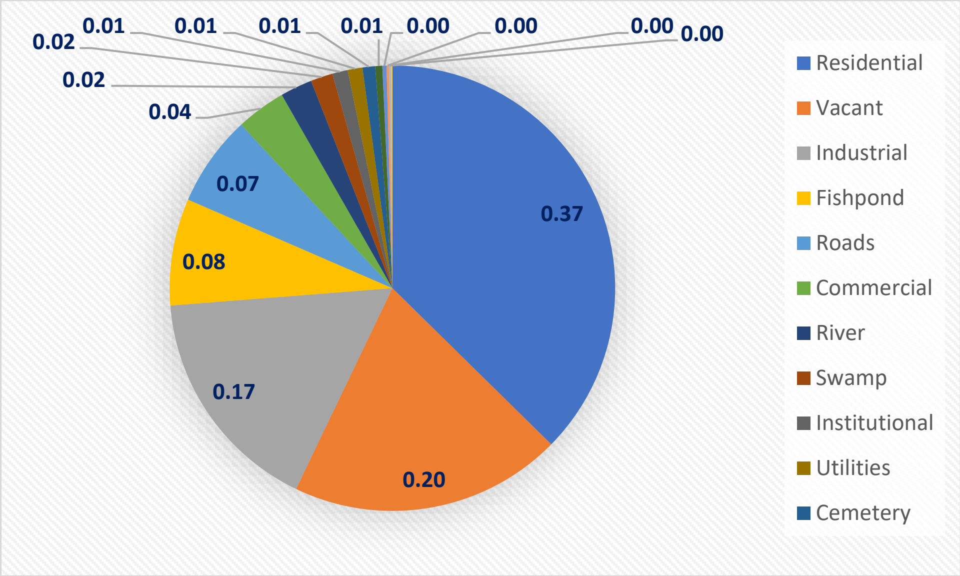
Geographically, it is bordered by four major interconnecting rivers, namely, Meycauayan River, Polo River, Calooing River and Tullahan River. With only an average elevation of 2.0m above sea level, the city is within an area that has a 16% frequency of tropical cyclones which makes it vulnerable to flooding during high tides and flash floods on rainy seasons (Department of Transportation, 2017). Since its early 1980, flood waters grew higher to the point that even the areas not usually affected by flood are inundated. Its Liquefaction Overlay Zone showed that almost one-third of the city has high susceptibility of liquefication i.e. a phenomenon where a saturated or partially saturated soil substantially losses strength and stiffness in response to applied stress such as earthquakes and climate change, causing it to behave like liquid.  The low-lying area combined with insufficient drainage and improper waste disposal allowed flood water to stay for weeks causing people who are stranded prone to water-borne diseases and businesses to close. During its 1990s, fishponds and farmlands in which it is mostly dependent on started yielding low production and was eventually converted to residences and subdivisions. However, this industrial shift transformed the city into a hub of emerging businesses and flourishing industries – head starting its economic boom.

**Figure A.2. Barangays in the City of Valenzuela**


Image from Roel Balingit with a creative commons license

With a total of 33 barangays, the city of Valenzuela is divided into two political districts to equally represent the entire city to the congress. Specifically, District 1 is comprised of barangays Arkong Bato, Balangkas, Bignay, Bisig, Canumay East, Canumay West, Coloong, Dalandanan, Isla, Lawang Bato, Lingunan, Mabolo, Malanday, Malinta, Palasan, Pariancillo Villa, Pasolo, Poblacion, Pulo, Punturin, Roncon, Tagalag, Viente Reales, and Wawang Pulo; and District 2 has barangays Bagbaguin, Karuhatan, Gen. T. De Leon, Mapulang Lupa, M:arulas, Maysan, Parada, Paso de Blas, and Ugong. Furthermore, the city can also be categorized into areas (i.e. clusters) through a Clustering System to easily identify the strategic location to where interventions are established.

**Figure A.3. Land Use Classification (in has)**




Source: City Planning and Development Office, Valenzuela City

Overall, the city has a total land area of 4,459.48 hectares which is distributed into different land uses such as commercial use, institutional use, industrial use, residential use, agricultural use, roads, parks, etc. Majority of its land area are allocated for residential use with 1666.29 hectares, occupying 37% of the city's land area. Specifically, Barangay Gen. T. de Leon has the largest residential land area with 284.47 hectares followed by Malanday and Ugong with 136.03 and 106.04 hectares, respectively. Moreover, industries and commercial buildings hold 741.74 and 160.61 hectares, respectively, together occupying 20% of Valenzuela. It is also worth noting that aside from businesses, the city is still holding agricultural areas, fishponds and rivers which diversifies its sources of livelihood. Unfortunately, only Brgy. Punturin remains to have an agricultural land which has an area of 22.81 has. Specifically, swamps, rivers and fishponds have an area of 71.89 has., 103.48 has., and 345 has., respectively, totally occupying 11.68% of the city's total area.

## BUSINESS ENVIRONMENT

To better understand the economic landscape of the City of Valenzuela, the database of the Business and Permits Licensing Office (BPLO) for their business permit applications is used to estimate the distribution of the number of establishments and the productive activities across the sectors. Exploiting self-reported data by business owners on revenues for old businesses, capital spending for new businesses, and number of employees, each business establishment was recategorized from the lines of business used in BPLO into the Philippine Standard Industry Classification (PSIC) codes. Such is also necessary in order to better compare the city's business profile with the National Capital Region (NCR) and with the entirety of the Philippines.

**Table A.1. Correspondence between Line of Business used in Business Permits and the PSIC codes**

| | *Lines of Business* | *PSIC Code* | *IO Code* | *Sector* |
|---|---|---|---|---|
| *INDUSTRIAL* | | | | |
| *1* | Agro-Industrial | 32-33 | 39 | Miscellaneous manufactures, nec |
| *2* | Assembler and Processing | 32-33 | 39 | Miscellaneous manufactures, nec |
| *3* | Chemical and Mineral Products | 20-21, 23 | 28-29, 31 | Chemicals and chemical products; Basic pharmaceutical products and pharmaceutical preparations; Non-metallic mineral products |
| *4* | Concrete Products and Hollow Blocks | 2394-2396 | within 31 | Cement; Lime and Plaster; Articles of concrete, cement and plaster |
| *5* | Electrical Products and Components | 26-28 | 34-36 | Computer, electronic and optical products; Electrical equipment; Machinery and equipment except electrical |
| *6* | Food Processing and Products | 10-11 | 18-19 | Food manufactures and beverage industries |
| *7* | Furnitures | 31 | 38 | Furniture and fixtures |
| *8* | Garments, Sewing Services and RTW | 14 | 22 | Wearing apparel |
| *9* | Handicraft, Leathercraft and Footwear | 15 | 23 | Footwear and leather and leather products |
| *10* | Manufacturing with or without Machineries | 32-33 | 39 | Miscellaneous manufactures, nec |
| *11* | Metal Products | 24-25 | 32-33 | Manufacture of basic metals; Manufacture of fabricated metal products |
| *12* | Fabrication, Machining | 32-33 | 39 | Miscellaneous manufactures, nec |
| *13* | Packaging and Repacking | 8292 | within 45 | Packaging activities |
| *14* | Paper and Paper Products | 17 | 25 | Paper and paper products |
| *15* | Plastic and Rubber Products | 22 | 30 | Rubber and plastic products |
| *16* | Recycling | 46-47 | within 45 | Wholesale and retail trade |
| *17* | Textile | 13 | 21 | Textile manufactures |
| *18* | Wood Products | 16 | 24 | Wood, bamboo, cane and rattan articles |
| *COMMERCIAL* | | | | |
| *19* | Advertising, Printing and Publishing | 18, 58 | 26, within 51 | Printing and reproduction of recorded media; Publishing activities |
| *20* | Amusement, Entertainment, Recreation | 90-93 | 64 | Creative, arts and entertainment activities; Libraries, archives, museums and other cultural activities; Gambling and betting activities; Sports activities and amusement and recreation activities |
| *21* | Apartment, Lessor and Real Estate | 68, 77 | 56-57, within 59 | Real Estate Activities; Ownership of Dwelling; Rental and leasing activities |
| *22* | Buy and Sell, Distributor and Trading | 46-47 | within 45 | Wholesale and retail trade |
| *23* | Construction Supplies and Hardware | 46-47 | within 45 | Wholesale and retail trade |
| *24* | Contractor and Professional Services | 41-43, 69-82 | 44, 58-59 | Construction; Legal and accounting activities; Activities of head offices; Management consultancy activities; Architecture and engineering activities; technical testing and analysis; Scientific research and development; Advertising and market research; Other scientifc and technical activities; Veterinary activities; Legal and accounting activities; Activities of head offices; Management consultancy activities; Architecture and engineering activities; technical testing and analysis; Scientific research and development; Advertising and market research; Other scientifc and technical activities; Veterinary activities; |
| *25* | Cooperatives and Non-Profit Organizations | 94 | within 65 | Activities of membership organizations |

| | | | | |
|---|---|---|---|---|
| *26* | Education | 85 | 62 | Education |
| *27* | Electricity, Gas and Water Supply | 35-36 | 40-42 | Electricity, steam and water |
| *28* | Exporter and Importer | 46-47 | within 45 | Wholesale and retail trade |
| *29* | Financial Intermediation | 64-66 | 53-55 | Banking Institutions; Non-bank Financial Intermediation; Insurance and activities auxiliary to financial intermediation |
| *30* | Health Services | 86-88 | 63 | Human Health and Social Work Activities |
| *31* | Hotels, Beer Gardens and Restaurants | 55-56 | 61 | Accommodation and Food Service Activities |
| *32* | Junkshop | 46-47 | within 45 | Wholesale and retail trade |
| *33* | Other Community, Personal and Social Services | 96 | within 65 | Other personal service activities |
| *34* | Security and Manpower Services | 78, 80 | within 59 | Employment activities; Security and investigation activities |
| *35* | Transport, Storage and Communication | 49-52, 53, 60-61 | 46-50, 52 | Land, water and air transport; Warehousing and support activities for transportation; Communication |
| *36* | Welding, Vulcanizing and Repair Shops | 95 | within 65 | Repair of computers and personal and household goods |
| *37* | Wholesaler and Retailer | 46-47 | within 45 | Wholesale and retail trade |

Source of basic data: Authors

As it is already well-known, Valenzuela City is a popular location for manufacturing firms in the National Capital Region. In fact, different forms of manufacturing firms comprise almost 15% of all establishments for year 2015 in the city based on the database of BPLO. Revenue data from the same database, however, reveals that manufacturing firms comprise of around 65% of revenues in Valenzuela for the year 2015. This is indicative of the size of these firms. Table 1 below further shows a disaggregation of manufacturing activities inside the city. As it is already known, rubber and plastic industries produce the most with their sales comprising around 15% of the revenues. The second and third largest manufacturing sectors are the food & beverages and the metals sectors, respectively.

The other big sector is the wholesale and retail trade & maintenance and repair, which comprises more than a third of the total number of establishments. Albeit their revenues only make up a quarter of the total revenues. Such can be expected that cities like Valenzuela with large manufacturing sectors also involve a lot of scrap recycling on top of the usual wholesale and retail trade. The database also reveals a significant number of firms involved in transport, storage & communication at 12.4%, albeit their contribution revenues are low at 2%. Another interesting result is the number of apartment rental businesses comprising almost 15% of all registered establishment most probably catering to the factory workers. However, real estate only comprises 1% of the total revenue.

**Table A.2. Distribution of Establishments and Revenues in Valenzuela City in 2015**

| *PSIC code* | *IO code* | | *Number* | *%* | *Revenues (millions PHP)* | *%* |
|---|---|---|---|---|---|---|
| | | Valenzuela | 15530 | 100.00 | 204,405 | 100.00 |
| *INDUSTRY* | | | | | | |
| *10-11* | 18-19 | Food and beverages | 383 | 2.47 | 27,272 | 13.34 |
| *13* | 21 | Textiles | 56 | 0.36 | 5,327 | 2.61 |
| *14* | 22 | Wearing apparel | 181 | 1.17 | 2,321 | 1.14 |
| *15* | 23 | Leather and related products | 43 | 0.28 | 401 | 0.20 |
| *16* | 24 | Wood and Wood products, etc. | 20 | 0.13 | 552 | 0.27 |
| *17* | 25 | Paper and products | 62 | 0.40 | 9,293 | 4.55 |
| *18, 58-59, 62-63* | 26, 51 | Printing, publishing and information | 275 | 1.77 | 1,026 | 0.50 |
| *20-21* | 28-29 | Chemicals and minerals | 111 | 0.71 | 18,187 | 8.90 |

| | | | | | | |
|---|---|---|---|---|---|---|
| *22* | 30 | Rubber and plastic | 417 | 2.69 | 31,826 | 15.57 |
| *24-25* | 32-33 | Metals | 87 | 0.56 | 21,795 | 10.66 |
| *26-28* | 34-36 | Computers, machinery and equipment | 27 | 0.17 | 1,668 | 0.82 |
| *31* | 38 | Furnitures | 64 | 0.41 | 1,791 | 0.88 |
| *32-33* | 39 | Other manufacturing | 525 | 3.38 | 12,861 | 6.29 |
| *35-39* | 40-43 | Electricity, gas and water | 358 | 2.31 | 3,801 | 1.86 |
| *SERVICES* | | | | | | |
| *45-47* | 45 | Wholesale and retail trade | 5514 | 35.51 | 50,107 | 24.51 |
| *49-53, 60-61* | 46-50, 52 | Transport, storage and communication | 1926 | 12.40 | 4,154 | 2.03 |
| *64-66* | 53-55 | Financial intermediation | 252 | 1.62 | 1,183 | 0.58 |
| *33* | 56-57 | Real estate | 2196 | 14.14 | 2,154 | 1.05 |
| *69-82* | 58-59 | Business activities | 918 | 5.91 | 5,043 | 2.47 |
| *55-56* | 61 | Accommodation and food service | 851 | 5.48 | 1,471 | 0.72 |
| *85* | 62 | Education | 171 | 1.10 | 400 | 0.20 |
| *86-88* | 63 | Health | 160 | 1.03 | 412 | 0.20 |
| *90* | 64 | Arts and entertainment | 105 | 0.68 | 220 | 0.11 |
| *91-99* | 65 | Other services | 828 | 5.33 | 1,139 | 0.56 |

Source of basic data: City Planning and Development Office, Valenzuela City

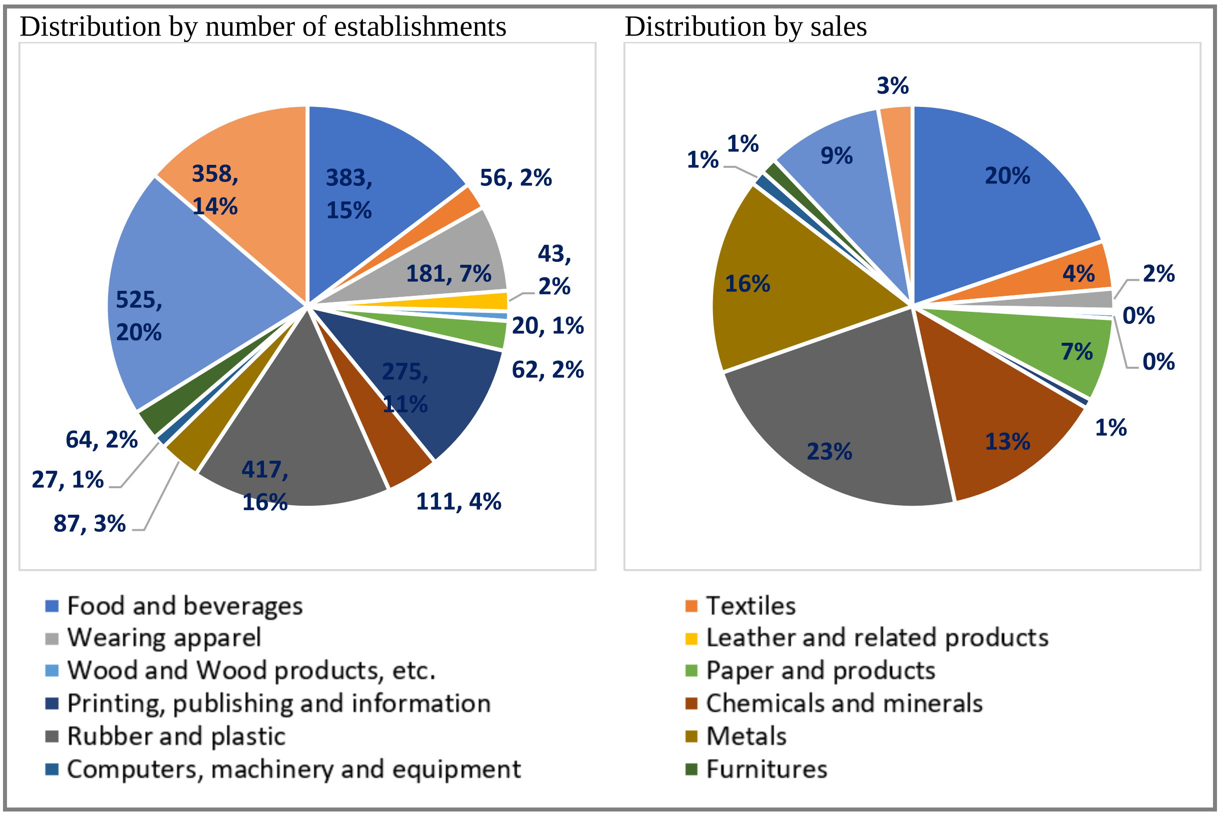
As shown in Table 2, the self-reported data on capital spending for newly-applied business permits show that the biggest capital investment in 2015 came from the metal sector at 6.5%. This is followed at around 4% by the other manufacturing which include the following activities: (1) agro-industrial processing, (2) assembly & processing, (3) metalcraft, machine works, and fabricators, and (4) all other manufacturing activities with or without machineries. Interestingly, data shows that self-reported investment is biggest for firms involved with trade at 41% of all capital spending. As it can be expected, investments made by apartment rental activities are also high. For the case of employment, the transport, storage & communication is surprisingly the biggest employer at 46% of all employees. The next biggest employer is trade at around 12%.

**Table A.3. Distribution of Capital Spending and Employees in Valenzuela City in 2015**

| *PSIC code* | *IO code* | | *Capital Spending (millions PHP)* | *%* | *Employees* | *%* |
|---|---|---|---|---|---|---|
| | | Valenzuela | 685.02 | 100.00 | 140,635 | 100.00 |
| *INDUSTRY* | | | | | | |
| *10-11* | 18-19 | Food and beverages | 6.48 | 0.95 | 6,430 | 4.57 |
| *13* | 21 | Textiles | 1.15 | 0.17 | 2,039 | 1.45 |
| *14* | 22 | Wearing apparel | 2.94 | 0.43 | 2,235 | 1.59 |
| *15* | 23 | Leather and related products | 0.90 | 0.13 | 516 | 0.37 |
| *16* | 24 | Wood and Wood products, etc. | - | - | 219 | 0.16 |
| *17* | 25 | Paper and products | 1.33 | 0.19 | 1,787 | 1.27 |
| *18, 58-59, 62-63* | 26, 51 | Printing, publishing and information | 12.85 | 1.88 | 1,331 | 0.95 |
| *20-21* | 28-29 | Chemicals and minerals | 1.25 | 0.18 | 3,962 | 2.82 |
| *22* | 30 | Rubber and plastic | 9.53 | 1.39 | 12,865 | 9.15 |
| *24-25* | 32-33 | Metals | 44.25 | 6.46 | 2,257 | 1.60 |
| *26-28* | 34-36 | Computers, machinery and equipment | - | - | 709 | 0.50 |
| *31* | 38 | Furnitures | 1.05 | 0.15 | 1,579 | 1.12 |
| *32-33* | 39 | Other manufacturing | 28.42 | 4.15 | 6,288 | 4.47 |
| *35-39* | 40-43 | Electricity, gas and water | 18.56 | 2.71 | 1,399 | 0.99 |
| *SERVICES* | | | | | | |
| *45-47* | 45 | Wholesale and retail trade | 282.10 | 41.18 | 17,088 | 12.15 |
| *49-53, 60-61* | 46-50, 52 | Transport, storage and communication | 53.53 | 7.81 | 64,695 | 46.00 |
| *64-66* | 53-55 | Financial intermediation | 14.68 | 2.14 | 1,077 | 0.77 |
| *33* | 56-57 | Real estate | 119.19 | 17.40 | 1,089 | 0.77 |
| *69-82* | 58-59 | Business activities | 34.55 | 5.04 | 5,780 | 4.11 |
| *55-56* | 61 | Accommodation and food service | 28.16 | 4.11 | 3,180 | 2.26 |
| *85* | 62 | Education | 1.06 | 0.15 | 1,021 | 0.73 |
| *86-88* | 63 | Health | 1.66 | 0.24 | 575 | 0.41 |
| *90* | 64 | Arts and entertainment | 3.99 | 0.58 | 230 | 0.16 |
| *91-99* | 65 | Other services | 17.39 | 2.54 | 2,284 | 1.62 |

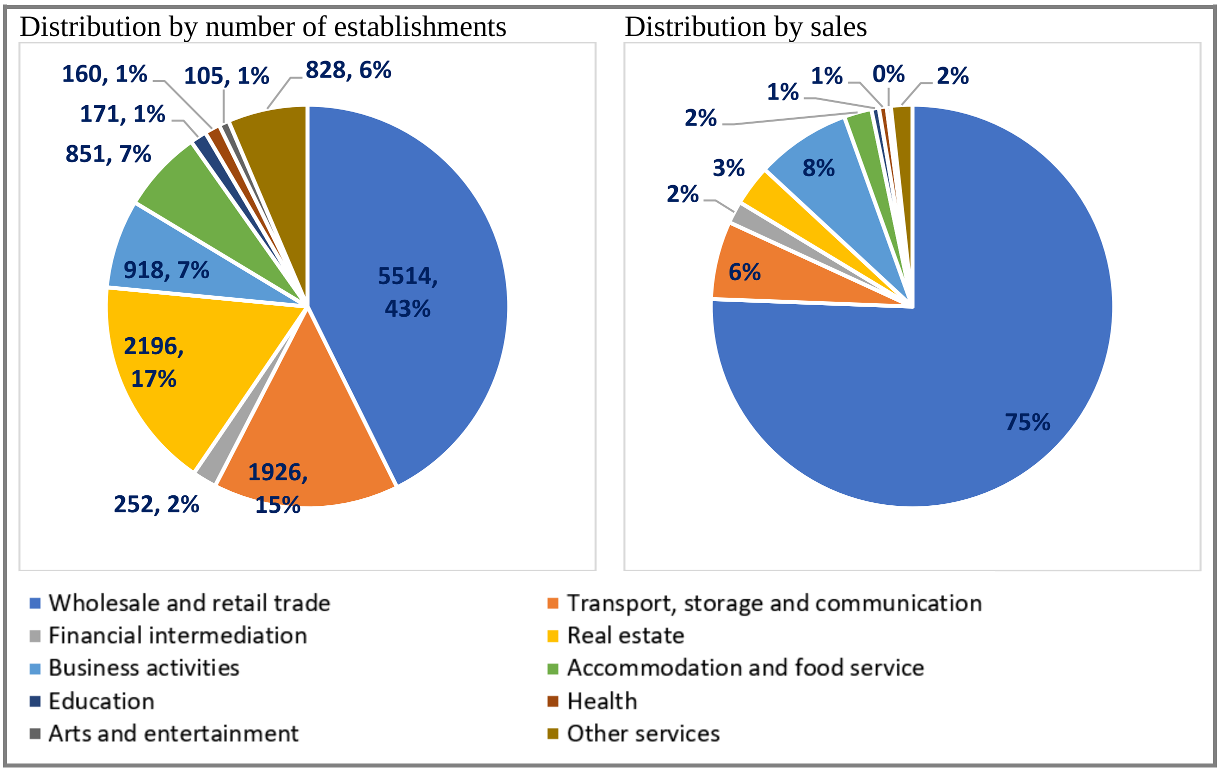
Source of basic data: City Planning and Development Office, Valenzuela City

**Figure A.4. Distribution of Establishments in Industry**




Source of basic data: City Planning and Development Office, Valenzuela City

**Figure A.5. Distribution of Establishments in Services**




Source of basic data: City Planning and Development Office, Valenzuela City

To further characterize Valenzuela's business environment, we may look at the distribution of businesses across its two legislative districts.

**Figure A.6. Districts in the City of Valenzuela**

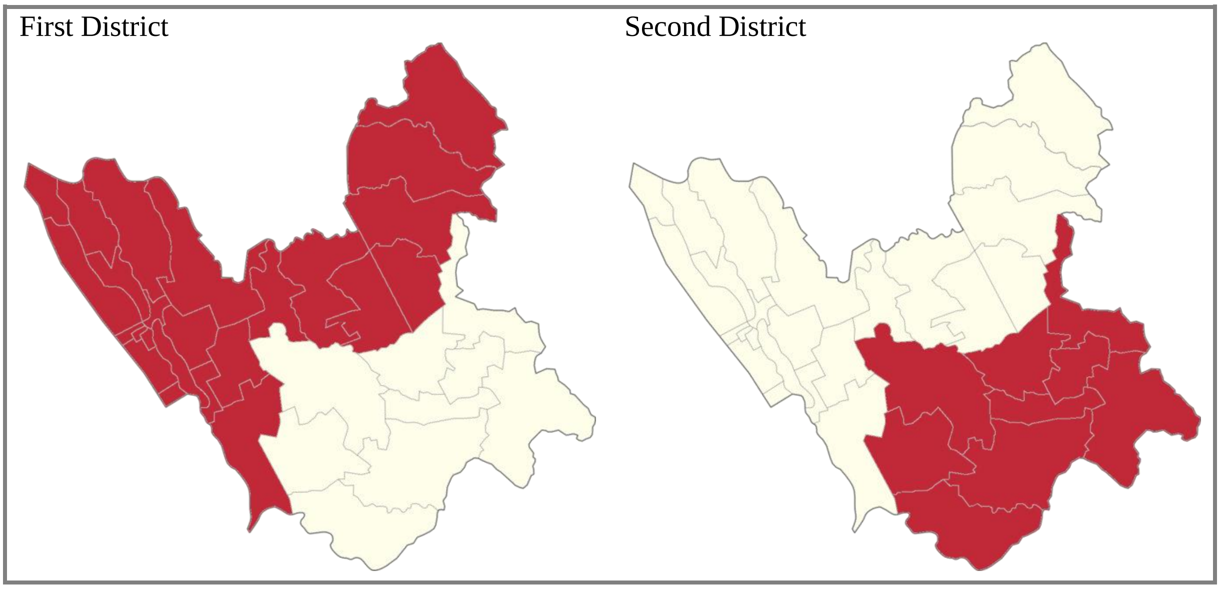
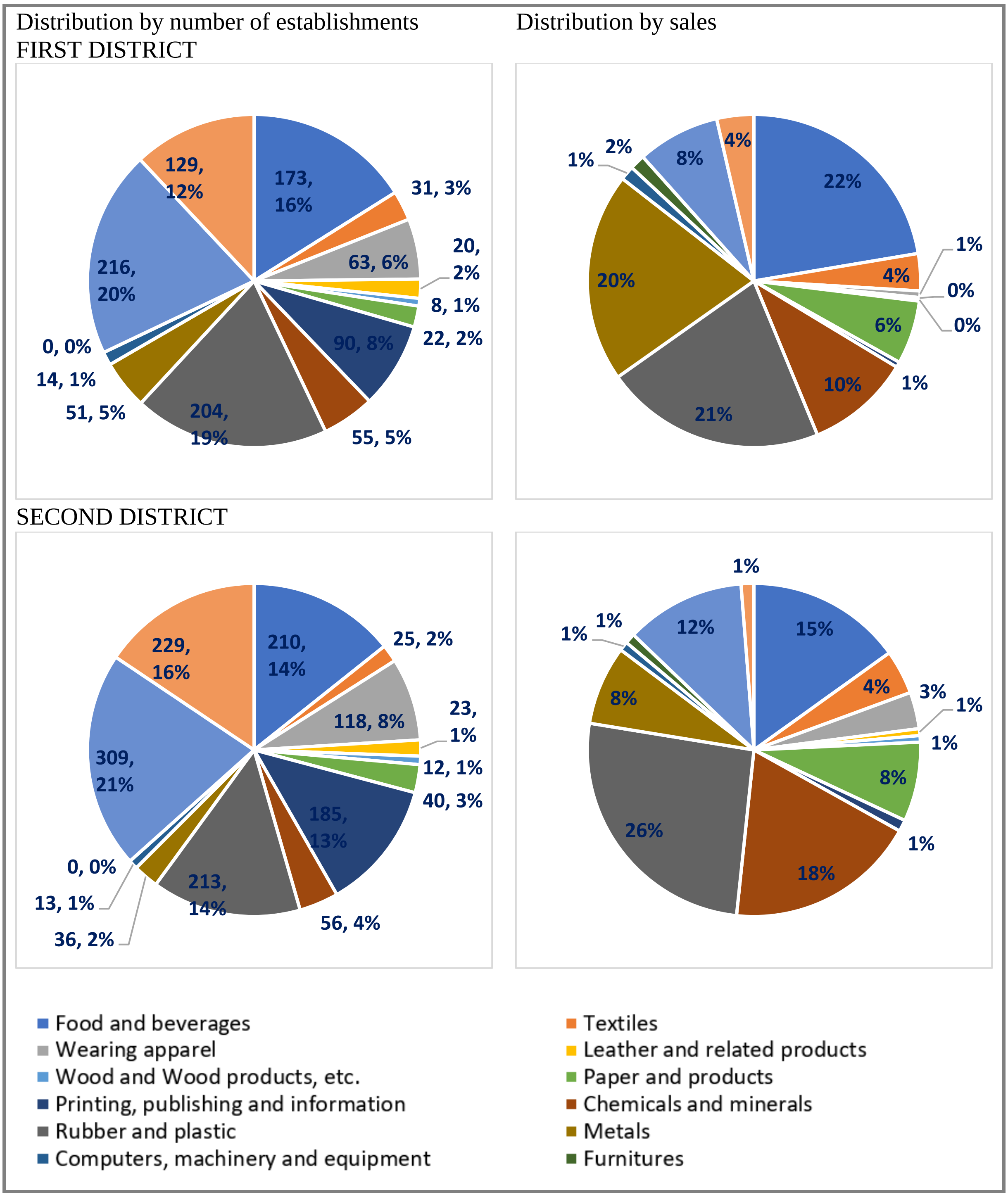


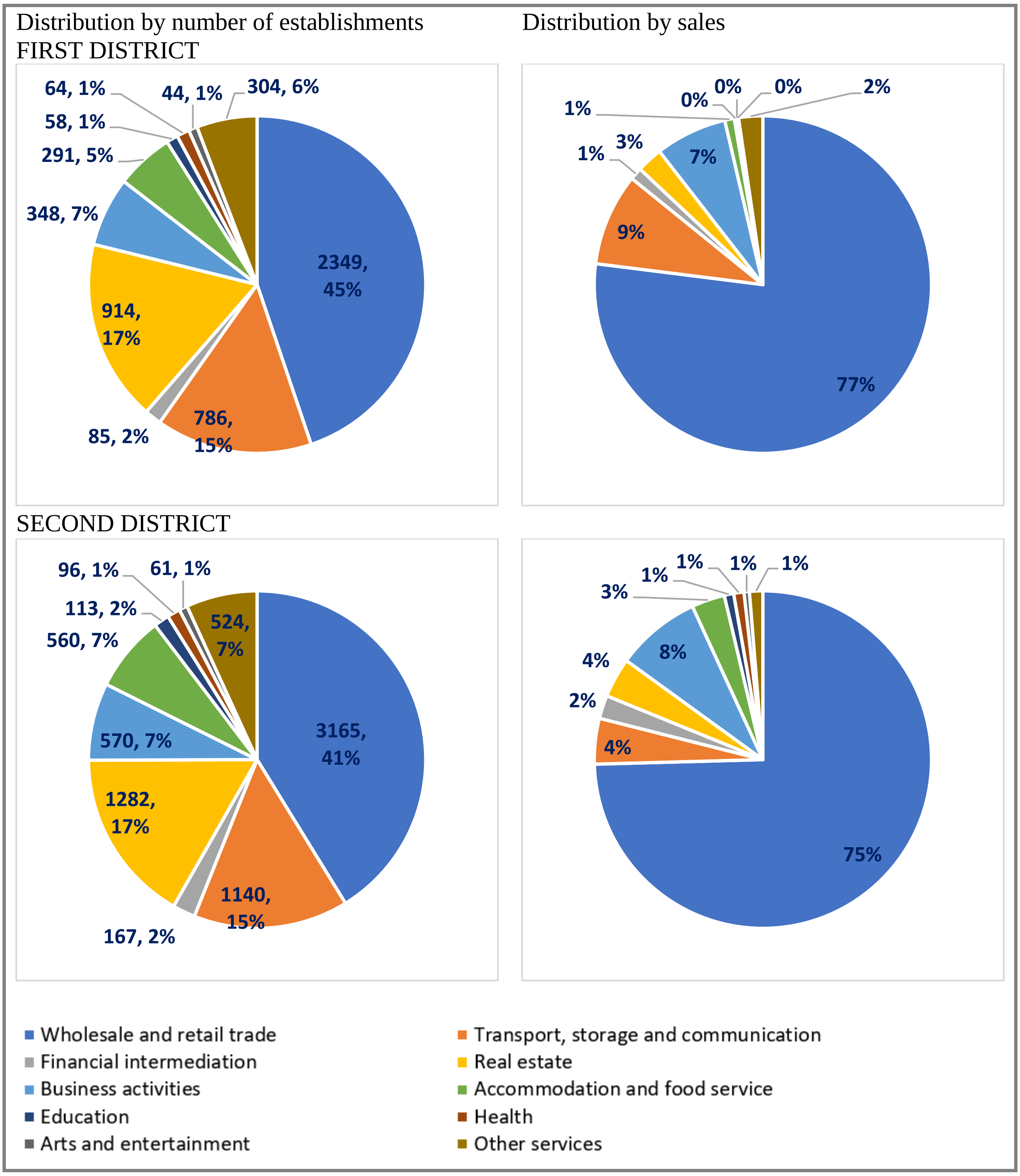

Image from Roel Balingit with a creative commons license

**Figure A.7. Distribution of Establishments in Industry across the Two Districts**




Source of basic data: City Planning and Development Office, Valenzuela City

**Figure A.8. Distribution of Establishments in Services across the Two Districts**




Source of basic data: City Planning and Development Office, Valenzuela City

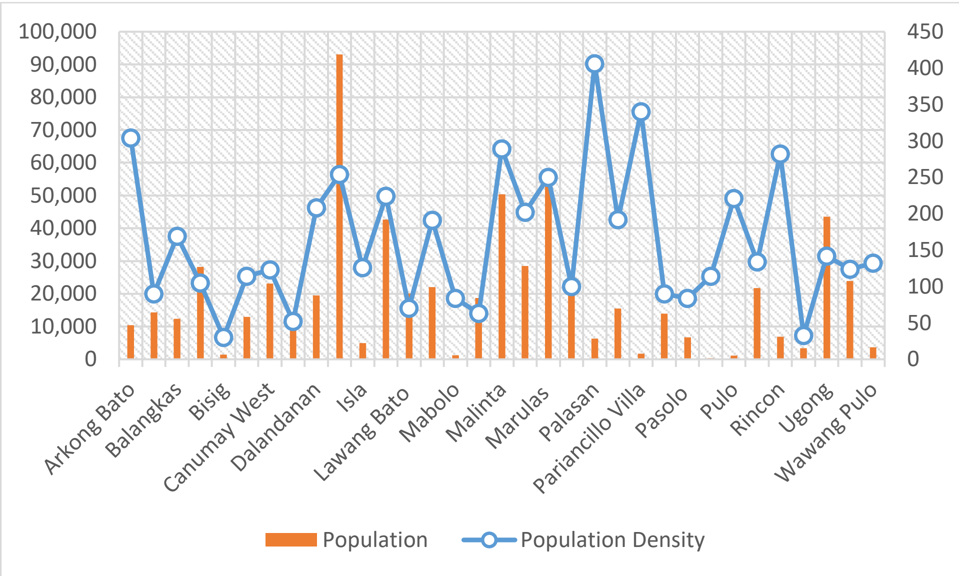
Based on the Doing Business 2011 report, the city is at the top amongst the ease of registering property in the Philippines. It has been one of the cities in the country with the lowest registration costs with only 3.5 percent of property value and 8 procedures that only takes 30 days. Moreover, it ranks fourth on ease of doing business and sixth in the easiest to deal with construction permits. These qualities were seen to reflect the prominent role of local governments in the city's business start-ups and construction requirements. Nonetheless, only Valenzuela and Taguig City ranked within the top 7 across all three indicators. Its remarkable improvements of the city's ease of doing businesses includes business reforms which includes cutting of 7 procedures and speeding up processes to 7 days. Specifically, starting a business in the city of Valenzuela only takes 32 days, 16 procedures (including local, national and private levels), a cost of 20.4 percent of income per capita and 6 percent for paid-in minimum capital.

It has also streamlined its business registration process by cutting down unnecessary certificates, permits, and clearances which were previously required. In addition, it has also introduced the one-time assessment and payment system and allowed application form to be available from the city's website for easy accessibility and shorter time in obtaining business permits. To make it easier to deal with construction permits, procedure for payment of fire clearance fee was added and connection cost refund process was changed. To increase competition among notaries within the city, notarization fees for preparing sale deeds and related documents were reduced to one percent in 2010, significantly lower than the range of 1 to 3 percent in 2008. On average, it cuts PHP 41,700 (USD 895) from the entrepreneur's cost (Department of Trade and Industry 2011).

## POPULATION STRUCTURE

Based on the 2015 Population data from Philippine Statistics Authority (PSA), the city of Valenzuela is recorded to have a population count of 620,422, 7$^{th}$ highest in the NCR Region, next to Parañaque City. Using a Geometric Growth Model estimated by the city's Planning and Development Office, Valenzuela is projected to have 675,979 residents by 2021. With a population growth rate of 1.52, the city contributed 4.8 percent to the 12.8 million population in the National Capital Region. At the national level, it shared 0.6 percent to the total population of 100.9 million (PSA, 2015).

**Figure A.6. Population and Population Density**

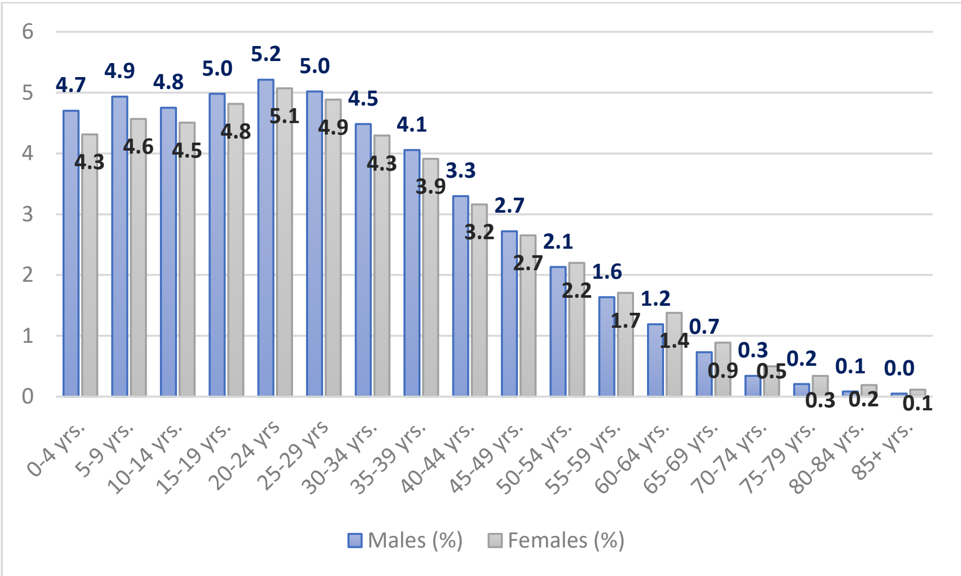



Source: City Planning and Development Office, Valenzuela City

In terms of population per se (i.e. based on the actual numbers of population living in an area), Brgy. Gen T. de Leon is recognized to have the highest population with 89,441 residents (14% of the city's total population), followed by Marulas and Malinta with 53,978 (9%) and 48,397 (8%) residents, respectively. Among top barangays which are heavily populated also includes Ugong with 41,821 (7% of city's total population) and Karuhatan with 40,996 (7%). The mentioned barangays captured 43% of Valenzuela's total population, almost half of the city. On the other hand, barangays with the least population are Pariancillo Villa, Bisig, Mabolo, Pulo, and Poblacion with a population count of 1,634, 1,333, 1,217, 1,103, and 372, respectively, accumulating just less than one percent of Valenzuela City's total population. To show the average number of population per area, population density was obtained, computed as the number of residents divided by the its land area. Among all barangays, it was Brgy. Palasan who was recorded to have the densest population in Valenzuela. In reference with the table below, it shows that Brgy. Periancillo Villa, Brgy. Bisig and Brgy. Malinta follows in the rank of densest barangays on the city. On the other note, household density where the density of the barangay given the number of household present, is also observed. With that said, Brgy. Palasan is recorded to have the densest household with 98 households per unit area, followed by Brgy. Pariancillo Villa with 82 households per unit area. Contrarily, the sparsest barangays in terms of households were Brgy. Bisig and Brgy. Tagalas with only 7 and 8 households per unit area, respectively. Furthermore, Barangay Gen T. de Leon is observed to have the largest number of households among all barangays of Valenzuela City.

In terms of its gender composition, the city has 50.51% male (313,419) and 49.48% female (307,003), with a sex ratio of 102 i.e. 102 males for every 100 females. Based on figure 4 below, the city's sex structure with regards to age is aligned with the flow of the global pattern where males predominate at birth and gradually declines with age since males have higher age-specific mortality rates. Furthermore, it is observed that most of the city's population are aged between 20 to 24 while the least are aged between 85 onwards. Specifically, there are 55,921 who are in the young population category (i.e. 0-4 years old), 426,788 who are in the working population (i.e. individuals who are 15-64 years old) and an elderly count of 21,345 where males dominate the first two categories (young and working population) and female dominating the elderly population. This reflects the higher concentration of its population distribution on labor force where 69% of the population are between 15 to 64 years old. This translates to high ration of young dependents where there is only 5 elderly people who are dependent to every working individual. It's improving population status, either qualitatively or quantitatively, can be blamed on its effective policies in social protection. For instance, the city has been recognized to be the first city to advocate for World Contraception Day, offering reproductive health services on weekdays and during the working hours of men[9].

**Figure A.7. Population Distribution by Age**




Source: Philippine Statistics Authority

**POVERTY**

Given its consistently growing economy, the city of Valenzuela is also determined to ensuring inclusive and sustainable growth through government programs and projects to eliminate its poverty issues in terms of income and livelihood, health, housing, water and sanitation, education, and peace and order.

**Figure A.8. Income and Livelihood Indicators by Barangay**

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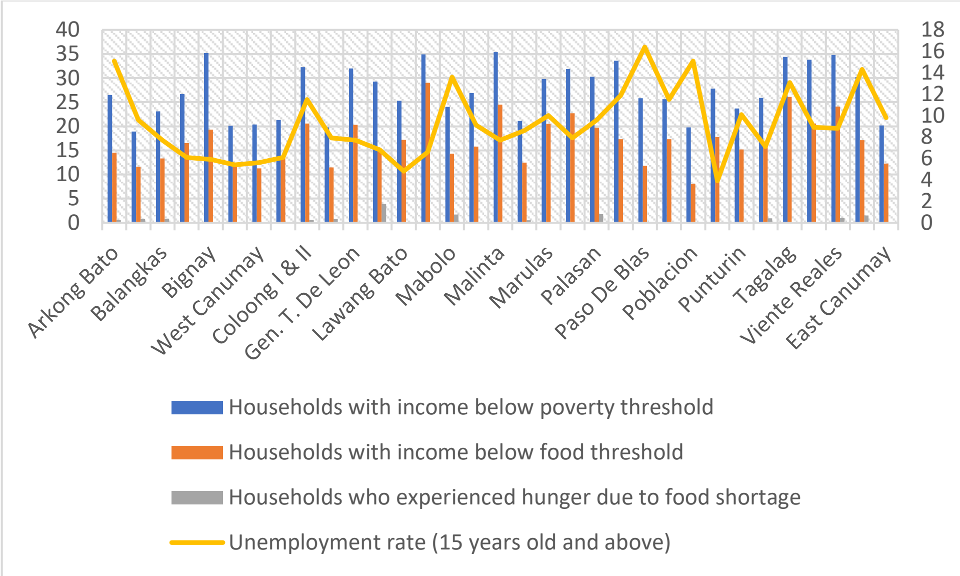
[9] https://www.cosmo.ph/health/world-contraception-day-forum-a1028-20180930-lfrm



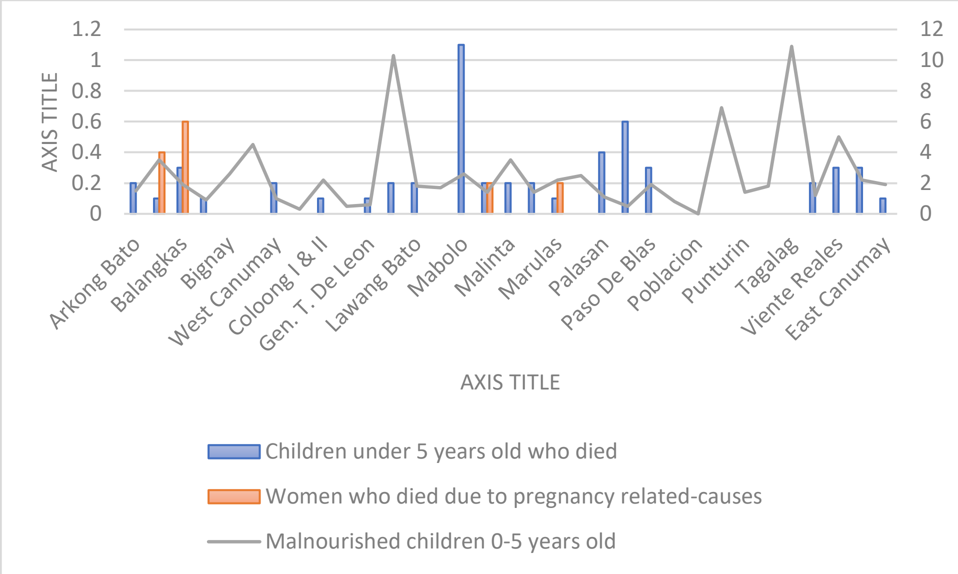

Source: Community-Based Monitoring System, 2015

With rising businesses and booming industries, employment opportunities were expanded and more residents were able to find jobs, resulting to an unemployment rate of 8.5 percent – substantially lower than the 12.8 percent unemployment rate of 2012. The government also conducted a two-day mega job fair where the City Public Employment Service Office (PESO) went to barangays to be able to accommodate as many applicants as possible. From 2005 to 2012, PESO was able to provide jobs to 146,184 city residences.

Poverty incidence was still high at 28.2 percent i.e. 28 out of 100 households were living below the poverty threshold. With CAMANAVA, it is one of the least poor provinces in the first semester of These are the households who cannot afford basic food and non-basic needs due to insufficiency of their income. The barangays that recorded to have the highest households recorded with income below poverty threshold were Brgy. Malinta, Brgy. Bignay and Brgy. Lingunan with 35.4 percent, 35.2 percent and 34.9 percent, respectively. Furthermore, the city has a subsistence incidence of 18% wherein 18 out of 100 households have income below the food (subsistence) threshold. Specifically, barangays Lingunan, Tagalag, Malinta, Viente Reales and Maysan has the highest subsistence incidence with an average of 25.28 percent. Therefore, food shortage was not an alarming issue for the city. Statistically, the proportion of households who experienced hunger due to lack of food was 0.3 percent, where Brgy. Isla is at top with 3.9 percent, followed by Brgy. Palasan and Mabolo with 1.8 percent and 1.7 percent, respectively.

Being recognized as the safest city in the Philippines, Valenzuela has been focusing on providing its residents with effective local social services programs to eradicate crime. This resulted to low crime rate where only 0.1 percent of the city population has been victims of crime, standing up to its reputation as the Best Police Station in NCR. It is worth noting that almost half of the city has no reported crime victims and these barangays include Brgy. Parada, Brgy. West Canumay, Brgy. Karuhatan, Brgy. Gen. T. De Leon, Brgy. Lawang Bato, Brgy. Lingunan, Brgy. Malanday, Brgy. Malinta, Brgy. Marulas, Brgy. Maysan, Brgy. Pariancillo Villa, Brgy. Paso De Blas, Brgy. Poblacion, Brgy. Pulo, Brgy. Tagalag, and Brgy. Ugong. In August 2016, the city launched its community-based drug rehabilitation "Valenzuela City Cares Plus." It is a comprehensive, responsive, completer and sustainable care program for identified drug suspects and provides a full economic and moral support. Initially, the drug dependent will undergo a six-month long rehabilitation either in Central Luzon Rehabilitation Center in Pampanga or in Community Based Wellness Program in the barangay, which will depend on the results of the assessment. This program is under the latter where drug dependents are reintegrated into the community for 18 months. The government will monitor these surrenderees to make sure they won't be using drugs again. This is known to be the After-Care Program. There were 1,568 drug surrenderees who enrolled at the Community-Based Wellness Program and 530 were brought to Pampanga for a center-based rehabilitation. In line with this, the city government partnered with the Valenzuela Philippine National Police (PNP) in introducing the *Tokhang-on-Wheels* which is the Philippines' first mobile drug testing. The aim of this project is to encourage drug users to surrender and undergo the rehabilitation.

**Figure A.9. Health and Nutrition Indicators by Barangay**

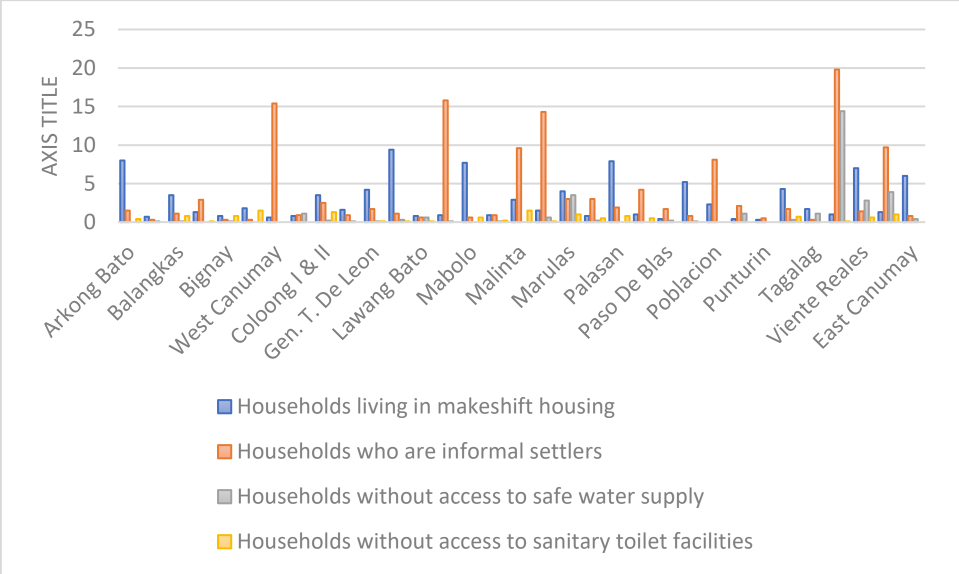



Source: Community-Based Monitoring System, 2015

Local government unit (LGU) through its Community-Based Monitoring System (CBMS) assessed the city's health condition where the label health poor is given to households wherein at least one child under 5 years old has died and nutrition poor if at least one child aged 0-5 years is malnourished. Based on the indicators by CBMS, the city has an average of 0.1 percent of households that has a member under 5-year-old who died. The barangay with the highest proportion was Mabolo with 1.1 percent. Moreover, the proportion of women who died during pregrancy-related causes was average at 0.0 since it was only barangays Palasan, Pariancillo Villa, Bagbaguin, and Gen. T. De Leon with 0.6 percent, 0.4 percent, 0.2 percent, and 0.2 percent, respectively, that had one while the rest had none. Lastly, the proportion of household with malnourished children were 1.9 percent. Specifically, the barangays with the most number of households who has a malnourished child was Poblacion with 10.9 percent, Malanday with 10.3 percent and Lingunan with 6.9 percent.

Thus, the government has been taking steps to enhance the quality of its residence from various health programs to facility development. In 2012, a budget of PhP 115,555,775,42 was allocated for improving its new Valenzuela City Emergency Hospital which includes 50 additional beds and a dialysis center. In the same year, the city already had forty-four health centers, three lying-in clinics, three physical therapy centers, an eye clinic, two animal bite clinics, a mega health center and thirty-six ambulances. On top of that, it has forty-one doctors, fifty-two nurses, and several health workers, population managers, and nutrition scholars to accommodate its increasing population. It was able to achieve the World Health Organization's ideal doctor-patient of 1: 20,000 and nurse-patient ratio of 1: 20,000 where the city has 1: 15,359 and 1: 12,110, respectively. Moreover, programs organized were able to include the senior citizens, infants, children and families. Its *Batang Valenzuelano, Malusog at Protektado* program was able to earn the "Best in Infant and Young Child Feeding Initiatives 2012" for NCR which was awarded by the National Nutrition Council. Also, the city was also able to initiate various programs such as the K to 6 In-school Feeding Program, reproductive health program, newborn screening to reduce infant mortality, family planning, and promotion of healthy lifestyle to avoid diseases.

**Figure A.10. Housing, Water and Sanitation Indicators by Barangay**



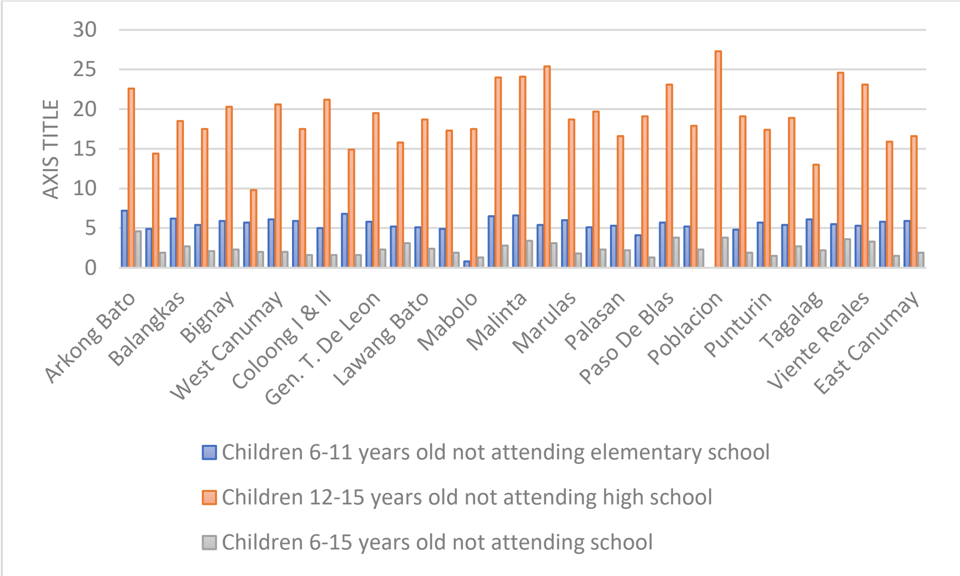

Source: Community-Based Monitoring System, 2015

In addition to its health and nutrition, housing has also been the government's local concern. Statistics shows that housing poor i.e. households living in makeshift housing – was at 2.6 percent. Moreover, 4.7 percent of its households are informal settlers. Most of these informal settlers are in Brgy. Ugong (with 19.8 percent of its population), Brgy. Lingunan (15.8 percent), Brgy. West Canumay (15.4 percent), and Brgy. Mapulang Lupa (14.3 percent). To mitigate this issue, the government and the National Housing Authority (NHA) constructed a housing project for the informal settlers families especially those who are very vulnerable to flooding. Based on the  The 11-hectare *Disiplina Village Bignay* community had a cost of PhP 1.2 billion which can accommodate 3,000 families (Melican 2014). The housing project also includes amenities such as schools, terminals, courts, centers and a church. It also targets to clear the areas near rivers and other waterways – known as dangers zones – where these informal settlers are.

In terms of water access and sanitation, there is only 1.4 percent of households who do not have access to safe water and 0.4 percent that do not have access to sanitary toilet facilities. Also known as "sanitation-poor households", barangays that had the highest proportion of households which has no access to sanitary toilets was Barangay Malinta and Bislig with 1.4 percent, and the highest number of cases recorded was at Barangay Malinta with 125 households.

As for December 2016, the total beneficiaries of the Disiplina Village Bignay housing projects reached 3,852 wherein 781 are beneficiaries of the PhP4,500 Meralco and Maynilad expenses, 1,008 came from the Site 2 units and 522 are from the Site 3 units, specifically.

**Figure A.11. Education Indicators**




Source: Community-Based Monitoring System, 2015

From 2004 to 2012, the city of Valenzuela was able to build more classroom and now has a total of 731 classrooms in its vicinity. Based on CBMS' education indicators, the city's proportion of children aged 6-15 years who are not attending school is at 5.8 percent. Specifically, the proportion of children aged between 6-11 years old who are not attending elementary school is only 2.4 percent. The top five barangays that had the highest proportion was Arkong Bato with 7.2 percent, Dalandanan with 6.8 percent, Malinta with 6.6 percent, Malanday with 6.5 percent, and Balangkas with 6.2 percent – averaging 6.6 percent. However, the proportion of children aged 12-15 years who are not attending elementary education is at 20 percent! Although all barangays have a percentage higher than 9, it is worth mentioning that Brgy. Poblacion has the highest proportion of its children who are not attending secondary schooling, with 27.3 percent. This is followed by Brgy. Mapulang Lupa (25.4 percent), Brgy. Ugong (24.6 percent), Brgy. Malinta (24.1 percent), and Brgy. Malanday (24 percent).

With regards to the Millennium Development Goals, the city of Valenzuela has been as good as the rest of the Philippines, with some factors it was even doing better. As presented in Table 1 below, its status in terms of income and livelihood does not go far than the country, performing better specifically in the proportion of households with income below the poverty threshold. Moreover, it has exceeded the country's performance on education with lower proportions in all indicators i.e. Proportion of children aged 6-12 years old who are not attending elementary school, proportion of children aged 13-16 years old who are not attending secondary school and proportion of children aged 6-16 years old who are not attending school having 13.7 (PH: 14.9), 25.3 (PH: 39.3), 3.8 (PH: 7.4), respectively. It also has significantly lower proportions in the health and nutrition category such as the city's proportion of children aged 0-5 who are malnourished which was only 2.2, compared to the country's 19.9, achieving the MDG's goal of having it below 13.3 only. Lastly, the city has outperformed the country in housing considering all indicators and fulfilling the MDGs impressively wherein the city's proportion of households who are informal settlers was only 4.7 of its population, far lower than the Philippines' 10.2 of its total population.

## Table A.4. Millennium Development Goals and the Status of Valenzuela City

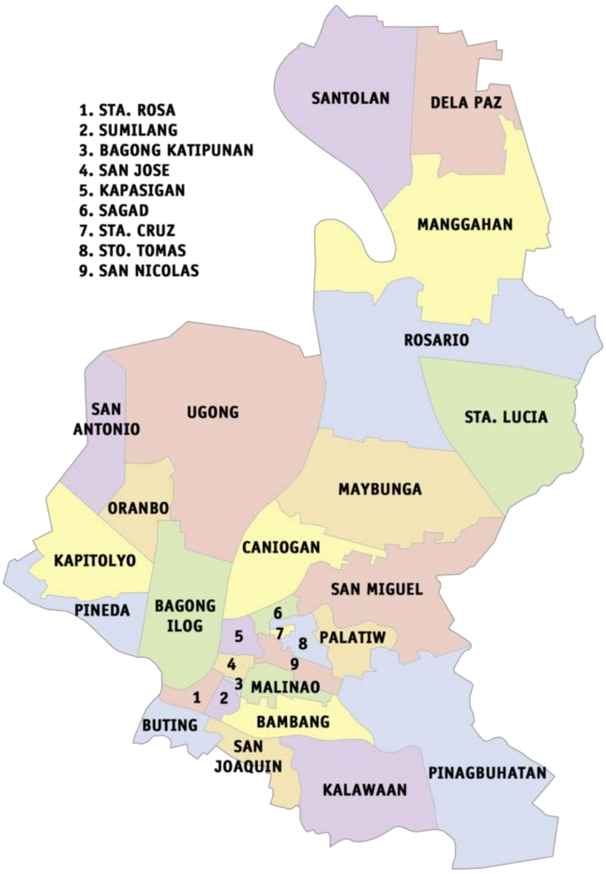
| Basic Needs | Indicators | Valenzuela City | | Philippines | MDG Target |
|---|---|---|---|---|---|
| | | 2012 | 2015 | 2015 | 2015 |
| Income and Livelihood | Proportion of households with income below the poverty threshold | 22.4 | 24.4 | 26.3<br>-2015 | 17.2 |
| | Proportion of households with income below the food threshold | 13.4 | 16.3 | 10.4<br>-2012 | 8.8 |
| | Proportion of households who experienced food shortage | 1.6 | 0.6 | No data available | No data available |
| | Proportion of persons in the labor force who are unemployed | 12.8 | 8.5 | 6.5<br>-2015 | decreasing |
| Education | Proportion of children aged 6-12 years old who are not attending elementary school | 20.3 | 13.7 | 14.9 | 100 |
| | Proportion of children aged 13-16 years old who are not attending secondary school | 31.5 | 25.3 | 39.3 | 100 |
| | Proportion of children aged 6-16 years old who are not attending school | 8.2 | 3.8 | 7.4 | 100 |
| Health and Nutrition | Proportion of children under 5 who died | 0.4 | 0.2 | 31<br>-2013 | 27 |
| | Proportion of women who died due to pregnancy related causes | 0.1 | 0.1 | 221<br>-2011 | 52 |
| | Proportion of children aged 0-5 who are malnourished | 2.6 | 2.2 | 19.9<br>-2013 | 13.3 |
| Housing | Proportion of households in makeshift housing | 2.9 | 2.6 | No data available | No data available |
| | Proportion of households who are informal settlers | 3.9 | 4.7 | 10.2<br>(2014) | decreasing |
| | Proportion of households without access to improved water source | 5.3 | 1.4 | 14.5<br>(2014) | 13.5 |
| | Proportion of households without access to sanitary toilet facilities | 0.6 | 0.4 | 5.9<br>(2014) | 16.2 |
| Peace and Order | Proportion of persons who are victims of crime | 0.4 | 0.1 | No data available | No data available |
| CBMS Composite Index | Average number of deprivations | 0.7 | 0.64 | | 0 |

Source: City Planning and Development Office, Valenzuela City

## Appendix B. Socio-economic Profile of Pasig City

Pasig City is among the cities and municipalities of National Capital Region's 2$^{nd}$ District (i.e. Eastern Manila District) with Mandaluyong, Marikina, Quezon City and San Juan. The city is divided into two districts: District 1 and District 2. District 1 has twenty-two (22) barangays namely Bagong Ilog, Bagong Katipunan, Bambang, Buting, Caniogan, Kalawaan, Kapasigan, Kapitolyo, Malinao, Oranbo, Palatiw, Pineda, Sagad, San Antonio, San Joaquin, San Jose, San Nicolas, Sta. Cruz, Sta. Rosa, Sto. Tomas, Sumilang, and Ugong. On the other hand, District 2 has only eight (8) barangays i.e. Dela Paz, Manggahan, Maybunga, Pinagbuhatan, Rosario, San Miguel, Santolan, and Sta. Lucia. Amongst all cities in Metro Manila, Pasig City is the smallest city with only 13 km$^2$.

**Figure B.2: Map of Pasig City**




Source: https://www.wikiwand.com/en/Pasig

Pasig City has been well-known for its river i.e. The Pasig River. Historically, this river has been known for its transportation, recreation and tourism advantages, specifically as transport route and water source. However, it has been declared as biologically dead due to industrial development, overpopulation and negligence. This includes the informal settlers and dumping around the river area. The government agency who was tasked to rehabilitate the river to its pristine form has also been abolished.

### LAND USE DISTRIBUTION

Regarding the distribution of its land, the city is dominated by residential spaces. Formal residential spaces occupied 47.74 percent of total land area while industrial area and the commercial spaces have 9.83 and 4.6 percent of the city's land area, respectively. **Table B.1** shows the detailed land use distribution of Pasig City.

**Table B.4: Land Use Distribution of Pasig City**

| Land Use Type | Existing Land Uses 2012 | | Proposed Land Uses 2015-2023 | |
|---|---|---|---|---|
| | Land Area (in hectares) | % Share to Total Land Area | Land Area (in hectares) | % Share to Total Land Area |
| Built-Up Area | | | | |
| Residential (Formal) | 1,638.87 | 47.75 | 1,608.22 | 46.86 |
| Residential (Socialized Housing) | 42.19 | 1.23 | 8.93 | 0.26 |
| Residential (Informal Settlement) | 274.85 | 8.01 | | 0.00 |
| Commercial (including Bulk Warehousing and Storage) | 157.85 | 4.60 | 356.13 | 10.38 |
| Mixed Use | 40.26 | 1.17 | 633.34 | 18.45 |
| Industrial | 336.92 | 9.82 | 58.27 | 1.70 |
| Institutional | 97.81 | 2.85 | 91.54 | 2.67 |
| Tourism Site | 6.96 | 0.20 | 6.14 | 0.18 |
| Utility | 18.93 | 0.55 | 14.16 | 0.41 |
| Sub-total | 2,614.64 | 76.18 | 2,776.73 | 80.91 |
| Open Spaces | | | | |
| Roads | 384.61 | 11.21 | 393.60 | 11.47 |
| Waterway | 133.36 | 3.89 | 133.20 | 3.88 |
| Legal Easement of Waterway | 2.32 | 0.07 | 28.15 | 0.82 |
| Open Spaces (City Parks, Linear Parks, Playgrounds, Sports Facilities) | 23.87 | 0.70 | 54.47 | 1.59 |
| Cemetery | 14.03 | 0.41 | 14.01 | 0.41 |
| Idle Land | 255.02 | 7.43 | - | 0.00 |
| Other Open Spaces | 4.15 | 0.12 | | |
| Buffer Areas and Ancillary Open Spaces | | 0.00 | 28.97 | 0.84 |

Specifically, residential spaces are mostly at the western and northern Pasig, with average to middle income class. The largest subdivision in the city is the Valle Verde, which occupies 80 hectares and is recognized as the only low-density subdivision in Pasig City. Moreover, the developments in the residential areas are concentrated on single-type dwellings and some medium rise types of housings. For the commercial land areas, majority of its land use is occupied by the city's central business district – the Ortigas Center – which has more than 80 condominium buildings that accommodate most of the city's largest businesses and other establishments.

**BUSINESS ENVIRONMENT**

Pasig City's business environment is flourishing with numerous businesses and establishments, primarily within its central business district**. Table B.2** below ranks these businesses based on its declared gross receipts and business tax paid.

**Table B.5: Top 50 Business Taxpayer According to Business Permit & License Office**

| Rank | Business Trade Name | Declared Gross Receipts | Business Tax Paid |
|---|---|---|---|
| 1 | SOUTH PREMIERE POWER CORP. | 33,745,665,825.02 | 199,093,825.48 |
| 2 | JOLLIBEE FOODS CORPORATION - MAIN OFFICE | 32,201,529,672.07 | 163,748,417.96 |
| 3 | SAN MIGUEL ENERGY CORPORATION (SMEC) | 11,991,278,391.05 | 89,937,297.92 |
| 4 | VOUNO TRADE & MARKETING SERVICES CORPORATION | 12,403,914,967.48 | 88,378,654.16 |
| 5 | TOYOTA PASIG | 8,984,210,626.48 | 65,446,155.24 |
| 6 | LG ELECTRONICS PHILIPPINES, INC. (FR. LG COLLINS ELEC. MLA., INC.) | 8,670,958,120.63 | 65,035,295.92 |
| 7 | DMCI PROJECT DEVELOPERS, INC. | 1,728,270,927.72 | 64,988,098.04 |
| 8 | VSTECS PHILS. INC. | 7,150,830,785.00 | 53,634,521.12 |
| 9 | METRO RAIL TRANSIT CORP. | 5,851,001,932.17 | 50,743,175.04 |
| 10 | FIRST GAS POWER CORPORATION | 9,327,128,937.87 | 50,393,793.52 |
| 11 | DAVIES PAINTS PHILIPPINES, INC. | 5,677,695,601.51 | 45,481,761.43 |
| 12 | PROFESSIONAL SERVICES, INC. (THE MEDICAL CITY) | 4,625,745,303.00 | 43,205,621.10 |
| 13 | EPSON PHILIPPINES CORPORATION | 5,698,459,028.29 | 42,738,842.72 |
| 14 | ROCKWELL LAND CORPORATION | 1,404,498,544.00 | 42,134,956.32 |
| 15 | PAG-ASA STEEL WORKS INC. | 7,455,979,336.59 | 42,014,685.12 |
| 16 | PMFTC INC. | 7,046,600,461.41 | 39,638,102.60 |
| 17 | ORTIGAS & COMPANY LIMITED PARTNERSHIP | 1,254,693,553.47 | 37,640,806.60 |
| 18 | ENERGY DEVELOPMENT CORPORATION | 7,040,181,285.31 | 37,622,911.40 |
| 19 | PORTICO LAND CORP. | 1,206,424,472.55 | 36,192,734.20 |
| 20 | GNPOWER MARIVELES COAL PLANT LTD. CO. | 6,501,885,549.46 | 34,745,377.16 |
| 21 | J.S. UNITRADE MERCHANDISE, INC. | 4,389,847,227.05 | 32,967,076.36 |
| 22 | VIVO MOBILE TECH., INC. | 4,317,599,116.82 | 32,382,393.40 |
| 23 | PHILIPPINE OPPO MOBILE TECHNOLOGY, INC. | - | 30,404,086.40 |
| 24 | FGP CORP. | 5,005,961,257.66 | 27,436,282.52 |
| 25 | ORTIGAS & COMPANY LIMITED PARTNERSHIP | 901,995,768.75 | 27,059,873.08 |
| 26 | ISUZU AUTOMOTIVE DEALERSHIP, INC. | 3,783,249,029.11 | 26,983,666.80 |
| 27 | ABENSON VENTURES, INC. | 2,862,311,343.00 | 26,840,568.88 |
| 28 | DMCI PROJECT DEVELOPERS, INC. | 846,927,110.54 | 25,407,813.32 |
| 29 | FINDEN TECHNOLOGIES INC. | 2,938,597,754.29 | 24,720,358.16 |
| 30 | LUNAR STEEL CORP. | 4,324,085,009.46 | 24,323,953.20 |
| 31 | PHILUSA CORPORATION | 3,672,997,745.02 | 23,373,954.56 |
| 32 | BULACAN HOLDING INC. | 900,000.00 | 22,438,230.88 |
| 33 | READYCON TRADING CONST. CORP. | 1,794,535,316.87 | 22,077,117.88 |

| | | | |
|---|---|---|---|
| 34 | CENTURY PACIFIC FOOD, INC. | 5,626,981,760.48 | 21,586,496.68 |
| 35 | THE ROCKWELL BUSINESS CENTER | 698,435,080.00 | 20,953,052.40 |
| 36 | MERALCO ENERGY, INC. | 2,650,612,849.03 | 20,717,662.24 |
| 37 | ALLIANCE IN MOTION GLOBAL INC. | 1,404,625,467.00 | 20,688,894.14 |
| 38 | L`OREAL PHILIPPINES, INC. | 2,742,172,165.31 | 20,566,691.24 |
| 39 | AMBERLAND CORPORATION | 676,320,256.84 | 20,289,607.72 |
| 40 | MAGNOLIA INC. | 5,591,606,479.64 | 20,219,589.64 |
| 41 | I3 TECHNOLOGIES CORPORATION | 98,053,032.60 | 18,796,372.58 |
| 42 | SM HYPERMARKET | 1,756,089,376.61 | 17,917,698.90 |
| 43 | MEDICAL CENTER TRADING CORPORATION | 1,903,912,060.76 | 17,467,685.28 |
| 44 | EPLDT, INC. | 2,446,040,870.87 | 17,430,615.68 |
| 45 | PANASIA ENERGY, INC. | 2,317,586,676.00 | 17,384,610.08 |
| 46 | UNIVERSAL ROBINA CORP | 586,401,334.00 | 15,773,560.90 |
| 47 | STRATEGIC POWER DEVT. CORP. | 1,996,094,933.39 | 15,490,218.20 |
| 48 | GREEN CORE GEOTHERMAL INC. | 2,873,222,352.58 | 15,355,724.60 |
| 49 | THE PUREFOODS-HORMEL COMPANY, INC. | 5,525,565,271.19 | 14,968,105.80 |
| 50 | INDRA PHILIPPINES, INC. | 1,991,053,446.03 | 14,935,610.84 |

Source: Pasig City Profile 2018

Based in the Business Permit and License Office, South Premier Power Corporation is recognized to be the largest business in Pasig city followed by Jollibee Foods Corporation and San Miguel Energy Corporation (SMEC) with 199 million, 163 million and 89 million taxes paid, respectively. South Premier and SMEC are subsidiaries of SMC Global Power under electric power generation industry. With just the top 50 businesses alone, the government of Pasig City has accumulated 1.9 billion revenue from their taxes paid.

According to the Finance and Budget Department, Pasig City has a total income of P10,090,816,480,83, with an Internal Revenue Allotment (IRA) share (i.e. share of the local government unit from the revenue of the national government) is P1,094,054,125. Not to mention, its total expenditure reached P8,073,968,877.25, as per stated in the city's website. One of the factors that contributed to the local government's high revenue is the increasing number of establishments in the city, as shown in **Table B.3.**

**Table B.6: Number of Establishment Applied**

| Year | New | Renewal | Total | Less Retirement | Net Total |
|---|---|---|---|---|---|
| 2013 | 4,146 | 25,665 | 29,811 | 1,084 | 28,727 |
| 2014 | 4,173 | 26,979 | 31,152 | 1,255 | 29,897 |
| 2015 | 3,618 | 22,976 | 26,594 | 1,143 | 25,451 |
| 2016 | 3,759 | 22,498 | 26,257 | 1,375 | 24,882 |
| 2017 | 4,084 | 23,758 | 27,842 | 1,447 | 26,395 |
| 2018 | 4,173 | 24,787 | 28,960 | 1,188 | 27,772 |

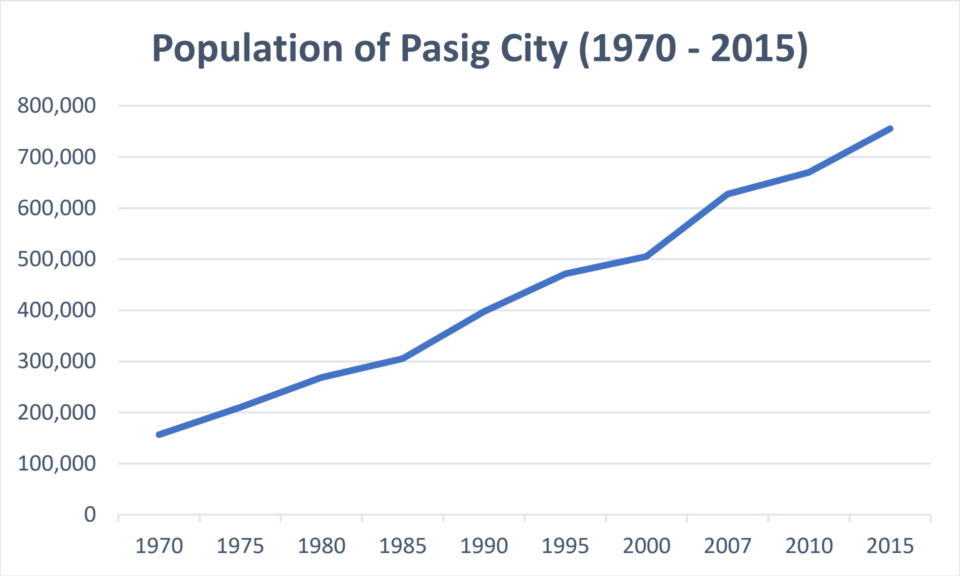
Source: Pasig City Profile 2018

In 2018, a total of 28,960 establishments have applied which is significantly higher than the past three years. Although in terms of new applications, this year has been the highest since 2013, similar with 2014.

**POPULATION STRUCTURE**

According to the 2015 Population Consensus, Pasig City has a total population of 755,500 with 180,612 households. The population density (i.e. persons per hectare) is 22,008 sq/m with an average household size of 4.2. It ranks as 4th biggest city in the National Capital region in terms of population contributing a percentage of 5.65 to the almost 12 million population in the region. The city's annual population growth rate is recorded to be 2.31 percent from 2010 to 2015. This is higher than the country's population growth rate which is 1.58 percent.

**Figure B.3: Population of Pasig City from 1970 to 2015**




Source: Pasig City Profile 2018

As illustrated in **Figure B.2**, the population of Pasig City has an increasing trend. This is reflected by the population growth rate listed in **Table B.4** below.

**Table B. 7: Population Growth Rate of Pasig City**

| Population Growth Rate | |
|---|---|
| 2010 - 2015 | 2.31% |
| 2000 - 2010 | 2.86% |
| 2000 - 2007 | 3.04% |
| 1990 - 2000 | 2.42% |
| 1995 - 2000 | 1.50% |
| 1990 - 1995 | 3.22% |
| 1980 - 1990 | 3.99% |
| 1970 - 1980 | 3.99% |
| 1960 - 1970 | 15.84% |

Source: Pasig City Profile 2018

Specifically, barangay Pinagbuhatan has the largest population in Pasig City with a population of 151,979 which accounts for 20.12 percent of its total population. This is followed by barangay Manggahan with 93,976 (12.44 percent) and barangay Rosario with 61,920 (8.20 percent). Cumulatively, these three barangays accounts for the 40.7 percent of the city's total population. For population density of the city, barangay Sto. Tomas is considered as the most densely populated barangay in the city, with 688 persons per hectare. This is followed by barangays Sta. Cruz and Sumilang. On the other hand, the barangays with the least density are Sta. Rosa, Ugong, San Nicolas and Dela Paz

**Table B.8: Total Household Population and Sex Ratio, by Sex and Age-Group**

| Age Group | Total | Male | Female | Sex Ratio |
|---|---|---|---|---|
| All ages | 753,030 | 367,476 | 385,554 | 95 |
| Under 5 | 72,620 | 37,658 | 34,962 | 108 |
| 05-09 | 70,088 | 36,472 | 33,616 | 108 |
| 10-14 | 68,662 | 35,187 | 33,475 | 105 |
| 15-19 | 67,934 | 32,525 | 35,409 | 92 |
| 20-24 | 74,026 | 34,768 | 39,258 | 89 |
| 25-29 | 75,051 | 36,248 | 38,803 | 93 |
| 30-34 | 68,622 | 33,518 | 35,104 | 95 |
| 35-39 | 58,396 | 29,014 | 29,382 | 99 |
| 40-44 | 48,374 | 23,817 | 24,557 | 97 |
| 45-49 | 40,784 | 19,804 | 20,980 | 94 |
| 50-54 | 32,999 | 15,531 | 17,468 | 89 |
| 55-59 | 26,610 | 12,275 | 14,335 | 86 |
| 60-64 | 19,770 | 8,906 | 10,864 | 82 |
| 65-69 | 13,049 | 5,805 | 7,244 | 80 |
| 70-74 | 7,119 | 2,878 | 4,241 | 68 |
| 75-79 | 4,895 | 1,799 | 3,096 | 58 |
| 80-84 | 2,501 | 858 | 1,643 | 52 |
| 85 and over | 1,530 | 413 | 1,117 | 37 |

Source: Pasig City Profile 2018

In terms of gender structure, male population comprised the 48.8 percent of the city's total population while female comprised 51.2 percent. In other words, there are 95 males for every 100 females. The age-sex distribution also showed that persons aged 25-29 comprised the largest age group with 10 percent of the household population. Moreover, the median age of the household is 26.54, implying that half of the population is younger than 26.54 years. Also, majority of the population are within the working age (68.2 percent), lowering the city's dependency ratio (i.e. the ratio of persons aged 15 years and below and those over 64 years to the working population aged 15 years old to 64 years) to 47 percent which is significantly higher than 66.4 percent in 2007. At the same time young dependents are also declining while old dependents are following an increasing trend.

## POVERTY

In June 2019, Philippine Statistics Authority released the 2015 Municipal and City Level Poverty Estimates. In the said report, cities and municipalities were leveled according to their estimated poverty incidents. Specifically, there are five (5) levels of poverty incidence shown in **Table B.6**.

**Table B.9: Classification of Poverty Incidence Among Population**

| Poverty classification | Poverty Incidence Among Population | % |
|---|---|---|
| Level 1 | At most 20 % | 36.8 |
| Level 2 | 21 to 40% | 37.1 |
| Level 3 | 41% to 60% | 21.5 |
| Level 4 | 61% to 80% | 4.8 |
| Level 5 | Greater than 80% | 0 |

Source: Pasig City Profile 2018

Fortunately, no city or municipality in the Philippines is under Level 5. For the NCR, all cities and municipalities are classified under Level 1, with Makati (1.86 percent) as the lowest and Port Area (12.22 percent) as the highest, as shown in **Table B.7**.

**Table B.10: National Capital Region Small Area Poverty Estimates, 2015**

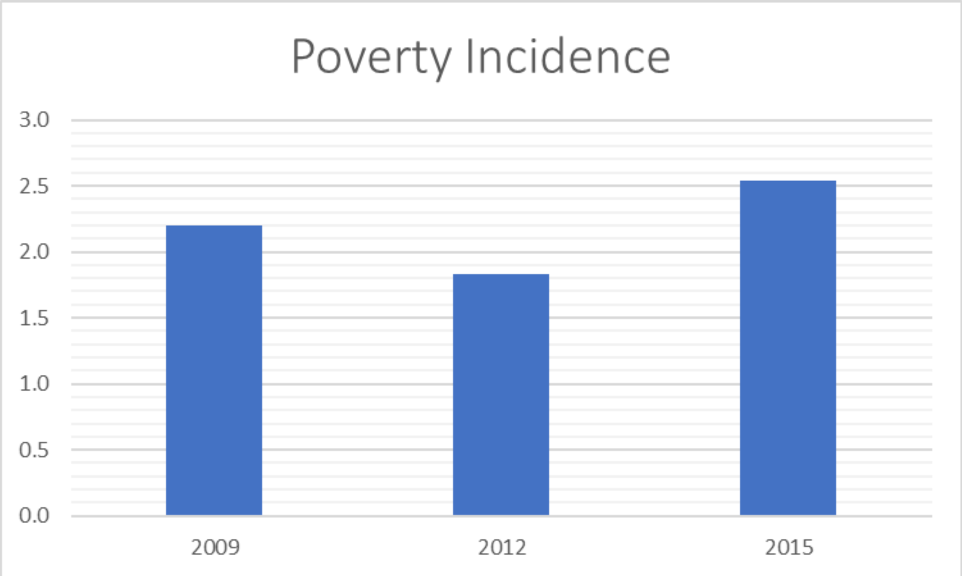
| City/ Municipal | Poverty Incidence |
|---|---|
| Makati City | 1.86 |
| San Juan City | 2.35 |
| Mandaluyong City | 2.41 |
| Pasig City | 2.54 |
| Pateros | 2.54 |
| Marikina City | 2.56 |
| Parañaque City | 2.66 |
| Sampaloc | 2.73 |
| Muntinlupa City | 2.87 |
| Las Piñas City | 2.92 |
| Pasay City | 3.04 |
| Taguig City | 3.12 |
| Paco | 3.18 |
| Quezon City | 3.31 |
| Binondo | 3.47 |
| Valenzuela City | 3.56 |
| Pandacan | 3.61 |
| Santa Ana | 3.82 |
| Malate | 4.17 |

| | |
|---|---|
| Caloocan City | 4.44 |
| Malabon City | 4.52 |
| Santa Cruz | 4.72 |
| Ermita | 5.26 |
| Navotas City | 5.50 |
| Tondo | 5.60 |
| San Nicolas | 6.68 |
| Quiapo | 7.10 |
| San Miguel | 7.16 |
| Intramuros | 10.2 |
| Port Area | 12.22 |

Source: 2015 Municipal and City Level Small Area Poverty Estimates, Philippine Statistics Authority

Based on the First Semester 2012 Poverty Statistics released by the National Statistical Coordination Board (NSCB), Pasig City, as part of the 2$^{nd}$ district of NCR, is recognized as one of the least poor provinces in the country. The region is estimated to have a poverty incidence of 21.0 percent in 2018, referring to the proportion of the population who are living below the poverty line to the total population. In 2015, Pasig City is recorded to be classified under Level 1 with poverty incidence of 2.5, making it fourth among the lowest poverty incidence in National Capital Region, following Mandaluyong City (2.4), San Juan City (2.4) and Makati City (1.86). However, this is higher than the poverty incidence in 2012 and 2009.

**Figure B.4: Poverty Incidence of Pasig City**




Source: 2015 Municipal and City Level Small Area Poverty Estimates, Philippine Statistics Authority

In view of its crime situation, Pasig City has a varying trend for crime volume through the recent years as shown in **Table B.8**.

**Table B.11: Total Crime Statistics of Pasig City, 2014-2018**

| | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|
| Total crime volume | 6,551 | 2,792 | 9,696 | 2,396 | 9,186 |
| Index Crime | 2,167 | 1,602 | 944 | 851 | 860 |
| Non-Index Crime | 4,384 | 1,190 | 8,752 | 1,545 | 8,326 |
| Crime Solution Efficiency Rating | 65.33% | 55% | 92.79% | 69.37 % | |
| Ave. Monthly Crime Rate (AMCR) | 72.81/mo. | 30.17/mo. | 101.86/mo. | 26.44/mo. | 101.35/mo. |
| Percent of Persons who were Victims of Crimes | 0.87% | 0.36% | 1.28% | 0.32% | 1.22 |

Source: Pasig City Profile 2018

Including barangay crimes, the city has a total of 6,551 crimes in 2014 which fell at 2,792 in the following year. In 2016, in light of the government's relentless campaign against illegal drugs, the city attained its highest total crime volume with 9,696 crimes recorded. Crime statistics is reported in **Table B.8**. The local government centered its actions on anti-criminality initiatives, illegal drug operations, relentless support of force multipliers and the active participation of the community in identifying criminal elements which resulted to lower crimes by 2017. However, it soared again by 2018 due to the high crime incidence i.e. non-index crimes. This includes damaging of properties, physical injuries, drugs, etc. The city's highest number of non-index crime are showed in **Table B.9.**

**Table B.12: Non-Index Crimes**

| Non-Index Crime | Number of Crimes |
|---|---|
| Malicious Mischief (RIR to Damage to Property) | 5091 |
| Physical Injury (Reckless Imprudence Resulting) | 1311 |
| Comprehensive Dangerous Drugs Act of 2002 (R.A. 9165) | 795 |
| Alarms and Scandal | 285 |
| Violation of PD 1602 (Illegal Gambling) | 138 |
| Child Abuse Act (R.A. 7610) | 93 |
| BP BLG. 6 | 91 |
| Lights Threats | 88 |
| Anti-Violence Against Women & their Children (R.A. 9262) | 61 |
| Estafa (Swindling) | 38 |

Source: Pasig City Profile 2018

On the other hand, index crimes were as follows in **Table B.10**.

**Table B.13: Index Crimes**

| Index Crimes | Number of Crimes |
|---|---|
| 1. Murder | 19 |

| | |
|---|---|
| 2. Homicide | 37 |
| 3. Physical Injuries | 193 |
| 4. Rape | 50 |
| 5. Robbery | 122 |
| 6. Theft | 383 |
| 7. Carnapping | 47 |
| 8. Motornapping (Motorcycle theft) | 9 |

Source: Pasig City Profile 2018

For health and sanitation, Pasig City has a fluctuating trends of birth statistics by far. **Table B.11** represents the summary of these indices.

**Table B.14: Birth and mortality rates of Pasig City for 2016, 2017 and 2018**

| INDICES | 2016 | | 2017 | | 2018 | |
|---|---|---|---|---|---|---|
| | Cases | Rate | Cases | Rate | Cases | Rate |
| Crude Birth Rate | 17,381 | 21.81 | 15,397 | 20.32 | 15,480 | 20.23 |
| Crude Death Rate | 3,479 | 4.37 | 3,352 | 4.42 | 3,484 | 4.55 |
| Infant Mortality Rate | 126 | 7.25 | 121 | 7.86 | 115 | 7.43 |
| Maternal Mortality | 8 | 0.46 | 7 | 0.45 | 6 | 0.39 |
| Child Mortality Rate | 39 | 0.40 | 173 | 11.24 | 149 | 9.63 |

Source: Pasig City Profile 2018

The city's crude birth rate was 20.23 in 2018 with 15,480 cases in the year, lower than the past two years. Moreover, the mortality rate in the same year was 4.55 with 3,484 number of deaths. Infant and child mortality rates are higher at 7.43 and 9.63, respectively, with 115 number of children who died under one year of age and 149 children died under five years of age. Maternal mortality, on the other hand, is lower in 2018 compared to the previous year, with 9.63 and 11.24 deaths per 100,000 live births, respectively.

Nutrition amongst the children in Pasig City can also be noted and is shown in **Table B.12**. Majority of children below 5 years of age are considered normal in terms of weight for age (98.22 percent of 76,148 children weighted), weight for height (98.41 percent) and height for age (94 percent of children measured). However, there are children who are recorded to be severely underweight (0.25 percent), obese (0.43 percent), stunted/ short (1.36 percent) and severely stunted (0.62 percent).

**Table B.15: Nutrition Profile of Children less than 5 years of age, 2018 (Weight for Age)**

| Weight for Age | | |
|---|---|---|
| Status | No. | % |
| Normal | 74,793 | 98.22 |
| Underweight | 705 | 0.93 |
| Severely Underweight | 187 | 0.25 |
| Overweight | 463 | 0.61 |

| | | |
|---|---|---|
| Total No. Weighed | 76,148 | 73.72 |

Source: Pasig City Profile 2018

**Table B.16: Nutrition Profile of Children less than 5 years of age, 2018 (Height for Age)**

| Height for Age | | |
|---|---|---|
| Status | No. | % |
| Normal | 72,209 | 94.83 |
| Stunted/Short | 1,032 | 1.36 |
| Severely Stunted | 474 | 0.62 |
| Tall | 2,433 | 3.20 |
| Total no.w/ height measurement | 76,148 | 73.72 |

Source: Pasig City Profile 2018

**Table B.17: Nutrition Profile of Children, 2018 (Weight for Height)**

| Weight for Height | Less than 5 years of age | | Elementary School Pupils | |
|---|---|---|---|---|
| | No. | % | No. | % |
| Normal | 74,934 | 98.41 | 1,271 | 1.95 |
| Wasted | 381 | 0.50 | 3,947 | 6.05 |
| Severely Wasted | 85 | 0.11 | 54,704 | 83.89 |
| Overweight | 423 | 0.56 | 3,928 | 6.02 |
| Obese | 325 | 0.43 | 1,359 | 2.08 |
| Total No. Weighed | 76,148 | 73.72 | 65,209 | 99.66 |

Source: Pasig City Profile 2018

Overall, there are 40 health centers in Pasig City. The ratio of health center to barangay population is shown in Table 14. Specifically, there are 23 health centers in District I and 11 in District II. Also, the city has 4 super health centers and 3 puericulture centers.

**Table B.18: Health Center to Barangay Population Ratio of Pasig City**

| Barangay | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|
| Bagong Ilog | 2:13,693 | 2:14,077 | 2:14,469 | 2:14,872 |
| Bagong Katipunan | 1:2,043 | 1:2,100 | 1:2,159 | 1:2,219 |
| Bambang | 2:14,016 | 2:14,409 | 2:14,810 | 2:15,222 |
| Buting | 1:14,212 | 1:14,609 | 1:15,017 | 1:15,435 |
| Caniogan | 1:37,517 | 1:38,567 | 1:39,642 | 1:40,746 |
| Dela Paz | 2:9,607 | 2:9876 | 2:10,151 | 2:10,434 |

| | | | | |
|---|---|---|---|---|
| Kalawaan | 2:14,583 | 2:14,992 | 2:15,409 | 2:15,838 |
| Kapasigan | 1:11,103 | 1:11,414 | 1:11,732 | 1:12,059 |
| Kapitolyo | 1:10,956 | 1:11,263 | 1:11,577 | 1:11,899 |
| Malinao | 1:6,969 | 1:7,164 | 1:7,364 | 1:7,569 |
| Manggahan | 3:30,735 | 3:31,596 | 3:32,476 | 3:33,380 |
| Maybunga | 2:16,912 | 2:17,386 | 2:17,871 | 2:18,368 |
| Oranbo | 1:5,314 | 1:5,462 | 1:5,615 | 1:5,771 |
| Palatiw | 1:23,398 | 1:24,052 | 1:24,723 | 1:25,411 |
| Pinagbuhatan | 4:15,116 | 4:15,539 | 4:15,972 | 4:16,417 |
| Pineda | 1:29,728 | 1:30,560 | 1:31,412 | 1:32,287 |
| Rosario | 1:75,628 | 1:77,745 | 1:79,912 | 1:82,137 |
| Sagad | 1:9,833 | 1:10,108 | 1:10,390 | 1:10,679 |
| San Antonio | 1:3,687 | 1:3,790 | 1:3,895 | 1:4,004 |
| San Joaquin | 1:18,548 | 1:19,067 | 1:19,599 | 1:20,145 |
| San Jose | 1:3,447 | 1:3,544 | 1:3,643 | 1:3,744 |
| San Miguel | 1:31,290 | 1:32,166 | 1:33,063 | 1:33,983 |
| San Nicolas | 1:3,302 | 1:3,394 | 1:3,489 | 1:3,586 |
| Sta. Cruz | 1:5,978 | 1:6,145 | 1:6,316 | 1:6,492 |
| Sta. Lucia | 2:24,120 | 2:24,796 | 2:25,486 | 2:26,196 |
| Sta. Rosa | 1:2,804 | 1:2,882 | 1:2,963 | 1:3,045 |
| Sto. Tomas | 1:11,456 | 1:11,777 | 1:12,105 | 1:12,442 |
| Santolan | 1:48,110 | 1:49,457 | 1:50,835 | 1:52,251 |
| Sumilang | 2:4,264 | 2:4,384 | 2:4,505 | 2:4,631 |
| Ugong | 1:31,501 | 1:32,383 | 1:33,286 | 1:34,212 |

Source: Pasig City Profile 2018

For hospitals, there are three public hospitals (i.e. Rizal Medical Center, Pasig City General Hospital and Pasig City Children's Hospital) and ten private ones.

Sanitary, on the other hand are impressive. Based on the City Profile in 2018, the percentage of household with safe main source of drinking water is 98 percent and percentage of those with sanitary type of toilet facilities is 99.87 percent. In addition, everyone in Pasig City has availed the city's health care services.

**Table B.19: Performance Standard of Secondary Level Education in Pasig City**

| Secondary Level | PUBLIC | PRIVATE |
|---|---|---|
| Number of Schools | 16 | 58 |
| Number of Teachers | 2,111 | 650 |
| Number of Students | 59,202 | 29,666 |
| Teacher – Student Ratio | 1:39.44 | 1:39.44 |

| | | |
|---|---|---|
| Number of Classrooms | 1,657 | 1,100 |
| Student – Classroom Ratio | 1:43.95 | 1:43.95 |
| No. of Furniture Seats | 40,416 | 40,416 |
| Furniture – Student Ratio | 1:1.065 | 1:1.065 |

Source: Pasig City Profile 2018

With regards to the city's education status, Pasig has a literacy rate of 99.81 percent for population aged 10 years old and over. Notably, female population has higher literacy (51.94 percent) than the male population (48.06 percent). It is observed from Table 15 that there are more private schools in Pasig than public schools. However, public schools have more teachers and students than in private schools.

**Table B.20: Enrollment in Pre-School, Elementary and Secondary Schools both Private and Public.**

| School Year | Pre-School | | | Elementary | | | Secondary | | |
|---|---|---|---|---|---|---|---|---|---|
| | Male | Female | Total | Male | Female | Total | Male | Female | Total |
| 2010-2011 | 5,360 | 5,282 | 10,642 | 48,224 | 47,335 | 95,559 | 27,992 | 29,482 | 57,474 |
| 2011-2012 | 6,041 | 6,156 | 12,197 | 48,498 | 17,390 | 65,888 | 28,048 | 29,415 | 57,463 |
| 2012-2013 | 7,335 | 7,312 | 14,647 | 48,767 | 47,561 | 96,328 | 29,340 | 30,594 | 59,934 |
| 2013-2014 | 8,359 | 8,115 | 16,474 | 53,353 | 51,327 | 104,680 | 29,580 | 31,439 | 61,019 |
| 2014-2015 | 7,811 | 7,699 | 15,510 | 55,978 | 48,981 | 104,959 | 30,411 | 32,469 | 62,880 |
| 2015-2016 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2016-2017 | 7,459 | 7,187 | 14,646 | 45,706 | 44,524 | 90,230 | 57,771 | 36,338 | 94,109 |

Source: Pasig City Profile 2018

## Appendix C. Manual for Constructing the City-level Social Accounting Matrix

### C.1. Introduction

Computable general equilibrium (CGE) models are quantitative analytical tools used to simulate how an economy reacts to economic shocks. CGE models have wide range of applications in international trade, fiscal policy, transport policy, industrial and labor policies, and environmental policy and their results have guided governments and policy makers in crafting policy proposals at the national level (Hosoe et al, 2010).

However, CGE models can also be useful in simulating impacts on subnational economies.[10] For instance, Burnett et al (2007) used a CGE model to simulate the economic impact of tourism increase on economic growth, employment and income distribution in Fort Collins, Colorado. Rokicki et al (2020) used a multi-region CGE model to evaluate the effects of investments in transport in 16 NUTS2 regions in Poland. Xu, et al (2018) also used a spatial CGE model calibrated to Beijing dataset to study the effects of public transport subsidies on social welfare, population distribution, and $CO_2$ emissions. Subnational CGE models are even more useful in evaluating impacts of localized exogenous shocks such as environmental disasters. Gertz et al (2019) used a dynamic CGE model to analyze the impacts of major coastal flood in Metro Vancouver. In the Philippines, Tuaño, Muyrong and Clarete (2016) estimated the impact of Typhoon Ondoy on local economies of Pasig and Marikina cities using a dynamic CGE model. Where they are appropriate, subnational CGE models allow deeper examination of issues and specific characteristics of smaller geographical areas commonly disregarded at national level analyses (Rodriguez, 2007 and Schwarm and Cutler, 2003). Although there have been countless subnational economic studies that use CGE modeling, building a localized model remains difficult primarily because of data limitations (Rodriguez, 2007).

Integral to any empirical CGE model is a social accounting matrix (SAM). Before a CGE model becomes useable, it must be calibrated first. Because a CGE model is actually a system of equations that relates various economic variables, calibration of a CGE model means estimating and fixing the values of coefficients of all its equations based on empirical data (Hosoe et al, 2010). Thus, calibration links the equations representing the behavior of agents in the CGE model to their behavior in the real world.

A SAM is a database that summarizes the flow of resources and economic transactions across producers, households, government, firms, financial institutions, and the rest of the world. In actuality, the SAM takes the form of a square matrix where rows and columns are labeled according to the accounts they represent: economic activities, commodities, households, firms, government, savings-investment and rest of the world.[11] Each cell in the SAM corresponds to payments made by the column entity to the row entity. For instance, the cell corresponding to (Household, Service) refers to payments made by households for services they availed. Similarly, the cell (Agriculture, Manufacturing) is the amount paid by agricultural producers for intermediate inputs such as agricultural equipment produced by manufacturers. The sum of cells along a column is the total expenditure made by the corresponding entity. Meanwhile, the sum of cells in a row is the total income of an economic agent. Row sum and corresponding column sum in a SAM are equal to denote equilibrium.

This paper discusses the procedure adopted in building a city-level SAMs for Pasig and Valenzuela cities. These SAMs will be used in simulating the economic impacts of extreme weather conditions using CGE model to assess their impacts on the local economy. The city-level CGE analysis using the city-level SAM would therefore allow estimating the impacts on various economic variables of the local economy including city-level GDP, prices and output, among others. The rest of the paper is organized as follows: **Part C.2** provides an overview of related literature on building subnational IOs and SAMs; **Part C.3** discusses the sub-matrices of the SAM as well as the accounts and sectors involved; **Part C.4** discusses how the entries of the sub-matrices are obtained from available datasets at city level; **Part C.5** discusses some balancing techniques for SAM; **Part C.6** concludes.

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[10] Rodriguez (2007) provides a list of other studies that used region-specific models.

[11] SAMs can differ in terms of presentation of accounts. For instance, Hosoe et al (2010) merged production and commodities market where as in Cororaton (2003) these are separate accounts. The point of choosing a particular structure for a social accounting matrix is to make calibration easier when the numerical program for a CGE is prepared.

### C.2. Brief Literature Review

Preparation of a SAM for subnational level can be challenging because datasets used to estimate parameters of CGE models are often only available at the national level (Rodriguez, 2007). For instance, in most countries, official input-output (IO) tables, which are integral in building SAMs, are rarely available at subnational levels. Hence modelers are forced to "regionalize" national IO tables to generate estimates of localized sectoral production parameters in CGE because the cost of conducting industry survey to build an IO table is extremely prohibitive (Kronenberg, 2009 and Martana, et al, 2012).

The common technique in building a subnational SAM is deriving from an IO table for a higher geographic level its localized version. In Gertz et al (2019), British Columbia IO table was used to construct an IO for Vancouver in two stages. First, Gertz, et al (2019) estimated Vancouver's sectoral output by multiplying Vancouver's sectoral employment figures to British Columbia's output-employment ratio. Secondly, after obtaining sectoral output, intermediate input values were filled by imputation. This procedure works if average labor productivity in sectors at the provincial level—for which an IO table is available—approximates city-level labor productivity. Gertz et al (2019) argue that since Vancouver accounts for half of British Columbia economy, the error in output estimates should not be large. Burnett et al (2007) adopted the approach proposed by Schwarm and Cutler (2003) to produce a city-level SAM. Their method starts at obtaining the proportions from the IMPLAN IO database which is then applied to city-level dataset on employment, wages, land, capital and local taxes. This approach also yields intermediate inputs of sectors which is then plugged into the SAM.

In Tuaño, Muyrong and Clarete (2016), a city-level SAM used to simulate the effects of typhoon in two cities in Manila was developed in three stages. First, a national SAM for 2009 was built following Cororaton (2003). Second, a regional SAM for National Capital Region (NCR) was produced by scaling down the national SAM using the proportion of NCR GDP to national GDP. Finally, shares of Pasig and Marikina GDP to NCR GDP were used to scale down NCR SAM to produce two city-level SAMs. Since the unit of time in the model is in weeks, the SAM was multiplied by $\frac{1}{52}$ to obtain weekly values.[12] One weakness of this approach however is that in the process of scaling down a national SAM into a city SAM, sectors that do not exist in the city may still be included in the SAM thus causing alterations in the city economic structure. In the case of Tuaño, Muyrong and Clarete (2016), however, this may not be a problem because their SAM only covered 16 major sectors.

The papers discussed above used non-survey methods to produce a subnational SAMs from existing national SAMs. The accuracy of SAMs constructed using non-survey methods is often raised as an issue of concern. Two types of accuracy must be considered in building subnational SAMs (Martana et al, 2012): first is partitive accuracy which concerns the accuracy of each cell of a SAM; and second, holistic accuracy which focuses not on the cells but on whether the entire table represents the main features of an economy (Jensen, 1980).[13] It is difficult to achieve partitive accuracy in constructing subnational SAMs unless one resorts to the "most respectable" method of conducting subnational surveys, thus achieving holistic accuracy is a more modest and realistic goal (Jensen, 1980). However, this does not necessarily mean that partitive accuracy must be dropped as a goal in constructing SAMs because there are ways to produce better estimates of values in SAMs using non-survey methods that approximates the actual structure of local economies. For instance, the use of city-specific data on firm profile which local governments collect annually for administrative purposes can produce good estimates of annual output of sectors. Using proportions from a national IO table, one can compute the intermediate inputs and value added of economic sectors which constitute the IO part of a city-level SAM. In this case, city-level sectors are assumed to exhibit the same production technology as firms at the national level while being consistent not only with the mix of economic activities at the city level but also with the actual output level generated by the local economy. Thus, combining economic data collected by local governments with existing datasets generated from surveys at the national level can balance partitive and holistic accuracy of subnational SAMs.

[12] Tuaño, Muyrong and Clarete (2016) also used other datasets to produce city-level SAMs.
[13] Martana et al (2012) adopted the typologies proposed by Jensen (1980).

### C.3. Sub-matrices of the SAM

**Figure C.1** presents the parts of the Valenzuela and Pasig SAMs. Both SAMs follow the same structure in terms of the main accounts: activity (production account), commodity, factors of production (labor and capital), households (by income decile), firm, government (local government and national government), savings and investment, and rest of the world account.

**Figure C.1. Overview of the Valenzuela and Pasig SAM**

| | Activity | Commodity | Labor | Capital | Household | Firm | Government | Savings-Investment | Rest of the World | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| Activity | | $c^1$ | | | | | | | $r^1$ | $A$ |
| Commodity | $a^1$ | | | | $h^1$ | | $g^1$ | $s^1$ | | $C$ |
| Labor | $a^2$ | | | | | | | | | $L$ |
| Capital | $a^3$ | | | | | | | | | $K$ |
| Household | | | $l$ | $k^1$ | | | | | $r^2$ | $H$ |
| Firm | | | | $k^2$ | | | | | | $F$ |
| Government | $a^4$ | | | | $h^2$ | $f^1$ | | | | $G$ |
| Savings-Investment | | | | | $h^3$ | $f^2$ | $g^2$ | | $r^3$ | $S$ |
| Rest of the World | | $c^2$ | | | $h^4$ | | | $s^2$ | | $R$ |
| Total | $A$ | $C$ | $L$ | $K$ | $H$ | $F$ | $G$ | $S$ | $R$ | |

Source: Based on Cororaton (2003)

Valenzuela and Pasig SAMs also exhibit familiar national income accounting identities that are rescaled to these cities. The city-level gross domestic product (GDP) is represented in the SAMs in two ways: on the expenditure side, the city GDP is the sum of household consumption spending, government consumption, savings-investments, and next exports:

$$GDP = \sum_{i=1}^{n} \left(h_i^1 + g_i^1 + s_i^1 + \left(r_i^1 - c_i^2\right)\right)$$

On the supply side, city GDP can be expressed as the sum of payments to factors of production and indirect taxes paid to the government:

$$GDP = \sum_{i=1}^{n} (a_i^2 + a_i^3 + a_i^4)$$

Although exhibiting the same structure, Valenzuela and Pasig SAMs differ in terms of economic activities covered because what is reflected in the SAMs is based on actual economic activities present in each city. There are 23 economic activities covered in the Pasig SAM and 26 economic activities in Valenzuela SAM as presented in Table 1. Note that there is no one-to-one correspondence between the set of economic activities in Pasig and Valenzuela because the structures of their local economies in terms of economic activities are different. Also, some sectors need to be aggregated to form one sector. For instance, in the absence of actual fishery sector in Pasig, the said activity is merged with agriculture.

**Table C.1. Sectors in Valenzuela and Pasig SAM**

| Pasig | | Valenzuela | |
|---|---|---|---|
| Code | Sector name | Code | Sector name |
| food | Food manufacturing | food | Food manufacturing |
| | | text | Textile, garments and leather |
| | | wood | Wood, bamboo, cane and rattan articles |
| | | papr | Paper and paper products |
| chem | Chemicals | chem | Chemicals |
| rupl | Rubber and plastic | rupl | Rubber and plastic (and non-metallic) products |
| otmn | Miscellaneous manufactures, nec | | |
| | | metl | Metals |
| | | mach | Computer, machinery and equipment |
| | | otmn | Miscellaneous manufactures, nec |
| util | Utilities | util | Electricity, gas and water |
| cons | Construction | cons | Construction |
| trad | Wholesale and retail trade and Maintenance and repair of motor vehicles | trad | Wholesale and retail trade and Maintenance and repair of motor vehicles |
| comm | Transportation service and Communication | tran | Transportation, storage and communication |
| finr | Financial activities and real estate | fina | Financial intermediation |
| | | real | Real estate |
| prst | Business activities | busa | Business activities |
| ppsr | Public Administration and Defense; Compulsory social security | ppsr | Public Administration and Defense; Compulsory social security |
| eduh | Education, health and social work | educ | Education |
| | | heal | Human Health and Social Work Activities |
| otsr | Other service activities, nec | otsr | Other Service Activities, nec |

Source: Authors' construction based on data from city governments

## C.4. Construction of the sub-matrices

*C.4.1 Activities: Intermediate and primary inputs, value added tax on activities*

In figure 1, $A^T$ is a vector of total revenues of economic activities in the city; $a^1$ is an $n \times n$ matrix of intermediate inputs where the elements $a_{ij}^1$ is the value of input $i$ used by sector $j$; $a^{2\prime}$ and $a^{3\prime}$ are vectors of sectoral payments to the primary inputs (i.e. labor and capital); and, $a^{4\prime}$ is a vector of sectoral value added tax payments to government. The values of the elements of $A^T$, which are values of total output produced, are obtained from either city government database of firms or from ASPBI when local government database is not available. Let $A_i$ be an element of $A^T$. Then

$$A_i = \sum_{i=1}^{n} a_{ij}^1 + a_i^2 + a_i^3 + a_i^4$$

The SAM assumes that Pasig and Valenzuela firms use the same production technology used by representative firms in the national input-output matrix. Thus, the elements $a^1$, $a^2$, $a^3$ and $a^4$ are obtained using technical coefficients computed from the input-output matrix.

*C.4.2 Household income and spending*

Household derives income from labor, capital, and remittances from the rest of the world. Labor income $l$ is the sum of wages paid by economic activities, hence $l = L = \sum_{i=1}^{n} a_i^2$. Household receives a portion of capital payments of economic activities as capital income $k_1$ (the rest of capital earnings is paid to firms which will be discussed later).

Capital income of households is obtained from the Family Income and Expenditure Survey (FIES). Household income from remittances from the rest of the world is obtained from FIES as the sum of remittances received from domestic as well as foreign sources.

Household spending on goods, $h^1$ is derived from FIES. To generate household expenditure by goods, a correspondence between input-output sectors and FIES commodities is constructed so that the commodities consumed by households is matched to the number of economic sectors in the SAM.[14] Household income taxes, $h^2$ is obtained from FIES and is directly paid to government. Household savings, $h^3$ is also obtained from FIES as total household deposits.

Instead of using a single representative agent, the SAM has ten households represented by aggregates in each income decile. Consumption of the representative household in a particular decile is the sum of consumption in the said decile. Similarly, the total income of the representative household in a certain decile is the sum of all incomes of households in that decile. The capital earnings of households in a decile is equal to the aggregate capital earnings of households in each decile which is obtained directly from the FIES. Wage is distributed across representative households using weights computed from wage incomes of households in each decile. Let $W$ be the total earnings of households from FIES-LFS such that $W = W^1 + W^2 + \cdots + W^{10}$ where $W^i$ is the aggregate earnings from labor of households in decile $i$. To distribute labor income from economic activities, shares of deciles in total wage income of households in FIES is computed and multiplied to total labor income $L$. Thus, the wage earning of household in decile $i$ is $l^i = w^i L$ where $w^i = \frac{w^i}{W}$ is the share of wage income of decile $i$ to total wage income of all households.

*C.4.3 Firm income and spending*

There is only one representative firm in the SAM. The firm derives income from capital earnings which is computed residually, i.e. $k^2 = K - k^1$. The firm pays government taxes and saves the rest of its income. Tax payments of the firm is equal to tax revenues obtained from BLGF.

*C.4.4 Government income and spending*

Government entity receives income mainly from value added taxes paid by economic activities ($a^4$), income taxes from households ($h^2$), income taxes from firms ($f^1$). Government can also receive income from savings/investments, if there is any. In the actual SAM, there are two government: local government and national government.[15] Local governments derive income from local taxes and fines paid by firms, and transfers from the national government. The national government receives value added taxes from economic activities (computed by distributing sectoral output as discussed above), and income taxes from households (obtained from FIES) and firms (obtained from BLGF).

The only expenditure item of the national government is transfers to local government which is obtained from BLGF. Local government spending is also derived from the BLGF. Note that the total output of public administration sector is equal to the public administration spending of local government.[16]

*C.4.5 Savings-investment*

City-level savings are recorded in the SAM as $S$ and this is the sum of savings of households $h^3$, firms $f^2$, government savings $g^2$, if any, and savings from rest of the world $r^3$. While household and government savings are obtained from databases, firm savings and savings from rest of the world are obtained residually. For firm savings, $f^2 = F - f^1$. Savings from the rest of the world $r^3$ is derived from the BOP by using the ratio of number of firms in the city of interest to number firms in the Philippines as weight. Meanwhile, savings flowing out to the rest of the world $s^2$ is derived residually.

*C.4.6 Rest of the world*

[14] Note that there may be economic activities that do not exist in the cities of interest, i.e. there is no production taking place, but these economic activities are still included in the SAM because there is consumption of products of such economic activities.
[15] This distinction is made to isolate the effects of policies carried out by local governments.
[16] The total output of public administration is distributed across the inputs the same way as in other sectors, i.e. using technical coefficients from the national input-output matrix.

The "rest of the world" in the context of a city-level SAM refers to all other places outside the cities of interest (Pasig and Valenzuela). ROW includes even neighboring cities of Pasig and Valenzuela. Various datasets at the national level are readily accessible to construct the rest of the world account. Foremost of these datasets is the balance of payments accounts that track flows of values from foreign to domestic and vice versa. National income accounts and the input output matrix also contain data about imports and exports of goods. Unfortunately, no dataset that tracks flows of values across cities exists. Perhaps the closest to external account that is available is the Commodity Flow Accounts although this dataset accounts flows across regions and not across cities. Due to absence of data, trade flows that will complete the rest of the world account for a city-level SAM will be estimated.

Exports $r^1$ is derived from flows of commodities. Since the values in flows of commodities represent flows to and from regions, imports and exports at city level are estimated as follows:

For imports of commodity $i$,

$$c_i^2 = \frac{n_i}{n_{i,ncr}} \cdot M_{i,ncr}$$

where $n_i$ is the number of sector $i$ enterprises in the city, $n_{i,ncr}$ is the total number of sector $i$ enterprises in NCR, $M_{i,ncr}$ is the import of commodity $i$ in NCR.

Exports $X_i$ are obtained similarly,

$$r_i^1 = \frac{n_i}{n_{i,ncr}} \cdot X_{i,ncr}$$

The number of sector $i$ firms in city is obtained from city database of enterprises. The number of firms in NCR is obtained from ASPBI. Imports and exports of commodities are obtained from the flows of commodities.

Data from the flows of commodities will suffice in building small SAMs where there are only few sectors involved. However, in the case of Pasig and Valenzuela, the number of commodities are more than the number reported goods in flow of commodity accounts, hence failing to capture the entire picture of trade. This is addressed by assuming that if the production of a certain good in the city is less than the total consumption of the said good, the city imports amount of goods equivalent to the shortfall. Likewise, if in the city production exceeds the amount of goods consumed, then the city exports the surplus to the rest of the world. These assumptions are convenient in cases where there are commodities and services that are not reflected in the flow of commodities account.

*C.4.7 Commodities*

The domestic supply of commodities is the diagonal matrix $c^1$ where the diagonal entries are the domestic supply of commodities. The diagonal elements of $c^1$ are obtained residually, i.e. $c_i^1 = C_i - c_i^2$ if consumption exceeds domestic production, and $c_i^1 = A^i - r_i^1$ if domestic production exceeds consumption.

### C.5. Balancing techniques

A balanced SAM where the column sum equals the corresponding row sum implies equilibrium in the economy. Column and row sums equality is required in standard CGE models.[17] However, due to discrepancies in various data sources, a SAM will unlikely emerge balanced. Some balancing techniques are useful in these cases.

Hosoe, Gasawa and Hashimoto (2010) proposes the following constrained minimization problem to balance a SAM:

$$\min \omega = \sum_i \sum_j \left( \frac{x_{ij} - x_{ij}^0}{x_{ij}^0} \right)^2$$

subject to

[17] In standard CGE models, parameters are derived from the SAM. If the SAM is balanced, the solution of a CGE model without shocks will reproduce the values in the SAM, thus exhibiting equilibrium.

$$\sum_j x_{ij} = \sum_j x_{ji} \quad \forall i$$

where $i, j$ are the row and column labels in the SAM, $x_{ij}$ is the value in $i$th row and $j$th column of the adjusted SAM, and $x_{ij}^0$ is the value in $i$th row and $j$th column of the original (unbalanced) SAM. Some values in the SAM are zero. In practice, terms where $x_{ij}^0 = 0$ are ignored because they render the objective function undefined so $x_{ij} = 0$ for these terms. This optimization problem can be solved numerically using various techniques.[18]

Another common method used in balancing SAM is the RAS method. Let $A^0$ be the original matrix. The objective of the RAS algorithm is to find anew matrix $A^1$ that has the same dimension as the original by applying row and column multipliers to the original matrix.[19] RAS is popular because of the simplicity of its iterative process, however, it has disadvantages. Fofana, Lemelin and Cockburn (2005) argues that adjustments in SAM done through the RAS method lacks economic foundation. Moreover, since multipliers change all the elements of rows, it is impossible to hold cell values that are deemed accurate or introduce new values when data become available.

**C.6. Conclusion**

SAMs are integral component of CGE models. While construction of national level SAMs is straight forward due to availability of datasets, CGE modeling at the subnational level is challenging mainly because most of these datasets required to build a subnational SAM are absent. Because of this, modelers are forced to produce SAMs by estimating the values each cell must have while keeping accuracy of estimates in mind.

This paper proposed a procedure that can be used to build a SAM for a city-wide economy. This paper also presented various datasets as well as data sources that can be used to estimate the values in a city-level SAM. Just as in building a national SAM, a subnational SAM may result in imbalance. To address this, this paper presented two ways by which an unbalanced SAM is corrected.

Non-survey methods to construct subnational SAMs still has a lot of rooms for improvement. This paper intends to encourage more work on this area to fill in the gaps in estimation of SAMs and raise the level of accuracy of these estimations.

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18 Iterative methods are typically used in numerical solutions to these problems. The simplest one is by using steepest descent method, although it is also possible to convert this problem into an unconstrained one.

19 Fonana, Lemelin and Cockburn (2005) provide a concise presentation of the RAS methodology.

## C.7 References


Burnett, P. H. Cutler and R. Thresher. 2007. The impact of tourism for a small city: A CGE approach. *The Journal of Regional Analysis and Policy*. No. 37(3): 233-242.

Castillo, Rolly Czar Joseph, Ramon Clarete, Marjorie Muyrong, Philip Arnold Tuaño, and Miann Banaag. 2018. Assessment of TRAIN's Coal and Petroleum Excise Taxes: Environmental Benefits and Impacts on Sectoral Employment and Household Welfare. *Philippine Institute for Development Studies Discussion Paper* No. 2018-41.

Cororaton, C. 2003. "Construction of Philippine Social Accounting Matrix for the Use of CGEMicrosimulation Study," Poverty and Economic Policy working paper http://www.pepnet.org/sites/pep-net.org/files/typo3doc/pdf/reconciliation-Philippines.pdf, (Accessed on July 15, 2018)

Fofana, I., A. Lemelin and J. Cockburn. 2005. Balancing a social accounting matrix: Theory and application.

Gertz, A. B., Davies, J. B., & Black, S. L. 2019. A CGE Framework for Modeling the Economics of Flooding and Recovery in a Major Urban Area. Risk Analysis. doi:10.1111/risa.13285

Hosoe, N., K. Gasawa and H. Hashimoto. 2010. Textbook of computable general equilibrium modeling: Programming and simulations. Palgrave Macmillian.

Jensen, R. 1980. The concept of accuracy in regional input-output models. *International Regional Science Review*. 5(2). 139:154.

Kronenberg, T. 2009. Construction of regional inpu-output tables using nonsurvey methods: The role of cross-hauling. *International Regional Science Review*. Vol. 32 No. 1. January 2009. 40:64.

Martana, K. D. Evison, J. Lennox and B. Manley. 2012. Constructing a regional social accounting matrix using non survey method for CGE modeling. New Zealand Agricultural and Resource Economics Society. Paper presented at 2012 NZARES Conference, New Zealand. August 30-31, 2012.

Rokicki, B., E. Haddad, J. Horridge and M. Stepniak. 2020. Accessibility in the regional CGE framework: The effects of major transport infrastructure investment in Poland. *Transportation* (2020).

Rodriguez, U. 2007. State-of-the-art in regional computable general equilibrium modeling with a case study of the Philippines. *Agricultural Economics Research Review*. Vol. 20. January-June 2007. 1:28.

Schwarm, W., & Cutler, H. 2003. Building Small City and Town Sams and CGE Models. *Review of Urban and Regional Development Studies*, 15(2), 132–147.

Tuaño, Philip Arnold P., Marjorie S. Muyrong, and Ramon L. Clarete. 2016. Economic Impact of Typhoon Ondoy in Pasig and Marikina Cities Using a Multiweek CGE Model Analysis. *Philippine Journal of Development*, 43 (2): 1-24.

Xu, P. W. Wang and C. Wei. 2018. Economic and environmental effects of public transport subsidy policies: A spatial CGE model of Beijing. *Hindawi Mathematical Problems in Engineering*. Vol. 2018. Pp12.

## Appendix D. Rainfall Impacts on Value Added using Panel Econometric Analysis

### D.1. Introduction

The impacts of climate change-related variables on households is well-studied in the Philippines and abroad. However, little is known on the impacts of, say, windspeed or rainfall exposure on the production activities of firms. Flooding events not only affects households but also firms. Not only are people unable to go to work because of the floods, firms may also be forced to stop their operations. However, in extreme climate change events like Tropical Storm Ketsana (known locally as "Ondoy") that inundated most of the Philippines' National Capital Region (NCR) and its neighboring areas in 2009, little remains understood on the impacts on firms. Understanding the economic impacts of climate change therefore involve understanding how firms' value-adding activities are affected.

Flooding data, however, remains unavailable in the Philippines. Understanding the impacts of climate change events therefore has involved the use of data on windspeed or rainfall. The current study therefore exploits the rainfall data across provinces made available by the Manila Observatory from the satellite-based rainfall data. Specifically, the study explores the impacts of rainfall exposure on the value added of firms as measured by returns to capital and labor compensation.

### D.2. Review of Literature

The literature on the economic impacts of extreme climate events has been extensive. It is now understood that climate change as a result of global warming have impacts not only on biodiversity but also in urban situations. Various papers have studied the types of risk and resilience plans and programs implemented across different countries in response to climate-related disasters. Various econometric strategies, on the other hand, have focused on the impacts of climate change variables but only among households. However, there remains little understanding on the impacts on the production activities of firms, not only in the Philippines but in other countries as well.

#### *D.2.1. Policy issues in climate change*

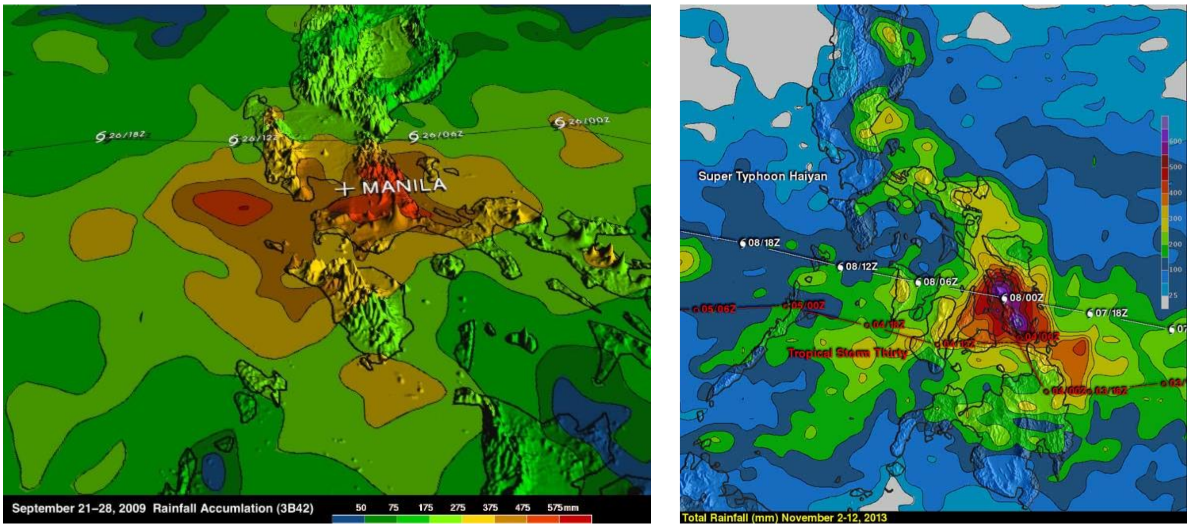
There is now consensus that the recent global warming due to anthropogenic causes has resulted in the "long-term changes in the climate system", i.e. the so-called climate change (IPCC 2018, 5). Global warming of 1.5°C above pre-industrial (1850-1900) level is projected to lead to extreme climates which includes incidences of heat waves and droughts in some regions while several regions experiencing heavy rainfall. The continuous battle of California in the United States against drought and forest fires today and the continuous onslaught of stronger typhoons experienced not only in the Pacific but also in the Atlantic reveal truths about climate change.

While IPCC (2018) highlights the extreme impacts on biodiversity in lands and oceans due to higher temperatures, they do not fail to explain that endangerment and extinction of various animal species will have great impacts on human lives too as we start to lose free environmental services. These ecosystem impacts, in turn, not only affect not only the welfare of the most vulnerable of the populations—those dependent on agricultural and coastal livelihoods—but also constrain economic growth for all.

In the Philippines, the impacts of climate change are demonstrated by two of the most infamous typhoons in the recent history of the county (**Figure D.1**). In September 2009, Tropical Storm Ketsana inundated the country's National Capital Region (NCR) with 454.9 millimeters (17.91 inches) of rain recorded at PAGASA Science Garden, Quezon City, NCR in just 24 hours with a month's worth of rain 341.122 millimeters (13.43 inches) falling in Manila in 6 hours between 8:00 a.m. and 2:00 p.m. on September 26, 2009.20 After four years, Super Typhoon Haiyan (known locally as "Yolanda") struck the Eastern Visayas region on November 8, 2013 with windspeed close to 315 kilometers (195 miles) per hour bringing along tsunami-like storm surge to the islands of Leyte and Samar.21

[20] See NASA Report on October 1, 2009 at https://www.nasa.gov/mission_pages/hurricanes/archives/2009/h2009_Ketsana.html
[21] See NASA Report on November 14, 2013 at https://www.nasa.gov/content/goddard/haiyan-northwestern-pacific-ocean/

**Figure D.1. Tropical Storm Ketsana (2009) and Super Typhoon Haiyan (2013)**




Credit: Hal Pierce, SSAI/NASA GSFC

While Tropical Storm Ketsana will be infamously remembered for the muddy floods that inundated the cities in the capital region, Super Typhoon Haiyan is infamously remembered for the great destruction it caused. Both will be remembered for the tremendous loss in human lives.

The recovery and reconstruction that followed these tropical cyclones however highlights the persistent issues of transient poverty due to impacts to livelihoods as well as the more persistent constraints to economic growth. While extensive reports have been made by the country's National Disaster Risk Reduction and Management Council (NDRRMC) on direct costs of all typhoons that fell in the country, the indirect impacts on the entire economy are not well-understood. As Wilbanks, et al. (2007, 361) explain, the impacts of climate events on the economy will be "through economic sectors affected by changes in input resource productivity or market demands for goods and services, through impacts on certain physical infrastructures, and through impacts of weather and extreme events on the health of populations." As Tuaño, Muyrong, and Clarete (2016, 3) put it another way, there will be not just direct costs of climate disasters, but also indirect costs associated with a decrease productivity of primary inputs and economy-wide 'secondary' costs captured by reduction in GDP, increase in prices, increased fiscal deficits, among others. In other words, the impacts of climate disasters will not just reverberate across the various sectors of the economy, but also through time as people mourn their losses and government and firms start recovery and reconstruction.

*D.2.2. Micro-level impacts of climate change*

Empirical methodologies looking at the impacts of climate change focus on regression analysis on incomes and expenditures. These studies take advantage of household or individual-level data that they can match with exposure to climate shocks.

Wishing to estimate the post-disaster impacts of climate events on Filipino households, Antilla-Hughes and Hsiang (2013) implemented a difference-in-difference (DID) methodology on a province and regional-level dataset using the Family Income and Expenditure Survey (FIES) and National Demographic and Health Survey (NDHS) with province-level windspeed as the treatment variable. Taking advantage of wind field data for every West Pacific typhoons from the International Best Track Archive for Climate Stewardship (IBTrACS) database using a model called Limited Information Cyclone Reconstruction and Integration for Climate and Economics (LICRICE), Antilla-Hughes and Hsiang were able to construct a province-level maximum windspeed exposure in meters per second (m/s). In this case, windspeed incidence may either be some positive value for provinces affected by the typhoon or zero for provinces not affected by the typhoons, allowing for DID. They found that, given the average typhoon exposure in the Philippine (16.9 m/s), typhoon exposure decreases average household income by 6.6 percent and expenditures by 7.1 percent. Even more interesting is that their analysis found that female infant mortality is significantly affected the year after typhoon exposure with as much as 15-to-1 ratio compared to the infants who died during the typhoon. Their results suggest that

Filipino households discount the future through reduction in human capital investment. As it turns out, these human capital disinvestments affect female infants more than male infants thereby suggesting intra-household gender bias.

Focusing instead on the rainfall shocks-poverty nexus, Bayudan-Dacuycuy and Baje (2017; 2019) turned their analysis on the impacts of rainfall shocks and other weather-related variables not just on chronic and transient poverty rates as well as on wages. Using data from FIES and the Annual Poverty Indicators Survey (APIS), Bayudan-Dacuycuy and Baje (2017) first implemented a generalized linear model (GLM) since poverty estimates are between 0 and 1 making them bounded dependent variables. These poverty estimates were ran on weather data from PAGASA: temperature, heat index and rainfall. They found that rainfall deviation from normal level (i.e. rainfall shocks) has the most impact on total and food chronic poverty incidences. An extension of the original study, Bayudan-Dacuycuy and Baje (2019) then implemented a simultaneous equations model (SEM) on more deeply investigate how rainfall shocks impact poverty incidence by first estimating impact of rainfall shock on income and wages, $z_i$, before using the latter variables as regressors for poverty alongside control variables, $z_i$:

$$Y_i = \varphi + \gamma \cdot rainfall\, shock_i + e_i$$

$$poverty_i = \alpha + \delta \cdot \hat{Y}_i + \phi \cdot z_i + \varepsilon_i$$

Rainfall shocks are computed as standard deviations (SD) from the mean allowing for binary variables depending on whether rainfall measure is within +1 SD from normal rainfall, -1 SD or -2 SD. They highlight that weather shocks are likely to reduce income through forgone earnings especially in the case of rural households wherein negative rainfall shocks that can affect crop yield that lead to reduction in rural agricultural wages by an average of 1.169% for provinces whose rainfall shock is -2 SD away from normal. However, the impact of either positive or negative rainfall shocks vary across types of wages.

A similar study was implemented using individual-level data for people residing in the US Gulf Coast when Hurricanes Katrina and Rita struck in the third quarter of 2005 (Groen, Kutzbach, and Polivka 2019). Using a dummy variable that tracks whether the individual was affected by the typhoon and whether the data point was recorded at certain quarters before or after the typhoon, they implement a quasi-experimental technique that divides the population into those affected by the storms and those who were not. They find that long-term differences between individuals' earnings can be explained by differences in wage growth between areas affected and not affected by the storms.

*D.2.3. Macro-level impacts of climate change*

Masson, et al. (2014, 410) explains that a city's complexity arises from being a "concentration of population and capital stocks (housing, production, water delivery, transportation and infrastructures) that comprises a complex system with social, economic and environmental aspects." Urban spaces require special planning for adaption according to Carter, et al. (2015, 4) because of the following: (1) continued urbanization, (2) unique micro-climates inside cities, and (3) network of large populations and material and cultural assets in a very small space.

Cities therefore take a central role in economic growth and development being the hub for various economic production and innovation signaling the need for cities to adapt to climate change to maintain these activities. High temperature inside cities (i.e. heat island effect, the potential of flooding due to cemented surfaces, among other things, therefore not only require planning to mitigate their effects in the short run, but also require adaptation measures. In addition to this, it is found that vulnerability of urban areas is going to be a confluence of the location, he economy and the size of the urban settlement (Wilbanks et al. 2007, 361). In this case, big cities located at coastal or riverine areas whose economies are driven by sectors dependent on climate and weather are most at risk.

In response to this need for localized studies that can be designed to inform local policymakers, Tuaño, Muyrong, and Clarete (2016) implemented a CGE analysis of the impacts of Typhoon Ondoy in the cities of Pasig and Marikina by. The study's methodology began with the construction of a city-level social accounting matrix (SAM) that provides a snapshot of the city's economy at a given year. The equilibrium scenario is then calibrated and changes in this equilibrium scenarios are designed to simulate who various types of macroeconomic variables (e.g. output, supply, prices, government spending) change across sectors as a result of changes brought by the climate change event. For the case of this study, the impact of Typhoon Ondoy (or the storms caused by Habagat that happened October 2009) enter the model through its impacts on the availability of labor, capital and raw materials over time with recovery estimated at a weekly basis. The study highlights that both cities may have lost a total of PHP 22.54 billion, 90 percent of which represent the loss of Pasig City. Taking advantage of the so-called equivalent variation (EV) of income embedded in the microeconomic model of the CGE, they also estimate how much people may be willing to pay in order to not suffer from the consequences of extreme flooding. For the case of Pasig, it is estimate that the residents must be willing to pay PHP 12 billion, the cumulative value of their welfare change from baseline over 28 weeks. The case of Marikina City however showed increase in overall welfare by a cumulative sum over 16 weeks before returning to normal which may be explained due to the reduction in prices that resulted in the city's CGE model as a result of changes in labor and capital availability.

**D.3. Research Methodology**

Analyzing GDP as a measure of national production is tied with the concept of value added. At the microeconomic level, a firm's actual level production is measured in terms of its value added, the "value of a producer's output minus the value of the intermediate goods that the producer buys to make the output" (Mankiw 2017, 494).

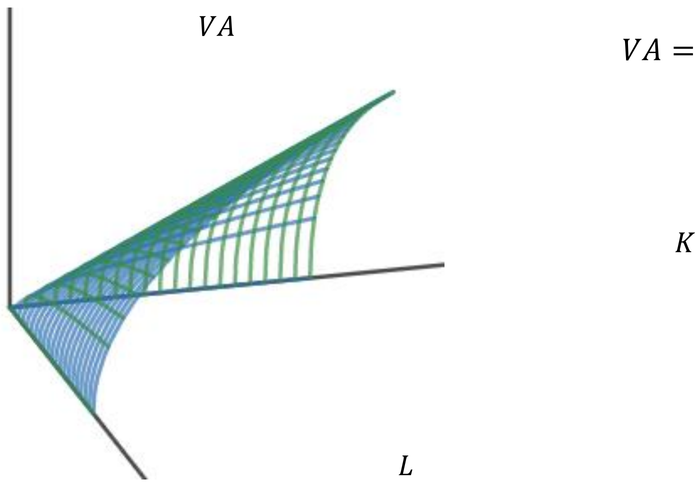
*D.3.1. Theoretical framework*

Intermediate goods refer to raw materials and auxiliary services purchased by firms. These intermediate inputs are transformed into another good or service by the firm. Final commodities, on the other hand, are purchases made for consumption rather than transformation. The value added is therefore differentiated from a firm's gross output. If we sum up the value added of related firms, the sectoral value added is computed. Hence, for every firm, the value added can be expressed as: $Value\ Added = Gross\ Output - Intermediate\ Costs$

Therefore, when we measure production in economics, it specifically refers to the value of the work that has gone into transforming intermediate inputs into a higher-value goods. With that said, GDP by value-added approach, demonstrates that GDP is also measure of national income. As the equation above suggests, value added refers to the value created by labor and capital (i.e. the factors of production) to transform intermediate inputs into higher-value products. To put it another way, the sources of value added in the production process are the capacities of labor and capital to transform intermediate inputs to outputs. As **Figure 2** above therefore shows, higher labor and capital leads to higher output, subject to diminishing marginal productivity according to microeconomic theory. The production function can therefore be expressed as $Value\ Added = f(L, K)$.

The impact of rainfall exposure, indicated by $R$, to the value added is therefore a reduction in productivity which shifts the production function inwards. It can therefore enter the production function as a multiplier: $Value\ Added = R \bullet f(L, K)$. Capital can be further divided into physical capital owned by firms and public infrastructure provided by government.

**Figure D.2. Two-input production function**




$VA = R \bullet f(L, K)$

Source: Graphed using www.desmos.com.

*D.3.2. Empirical framework and data used*

The study implements a fixed effects panel regression using firm-level information from the Annual Survey of Philippine Business and Industry (ASPBI) from period 2013-2016 alongside municipal-level data from the Department of Trade and Industry's Cities and Municipalities Competitiveness Index (CMCI), and satellite-based rainfall exposure from the Tropical Rainfall Measuring Mission (TRMM), which has more spatial coverage compared to weather stations of the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA).

In the data that will be used in the regression analysis, the main dependent variable is the natural logarithm of value added of firms computed from the value of the firm's gross output less than the cost intermediate inputs. Value added is then divided into labor compensation which measures the value added from the employees and returns to capital which measures the value added from the firm's physical assets. Natural logarithm of labor compensation and returns to capital are used. This allows empirical model to obtain percent changes in value added.

Following the production function framework discussed above, the independent variables include number of persons employed by the firm as well as the book value of the sum of both tangible and intangible assets. Like value added, the natural logarithms of these variables are also used in the empirical model.

Firm-level characteristics included in the model are the age of the firm and a binary variable for whether the firm is Filipino-owned or not. Municipal-level characteristics are related to the local government unit. The value of infrastructure investments per municipality is used. The natural logarithm infrastructure spending is also used in the empirical model.

The variable measuring rainfall exposure used in the model is the mean rainfall measured per municipality. The data as measured in millimeters (mm). Furthermore, the model specification involves dummy variables indicating the severity of rainfall exposure as compared to the average per region. Specifically, two dummy variables are used to measure exposure of a municipality to rainfall shock above positive 1 standard deviation and 2 standard deviations away from the mean rainfall per region.

As explained earlier in the conceptual framework, when climate change events occur, their impact on production enters through their impact on value added from labor and capital. Economic production falls because labor and capital availability are affected thereby affecting the capacity of firms to transform its intermediate inputs into higher-value goods. In this case, the empirical methodology would therefore include rainfall directly affecting economic production and interacting with labor and capital availability to indirectly impact economic activity. The baseline model can be expressed as:

$$Value\ added_i = \varphi + \gamma_1 \cdot L_i + \gamma_2 \cdot K_i + \gamma_1 \cdot rainfall_i + \theta_1 \cdot {z_i}^1 + \theta_2 \cdot {z_i}^2 + e_i$$

**Table D.1. Econometric framework**

| Model | | $Value\ Added = f(L, K, rainfall)$ | Unit | Level | Source |
|---|---|---|---|---|---|
| Dependent variables | | | | | |
| | ln_va | Value added | PHP | Firm | ASPBI |
| | ln_returns | Returns to capital | | | |
| | ln_comp | Labor compensation | | | |
| Independent variables | | | | | |
| | ln_employed | Employment | Persons | Firm | ASPBI |
| | ln_assets | Book value of tangible assets | PHP | Firm | ASPBI |
| | mean_rainfall | Rainfall | mm | Municipality | TRMM |
| | i1 | Exposure to rainfall shock above + 1-stdev | dummy | Municipality | TRMM |
| | i2 | Exposure to rainfall shock above + 2-stdev | dummy | Municipality | TRMM |
| Firm characteristics ${z_i}^1$ | | | | | |
| | age | Age of firm | years | Firm | ASPBI |
| | fil | Filipino ownership | dummy | Firm | ASPBI |
| Municipal characteristic ${z_i}^2$ | | | | | |
| | ln_infra | Infrastructure investments | PHP | Municipality | HDI |

Source: Authors' calculations.

**D.4. Results and Discussion**

**Table D.2** below shows the results. The first three models estimate the baseline model above. Initial finding show that age of firm is not significant in determining value added as well as Exposure to rainfall shock above 1 standard deviation away from the regional mean rainfall. The next three models run not only value added on the independent variables but also labor compensation and returns to capital. For every 1 mm of rainfall measured, value added decreases by 0.093% according to model, capital returns decrease by 0.105%, and compensation decrease by 0.016% according to model. This must mean that the impact of rainfall exposure is more significant on returns to capital compared to impact on labor compensation.

As it can be expected, the impacts of rainfall exposure on value added comes mostly from its impacts on value added from physical assets. The results suggest that value-adding activities of firms are affected by rainfall exposure when labor efforts of employees are funneled towards cleaning and repair of capital. As employees are still compensated despite their non-productive work after rainfall exposure, value-adding capacities of a firm's physical assets are affected due to rainfall exposure.

**Table D.2. Model results**

| VARIABLES | (1)<br>ln_va | (2)<br>ln_va | (3)<br>ln_va | (4)<br>ln_va | (5)<br>ln_return | (6)<br>ln_comp |
|---|---|---|---|---|---|---|
| ln_employed | 0.774*** | 0.774*** | 0.774*** | 0.774*** | 0.729*** | 0.957*** |
| | (0.016) | (0.016) | (0.016) | (0.016) | (0.018) | (0.009) |
| ln_assets | 0.242*** | 0.242*** | 0.242*** | 0.241*** | 0.260*** | 0.142*** |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.010) | (0.005) |
| ln_infra | 0.079*** | 0.078*** | 0.078*** | 0.079*** | 0.060*** | 0.054*** |
| | (0.011) | (0.011) | (0.011) | (0.010) | (0.011) | (0.006) |
| mean_rain | -0.097*** | -0.103*** | -0.095*** | -0.093*** | -0.105*** | -0.016*** |
| | (0.009) | (0.011) | (0.009) | (0.009) | (0.010) | (0.006) |
| age | -0.000 | -0.000 | -0.000 | | | |
| | (0.000) | (0.000) | (0.000) | | | |
| fil | -0.486*** | -0.482*** | -0.487*** | -0.487*** | -0.516*** | -0.350*** |
| | (0.079) | (0.079) | (0.079) | (0.078) | (0.105) | (0.036) |
| i1 | | 0.051 | | | | |
| | | (0.042) | | | | |
| i2 | | -0.292*** | -0.257*** | -0.255*** | -0.265** | -0.045 |
| | | (0.100) | (0.096) | (0.096) | (0.105) | (0.067) |
| Constant | 9.055*** | 9.111*** | 9.064*** | 9.047*** | 9.426*** | 8.594*** |
| | (0.261) | (0.262) | (0.261) | (0.258) | (0.285) | (0.146) |
| Observations | 23,962 | 23,962 | 23,962 | 24,104 | 21,523 | 33,142 |
| Number of TIN_id | 17,788 | 17,788 | 17,788 | 17,864 | 16,368 | 21,803 |
| Adjusted R-squared | 0.581 | 0.582 | 0.582 | 0.581 | 0.575 | 0.696 |

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Authors' calculations

**D.5. Summary and Conclusions**

The study exploits municipality-level rainfall data to understand rainfall exposure impact on value added of firms. Using fixed-effects panel data econometric analysis, estimates show that rainfall exposure affects production activities of firms through its impacts on returns to capital. For every 1 mm of rainfall measured, value added decreases by 0.093% according to model, albeit the impact of rainfall exposure is more significant on returns to capital compared to impact on labor compensation.

## D.6 Bibliography


Anttila-Hughes, Jesse Keith, and Solomon M. Hsiang. 2013. “Destruction, Disinvestment, and Death: Economic and Human Losses Following Environmental Disaster.” *SSRN Electronic Journal*, no. 415. https://doi.org/10.2139/ssrn.2220501.

Bayudan-Dacuycuy, Connie, and Lora Kryz Baje. 2017. “Chronic and Transient Poverty and Weather Variability in the Philippines: Evidence Using Components Approach.” 2017–24. PIDS Discussion Paper Series. https://pidswebs.pids.gov.ph/CDN/PUBLICATIONS/pidsdps1724.pdf.

———. 2019. “When It Rains, It Pours? Analyzing the Rainfall Shocks-Poverty Nexus in the Philippines.” *Social Indicators Research* 145 (1): 67–93. https://doi.org/10.1007/s11205-019-02111-1.

Groen, Jeffrey, Mark Kutzbach, and Anne Polivka. 2019. “Storms and Jobs: The Effect of Hurricanes on Individuals’ Employment and Earnings over the Long Term.” *Journal of Labor Economics*, no. March. https://doi.org/10.1086/706055.

IPCC. 2018. “Summary for Policymakers SPM.” In Global Warming of 1.5°C. An IPCC Special Report on the Impacts of Global Warming of 1.5°C above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, edited by V. Masson-Delmotte, P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, et al., 32. Intergovernmental Panel on Climate Change (IPCC). https://www.ipcc.ch/site/assets/uploads/sites/2/2019/05/SR15_SPM_version_report_LR.pdf.

Mankiw, N Gregory. 2017. *Principles of Economics*. 8th ed. Boston.

Masson, V., C. Marchadier, L. Adolphe, R. Aguejdad, P. Avner, M. Bonhomme, G. Bretagne, et al. 2014. “Adapting Cities to Climate Change: A Systemic Modelling Approach.” *Urban Climate* 10 (P2): 407–29. https://doi.org/10.1016/j.uclim.2014.03.004.

Tuaño, Philip, Marjorie Muyrong, and Ramon Clarete. 2016. “Economic Impact of Typhoon Ondoy in Pasig and Marikina Cities Using a Multiweek CGE Model Analysis.” *Philippine Journal of Development* 43 (2).

Wilbanks, Tom, Patricia Romero Lankao, Manzhu Bao, Frans Berkhout, Sandy Cairncross, Jean-Paul Ceron, Manmohan Kapshe, Robert Muir-Wood, and Ricardo Zapata-Marti. 2007. “Industry , Settlement and Society.” In *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution OfWorking Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, edited by M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linder, and C.E. Hanson, 357–90. Cambridge: Cambridge University Press.